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July 15, 2016

Mr. Darrell Nitschke
Executive Director
NORTH DAKOTA PUBLIC SERVICE COMMISSION
600 E. Boulevard Avenue, Dept. 408
Bismarck, ND 58505-0480

Re: Glacier Ridge Wind Farm Application for Certificate of Site Compatibility
Case No. PU-16-___

Dear Mr. Nitschke:

Please find enclosed for filing an original and ten copies of Glacier Ridge Wind Farm, LLC's application for a Certificate of Site Compatibility, along with an electronic copy of the application on CD. Glacier Ridge Wind Farm, LLC, a subsidiary of Renewable Energy Systems Americas Inc., respectfully submits this application to the North Dakota Public Service Commission pursuant to Chapter 49-22 of the North Dakota Century Code and Article 69-06 of the North Dakota Administrative Code. Pursuant to Section 49-22-22 of the North Dakota Century Code, a check in the amount of $100,000.00 for the filing fee is being submitted separately.

Glacier Ridge Wind Farm, LLC is proposing to build a wind farm of up to 300.15 megawatts to be located in Barnes County, North Dakota. The Glacier Ridge Wind Farm would include a project area of approximately 34,450 acres approximately 5 miles northeast of Valley City in Barnes County.

Very truly yours,

Sara E. Bergan
Sarah Johnson Phillips
Andrew J. Pieper
Attorneys for Glacier Ridge Wind Farm, LLC

Enclosures

1 PU-16-539 Filed 07/19/2016 Pages: 367
Application for Certificate of Site Compatibility
Glacier Ridge Wind Farm, LLC
Sara Bergan, Attorney

Glacier Ridge Wind Farm
Glacier Ridge Wind Farm, LLC
Barnes County, North Dakota

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

July 2016

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TETRA TECH

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APPENDICES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AADT	Average Annual Daily Traffic
APFO	Aerial Photography Field Office
APLIC	Avian Power Line Interaction Committee
AWEA	American Wind Energy Association
BBCS	Bird and Bat Conservation Strategy
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practice; prevents soil erosion and sedimentation
Certificate	Certificate of Site Compatibility
CFR	*Code of Federal Regulations*
CRP	Conservation Reserve Program
CUP	Conditional Use Permit
CWS	Canadian Wildlife Service
dBA	Decibel
DHS	U.S. Department of Homeland Security
Distribution	Relatively low-voltage lines that deliver electricity to the retail customer’s home or business
DNV GL	DNV KEMA Renewables, Inc.
DoD	Department of Defense
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
EPA	U.S. Environmental Protection Agency
EPC	Engineering, procurement, and construction
ERC	Emission Rate Credit
ESA	Endangered Species Act
ESRI	Environmental Sciences Research Institute
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
Gearbox	An assembly of parts including speed-changing gears and propeller shaft by which power is transmitted from an automobile engine to a live axle; speed-changing gears in such an assembly
Generator	A machine by which mechanical energy is changed into electrical energy

Acronyms/Abbreviations	Definition
GSU	Generator Step-up Unit
Geotechnical	A science that deals with application of geology to engineering
GIS	Geographic Information System
Glacier Ridge	Glacier Ridge Wind Farm, LLC
GPS	Global Positioning System
Hub	Central part of a circular object (as a wheel or propeller)
ICBM	Intercontinental ballistic missile
Interconnection	To be or become mutually connected
IRP	Integrated resources planning
kV	Kilovolt
mph	Miles per hour
m/s	Meters per second
MW	Megawatt
MWh	Megawatt-hour
MERRA	Michigan Energy and Resources Research Association
MET	Meteorological
Micrositing	Process by which local, state, and federal agencies evaluate locations for wind turbines and associated facilities, involving considerations of wind resources, potential environmentally sensitive areas, soil conditions, and other site factors
MISO	Midcontinent Independent System Operator
N/A	Not applicable
NAIP	National Agriculture Imagery Program
NDDOT	North Dakota Department of Transportation
NDAC	*North Dakota Administrative Code*
NDCC	*North Dakota Century Code*
NDDMR	North Dakota Department of Mineral Resources
NDDTL	North Dakota Department of Trust Lands
NDGF	North Dakota Game and Fish Department
NDGS	North Dakota Geological Survey
NDSWC	North Dakota State Water Commission
NEPA	National Environmental Policy Act
NIEHS	National Institute of Environmental Health Sciences
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service

Acronyms/Abbreviations	Definition
NRHP	National Register of Historic Places
NTIA	National Telecommunications and Information Administration
NWI	National Wetlands Inventory
NWP	Nationwide Permit
O&M	Operations and Maintenance
Peak	Peak Wind Development, LLC
PCN	Preconstruction notification
Pitch	The action or a manner of pitching; especially an up-and-down movement
PLOTS	Private Lands Open to Sportsmen
Project, the	Glacier Ridge Wind Farm
PSC	North Dakota Public Service Commission
PTC	Production Tax Credit
RENEW	Recover of the Nationally Endangered Wildlife
RES Americas	Renewable Energy Systems Americas Inc.
Rotor	The rotor consists of three blades mounted to a rotor hub
rpm	Revolutions per minute
SCADA	Supervisory Control and Data Acquisitions (communications technology)
SHSND	State Historical Society of North Dakota
SPCC	Spill Prevention Control and Countermeasures
Step-up transformer	A transformer that increases voltage
Substation	A subsidiary station in which electric current is transformed
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total maximum daily load
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	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOE	U.S. Department of Energy
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Acronyms/Abbreviations	Definition
WMA	Wildlife Management Areas
WoUS	Water of the United States
US DOT	U.S. Department of Transportation
WAPA	Western Area Power Administration
WPA	Waterfowl production area
WNS	White-nose-syndrome
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

1.0 INTRODUCTION

Glacier Ridge Wind Farm, LLC (Glacier Ridge), a subsidiary of Renewable Energy Systems Americas Inc. (RES Americas), is submitting this Application for a Certificate of Site Compatibility (Certificate) to the North Dakota Public Service Commission (PSC) for the proposed Glacier Ridge Wind Farm (the Project). Proposed locations of all Project facilities are in Barnes County, North Dakota (**Appendix A**, **Figures 1 and 2**). The proposed Project will have a nameplate capacity of up to 300.15 megawatts (MW), consisting of up to 87 wind turbines using Vestas V126 3.45 MW turbine generators. Additional facilities proposed in this Application include access roads, electrical collection and communication systems and cabling, meteorological (MET) towers (one temporary and up to four permanent), an operation and maintenance (O&M) building, and a substation (**Figure 2)**.

The Project will encompass an approximately 34,450-acre project area (Project Area) approximately 5 miles northeast of Valley City, Barnes County, North Dakota. The Project Area encompasses all parcels where proposed Project facilities are to be located. At the time of application submittal, approximately 90 percent of proposed Project facilities are within parcels previously under option or easement (see additional discussion on land rights in Section 4.3). An approximately 52,800-acre study area (Study Area), which includes the Project Area, was assessed during the environmental review to ensure that the Project Area is best positioned to avoid or minimize impacts.

Glacier Ridge also plans to construct a 345 kilovolt (kV) overhead generator tie line extending between 4 and 20 miles—depending on the point of interconnection selected—to facilitate the Project's interconnection. The transmission line must be permitted separately, and Glacier Ridge will submit a separate application for a Certificate of Corridor Compatibility and Route Permit for the line in 2017.

The Project has historically been a joint development between RES Americas and Peak Wind Development, LLC (Peak). Peak is a North Dakota limited liability company wholly owned by the landowners within the Project Area. The Project was originated by Peak and is truly a local, grassroots wind energy development project.

RES Americas and Peak entered into an agreement to jointly develop the Project in 2009. The unique partnership with Peak landowners has won for the Project strong support in the local community, which is enthusiastic to see the Project through to successful completion. Peak takes an active role in development of the Project, providing consultation on real estate, permitting, and especially civil design issues.[1]

RES Americas, through its affiliates, develops renewable projects throughout the United States, Canada, and Chile. RES Americas is one of the top renewable energy companies in North America, having constructed more than 160 renewable energy projects with total capacity of more than 10,000 MW around the world. RES Americas has been active in North America since 1997, and has a renewable energy and storage construction portfolio that exceeds 8,000 MW and over 80 projects, and has constructed more than 650 miles of overhead and transmission lines. In addition, RES Americas has a robust development pipeline of wind, solar, and energy storage projects across North America, and the company currently operates more than 250 MW of renewable energy and storage projects. RES Americas designs, constructs, and operates its facilities in an environmentally sound and responsible manner. RES Americas developed and constructed the 150-MW Border Winds Project in Rolette County, North Dakota, substantially completed in 2015. **Appendix B** conveys RES Americas' sustainability mission statement.

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 requires an application for a Certificate to meet the criteria set forth in *North Dakota Century Code* (NDCC) Chapter 49-22 (NDCC 2016) and *North Dakota Administrative Code* (NDAC) Article 69-06 (NDAC 2016). Siting of an energy conversion facility is to proceed in an orderly manner compatible with environmental preservation and efficient use of resources (NDCC 49-22-02).

In the design of the proposed Project, Glacier Ridge considered exclusion and avoidance areas and selection and policy criteria specified in NDAC Section 69-06-08-01. Glacier Ridge provides information about these considerations in this Application. Moreover, sufficient Project design, wind resource, and technical information is provided for a thorough evaluation of the proposed Project. **Table 1-1** outlines information required to fulfill requirements for a Certificate with PSC, and where these requirements are addressed in this document.

[1] Per request of the Peak owners/landowners, RES Americas is purchasing 100 percent ownership of the Project assets.

Table 1.1 Certificate Completion Checklist.

State Authority	Description	Section
NDAC 69-06-04-01	**Certificate of Site Compatibility Application**	
Section 2	**Contents**	
a.	A description of:	
	(1) Type of energy conversion facility proposed	1.0, 4.0
	(2) Gross design capacity	1.0
	(3) Net design capacity	1.3.2
	(4) Estimated thermal efficiency of the energy conversion process and assumptions on which the estimate is based	Not applicable
	(5) Number of acres that the proposed facility would occupy	1.3.1, **Table 1-3**
	(6) Anticipated time schedule for: (a) Obtaining the certificate of site compatibility (b) Completing land acquisition (c) Starting construction (d) Completing construction (e) Testing operations (f) Commencing commercial production (g) Beginning any expansions or additions	1.4
b.	Copies of any evaluative studies or assessments of environmental impact of proposed facility submitted to any federal, regional, state, or local agency	**Appendix B**
c.	Analysis of 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 need	2.1
d.	Description of any feasible alternative methods of serving the need	2.2
e.	A study area that includes the proposed facility site, of sufficient size to enable the commission to evaluate the factors addressed in NDCC Section 49-22-09	1.0, 1.3, 3.0, 7.0-7.17, 10.0-10.12, **Figures 1, 3 through 5, 7, 8**
f.	The Application shall contain a discussion of the utility's policies and commitments to limit the environmental impact of its facilities, including copies of board resolutions and management directives	**Appendix B**
g.	Map identifying criteria for selection of location of proposed facility within the Study Area	**Figure 3-4**

h.	Discussion of criteria evaluated within the Study Area, including exclusion areas, avoidance areas, selection criteria, policy criteria, design and construction limitations, and economic considerations	3.0-3.6, **Table 3-1, 3-2, 3-3, 3-4,** **Figure 3 and 4**
i.	Discussion of mitigative measures that the application would take to minimize adverse impacts resulting from location, construction, and operation of proposed facility	7.2.3, 7.3.3, 7.4.3, 7.5.3, 7.6.3, 7.7.3, 7.8.3, 7.9.3, 7.10.3, 7.11.3, 7.12.3, 7.13.3, 7.14.3, 7.15.3, 7.16.3, 7.17.3
j.	Qualifications of each person involved in the facility site location study.	11.0
k.	Map of the Study Area showing location of the proposed facility and criteria evaluated.	**Figures 2 and 4**
l.	An 8-1/2 by 11-inch black and white map suitable for newspaper publication depicting the site area	Provided on CD
m.	Discussion of present and future natural resource development in the area	7.3.1
n.	Map and Geographic Information System (GIS) requirements. The applicant shall provide information that is complete, current, presented clearly and concisely, and supported by appropriate references to technical and other written material available to the commission.	**Figures 1 through 5, 7, 8** Provided on CD
NDCC 49-22-08	**Application for a certificate**	
Section 1	**An application for a certificate shall be in such form as the commission may prescribe, containing the following information:**	
a.	Description of size and type of facility	1.0, 1.3.1, 4.0, **Tables 1-2, 1-3**
b.	Summary of any previous studies of environmental impact of the facility	7.0
c.	Statement explaining need for the facility	2.1
d.	Identification of location of the preferred site for any energy conversion facility	1.3.1, **Figures 1 and 2**
e.	Identification of location of the preferred corridor for any transmission facility	Not applicable
f.	Descriptions of merits and detriments of any location identified, and a comprehensive analysis with supporting data explaining why the preferred location is best suited for the facility	7.0
g.	Description of mitigative measures that would be taken to minimize all foreseen adverse impacts resulting from location, construction, and operation of the proposed facility	7.2.3, 7.3.3, 7.4.3, 7.5.3, 7.6.3, 7.7.3, 7.8.3, 7.9.3, 7.10.3, 7.11.3, 7.12.3, 7.13.3, 7.14.3, 7.15.3, 7.16.3, 7.17.3

h.	Evaluation of the proposed site or corridor with regard to applicable considerations specified in Section 49-22-09 and the criteria established pursuant to Section 49-22-05.1	10.0
i.	Other information that the applicant may consider relevant or the commission may require.	**Appendix C**
NDCC 49-22-09	**Factors to be considered in evaluating applications and designation of sites, corridors, and routes.**	**10.0**
1.	Available research and investigations relating to effects of location, construction, and operation of the proposed facility on public health and welfare, natural resources, and the environment	10.1
2.	Effects of new energy conversion and transmission technologies and systems designed to minimize adverse environmental effects	10.2
3.	Potential for beneficial uses of waste energy from a proposed energy conversion facility	10.3
4.	Unavoidable adverse direct and indirect environmental effects from designation of the proposed site or route	10.4
5.	Alternatives to the proposed site, corridor, or route developed during the hearing process and which minimize adverse effects	10.5
6.	Irreversible and irretrievable commitments of natural resources should the proposed site, corridor, or route be designated	10.6
7.	Direct and indirect economic impacts of the proposed facility	10.7
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	10.8
9.	Effects of the proposed site or route on existing scenic areas, historic sites and structures, and paleontological or archaeological sites	10.9
10.	Effects 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	10.10
11.	Problems raised by federal agencies, other state agencies, and local entities	10.12

1.2 FLEXIBILITY IN SITING

Wind facility siting is a process through which input is considered from several different entities. When considering where to locate this wind farm in North Dakota, Glacier Ridge identified the proposed Study Area (see **Figure 1**) for further investigation based on the modeled wind resource, interest from Peak landowners, and potential offtaker, as outlined in Section 1.3 below. Glacier Ridge analyzed the available land, initiated discussions with Peak landowners, and applied setbacks required by Barnes County, PSC, and RES Americas' internal setbacks. Glacier Wind then conducted environmental desktop and field studies in the Study Area and Project Area, as applicable, results of which are incorporated in the appropriate sections of this Application.

Glacier Wind previously negotiated agreements with landowners interested in hosting wind turbines and associated facilities on their properties. Concurrently, Glacier Ridge identified preliminary turbine locations based on initial site inspection, topographic maps, known environmentally sensitive areas, review of North Dakota's power plant siting exclusion and avoidance areas, and communications with local, state, and federal agencies.

Glacier Ridge seeks a Certificate of Site Compatibility for the Project Area, as opposed to specific turbine locations, as indicated on **Figure 2**. Glacier Ridge suggests that the Certificate define the Project Area, number of turbines, and structures related to wind generation to be located within the Project Area based on information presented in this Application. Moreover, Glacier Ridge proposes that, within the permitted Project Area, (1) final turbine placement be subject to required setbacks from environmentally sensitive areas, and (2) those setbacks suffice to meet required sound levels.

Glacier Ridge is completing additional required studies, including final cultural resource surveys and wetland surveys. Completion of these studies is anticipated by August 2016. In addition, Glacier Ridge will seek further input from landowners regarding locations of wind turbines and associated facilities. Upon completion of these additional studies and communications, preliminary turbine locations will be re-evaluated for consistency with anticipated Certificate conditions and buffers. A final site plan for the proposed Project will be submitted to PSC prior to construction, and a pre-construction conference call will be held with PSC staff to ensure that the site plan conforms to Certificate requirements.

Glacier Ridge believes that the aforementioned siting process is consistent with North Dakota siting rules and provides Glacier Ridge with the flexibility necessary to develop a timely, cost-effective project in an environmentally responsible manner.

1.3 PROJECT SUMMARY

Glacier Ridge selected the Project Area for the proposed 300.15 MW wind generation facility because it is an optimal wind resource, includes willing landowner partners, is accessible to transmission, and is environmentally suitable. The proposed Project Area was selected considering the exclusion and avoidance criteria outlined in NDAC 69-06-08-01.

1.3.1 Proposed Project Area

The proposed Project Area is the location where proposed Project facilities may be located. At the time of application submittal, nearly 90 percent of proposed Project facilities were within parcels previously under option or easement by Glacier Ridge (**Table 1-2**). The proposed Project Area was selected to include all areas necessary for Glacier Ridge to optimize the wind resource while complying with required setbacks and avoiding and minimizing impacts on environmental resources.

Table 1-2. Project Area Location.

County	Township	Range	Sections
Barnes County	140 N	57 W	2-5, 9-11
	141 N	56 W	6, 7, 17-20, 30
	141 N	57 W	1, 2, 9-16, 22-28, 34-36
	142 N	56 W	6, 7, 18, 19, 30, 31
	142 N	57 W	1-3, 12-15, 22-27, 34-36
	143 N	56 W	18, 19, 30
	143 N	57 W	14, 23-26, 34-36

The Project Area encompasses approximately 34,450 acres (54 square miles) in northeastern Barnes County. Although the turbines will be placed throughout the Project Area, the permanent Project facilities will occupy only up to 92 acres during operation (**Tables 1-3 and 1-4**), or less than 1 percent of the total Project Area. **Table 1-3** summarizes assumptions underlying calculations of impacts categorized by proposed Project facilities. Project infrastructure that could exert permanent impacts includes turbines, MET towers, access roads, collection system junction boxes, the substation, and the O&M building. Temporary impacts would occur during construction to accommodate equipment and temporary laydown activities beyond the built Project infrastructure. **Table 1-4** summarizes estimated impacts of each proposed Project component during both construction (temporary) and operation (permanent). The Project Area and proposed Project layout are shown on **Figures 1 and 2**.

Table 1-3. Proposed Project Facility Impact Assumptions.

Proposed Project Component	Construction Disturbance	Temporary Construction Disturbance to be Reclaimed	Permanent Disturbance (Operation)

Wind Turbines a/	4.5 acres per turbine	4.3 acres per turbine	0.2 acre per turbine
Access Roads b/	68 feet wide per linear foot of road	48 feet wide per linear foot of road	20 feet wide per linear foot of road
Collection Lines c/	40 feet wide per linear foot	40 feet wide per linear foot minus 12 x 8 feet for each junction box	12 x 8 feet for each junction box
Meteorological Towers d/	1.25 acres per tower	1.25 acres per tower	5 square feet per tower
Temporary Crane Paths	80 feet wide per linear foot	80 feet wide per linear foot	0 acres
Substation	5 acres	3 acres	2 acres
O&M building	3 acres	1 acre	2 acres
Laydown/staging areas	8 acres	8 acres	0 acres

a/ Assumes 4.5 acres of ground disturbance during construction, 0.2 acre/turbine of that remaining as permanent.
b/ Assumes a 68-foot-wide easement for roads during construction, 20 feet of that remaining during operation, including two 2-foot shoulders.
c/ Assumes a 40-foot-wide easement for roads during construction for the collection lines, and no permanent impact from the collection lines. Junction boxes will be located on the ground throughout the Project Area and will each require approximately 12 x 8 feet. Currently, requirement of 36 junction boxes is anticipated.
d/ One temporary and up to 4 permanent MET towers x 1.25 acres = 6.25 acres disturbance during construction; 4 permanent MET towers, assuming guyed, equals 20 square feet of permanent disturbance.
e/ Assume a 60-foot-wide easement for crane paths, and no permanent impacts.

Table 1-4. Proposed Project Impacts.

Proposed Project Component	Construction Disturbance (acres)	Temporary Construction Disturbance to be Reclaimed (acres)	Permanent Disturbance (Operation) (acres)
Wind Turbines a/ (87 turbines)	391.5	374.1	17.4
Access Roads b/	245.2	175.0	70.2
Collection Lines c/	266.7	266.7	<0.1 (3,456 sq. ft.)
Meteorological towers d/	6.25	6.25	<0.1 (20 sq. ft.)
Temporary Crane Paths e/	87.2	87.2	0
Substation/O&M building	10 acres	6 acres	4 acres
Laydown/staging areas	8 acres	8 acres	0 acres

Total	**1,012**	**920**	**92**

a/ Assumes 87 turbines x 4.5 acres of ground disturbance during construction, 0.2 acre/turbine of that remaining as permanent. The 12 alternate turbines were not included in the calculation.

b/ Assumes total of approximately 46.8 linear miles of service roads. Assumes a 68-foot-wide easement for roads during construction, 20 feet of that remaining during operation, including two 2-foot shoulders. Overlapping area for turbines was excluded from the road impact calculations to avoid double counting the same footprint. Alternate access roads were not included in the calculation.

c/ Assumes total of approximately 78.4 linear miles of collection lines. Overlapping area for turbines and the access roads was excluded from the road impact calculations to avoid double counting the same footprint. Approximately 4.3 miles of collection lines run parallel to the access roads, and 74.1 miles extend cross-country. Junction boxes will be located on the ground throughout the Project Area, and will each require approximately 12 x 8 feet. Currently, requirement for 36 junction boxes is anticipated. Alternate collection lines were not included in the calculation.

d/ One temporary and up to 4 permanent MET towers x 1.25 acres = 6.25 acres disturbance during construction; 4 permanent MET towers, assuming guyed, equals 20 square feet of permanent disturbance. For the purposes of this calculation, construction of all 4 permanent MET towers is assumed.

e/ At time of publication, temporary crane paths had not been identified. Access roads, collection line routes, and public roads will be utilized for crane travel, and new crane paths will be avoided if possible. Estimated impacts assume a 60-foot-wide crane path for 12 miles that does not overlap with other infrastructure footprints.

1.3.2 Projected Output

The proposed Project will have a nameplate (gross) capacity of 300.15 MW. Assuming a net capacity factor of 39.6 percent, projected average annual output is estimated at 1,041,208 MW hours (MWh) per year. As with all wind energy projects, output depends on wind resource, final design, site-specific features, and equipment.

1.4 PROPOSED PROJECT SCHEDULE

The commercial operation date depends on permitting, equipment deliveries, and other development activities. Glacier Ridge is targeting site construction to begin in November 2016, provided all pre-construction permits and approvals will have been obtained. Key schedule milestones include the items described below.

1. **Certificate of Site Compatibility**: Glacier Ridge anticipates and has requested with this filing issuance of the Certificate in October 2016. The U.S. Congress' most recent extension of the wind energy production tax credit (PTC) projects that safe harbor equipment or initiation of construction in 2016 can lead to completion of the project by 2020 with retention of full value of the PTC. For this Project to remain economically competitive in this timeframe, it is critical that the Project qualify for the full 100 percent value of the PTC by initiating construction in 2016.

2. **Land Acquisition**: Glacier Ridge anticipates obtaining all necessary land easement agreements for the wind generation facility by the end of July 2016.

3. **Permits**: Glacier Ridge will submit a separate application for a Certificate of Corridor Compatibility and Route Permit for the associated transmission line in 2017. Glacier Ridge anticipates the Certificate will be issued by the PSC in November 2016. Glacier Ridge received a Conditional Use Permit from Barnes County for the Project in March 2009. Update of this is occurring to reflect the final Project layout. Glacier Ridge will acquire all other permits necessary for construction of the Project prior to conducting the work for which the permit is required. **Table 9-1** fully lists potential permits and approvals.

4. **Equipment Procurement, Manufacture, and Delivery**: Glacier Ridge will order all long-lead equipment for the proposed Project, including substation equipment, transformers, and wind turbines within a timeframe that supports scheduled commencement of operation in 2019.

5. **Construction**: Construction is scheduled to begin in November 2016 subject to road restrictions, weather, and permitting. Completion of construction could take up to 14 months, not including initial preparation of some turbine foundations in late 2016.

6. **Testing Operations**: Glacier Ridge anticipates initiation of testing in November 2019.

7. **Commercial Operation**: Glacier Ridge anticipates commercial operation of the proposed Project to begin in December 2019.

8. **Expansions or Additions**: Definitive plans and schedules for addition or expansion have not been determined at this time. However, should the opportunity arise for expansion or addition to the proposed Project, Glacier Ridge would take action to develop additional adjacent areas that have been deemed suitable for expansion. Glacier Ridge would obtain all necessary permits and approvals for any expansion project.

1.5 PROJECT OWNERSHIP

Glacier Ridge will own the entire proposed Project and, as a result, will manage construction of all equipment and associated facilities related to the proposed Project. RES Americas will likely perform the initial engineering and will serve as general contractor for construction of the Project, although Glacier Ridge reserves the right to select a third-party engineering, procurement, and construction (EPC) contractor. Glacier Ridge will procure the turbine/tower equipment directly from a manufacturer.

2.0 NEED FOR FACILITY

2.1 NEED ANALYSIS

Demand for wind energy in the region is expected to remain strong in coming years. Many public utilities that are potential Project customers have publicly announced a future demand for wind energy, either via press releases or through formal integrated resources planning (IRP) processes. For example, Basin Electric Power Cooperative issued a Request For Proposals for power supply in February 2016 that included wind energy; Minnkota Power Company announced an agreement to purchase additional wind in April 2016; and Excel Energy proposes to continue transitioning from coal to renewables and natural gas (including 35 percent renewable energy from wind and solar by 2030) in its 2016-2030 Upper Midwest IRP (Excel Energy 2016). Glacier Ridge believes it is well-positioned to offer economically competitive power sourced from wind energy within a supportive community seeking similar, future procurements of power.

Additionally, on October 23, 2015, the U.S. Environmental Protection Agency's (EPA) final *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units* (Clean Power Plan) was published in the *Federal Register*. Under the Clean Power Plan, EPA established interim and final carbon dioxide emission performance rates for steam electric and natural gas-fired power plants, as well as state-specific interim and final goals, based on these limits and each state's mix of power plants. The Clean Power Plan requires each state to develop and implement plans to ensure that power plants within that state achieve the interim and the final carbon dioxide emission performance rates, and rate-based goals or mass-based goals by 2030. North Dakota's 2012 carbon dioxide emission rate was 2,368 pounds per MWh, and its 2030 goal is 1,305 pounds per MWh (EPA 2015a). EPA anticipates that renewable energy will be a significant strategy for states and existing sources. New renewable energy facilities benefit mass-based states by avoiding emissions from affected fossil fuel-fired electric generating sources. States using a mass-based approach may provide additional support for renewable energy through direct allocations of emission allowances to renewables, or through distribution of proceeds from auctions of emission allowances to renewable energy generators (EPA 2015b). A renewable energy generator installed after 2012 in a rate-based state may be issued Emission Rate Credits (ERC) for every MWh of zero-emission generation in 2022 and thereafter (EPA 2015b). Additionally, the Clean Power Plan facilitates trading of ERCs for compliance across state lines (EPA 2015b).

Although implementation of the Clean Power Plan is currently stayed by order of the United States Supreme Court, if it is ultimately implemented, the proposed Project can contribute to fulfillment of any requirements for North Dakota under the Clean Power Plan to meet its interim and final carbon dioxide emission rate goals under either a mass-based or rate-based compliance regime.

Finally, in its 2014 regional transmission planning process, Midcontinent Independent System Operator (MISO) recently included five future scenarios, with every scenario assuming over 12,000 MW of generation capacity retiring before 2028, and one scenario assuming over 22,000 MW of generation capacity retiring by 2028. On the new generation side, four of the five scenarios show need for 20,000 MW or more additional nameplate capacity between 2013 and 2028, with the "limited growth" scenario still showing need for 13,000 MW of additional generation capacity over the same time period (MISO 2014).

In summary, Glacier Ridge expects strong demand for additional generation from wind in this geographic market within the proposed Project timeline, and seeks permit approval to provide the lowest cost power from wind possible for potential off-takers and, ultimately, ratepayers.

2.2 ALTERNATIVES

Feasible technology alternatives to wind include electricity generation using coal, natural gas, or biomass. Pricing for energy from wind generation is at all-time lows. Wind energy uses no water and requires no fuel, which buffers this technology from fluctuations in energy markets. For these reasons, no other technology was considered.

Although the proposed Project will include 87 planned turbines, an additional 12 turbine locations have been included in the proposed Project layout to provide siting flexibility based on ongoing environmental studies and landowner input.

2.3 10-YEAR PLAN

As required by NDCC 49-22-04, Glacier Ridge will file a 10-Year Plan with PSC by July 1, 2019.

3.0 SITE SELECTION CRITERIA

Glacier Ridge is evaluating the proposed 34,450-acre (53.8 square-mile) Project Area to determine the best locations for up to 87 wind turbines (**Figure 1**). Siting turbines is a process through which input from several different entities is considered. The Project Area was identified as an optimal site from wind resource, transmission, landowner participation, economic, and environmental perspectives. An additional 12 turbine locations have been included in the proposed Project layout to provide siting flexibility based on ongoing environmental studies and landowner input; however, only up to 87 wind turbines will be constructed.

Glacier Ridge previously secured voluntary wind option agreements with landowners and identified preliminary turbine locations based on site inspection, topographic maps, known environmentally sensitive areas, review of North Dakota's power plant siting exclusion and avoidance areas, review of Barnes County and state wind siting requirements, and communications with local, state, and federal agencies. RES Americas applied this siting process in developing recent wind turbine projects, including the Border Winds Project in North Dakota. Through this process, RES Americas addressed environmental issues that commonly arise during project development and worked within the parameters of state rules. North Dakota has several site selection criteria that PSC considered to determine site suitability. Glacier Ridge has reviewed the criteria in Chapter 69-06-08, and has considered these criteria in the proposed Project design. These criteria are discussed in this section.

3.1 EXCLUSION AREAS

In accordance with NDAC Section 69-06-08-01(1) and (2), geographical areas listed in **Table 3-1** shall be excluded from 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 within the Project Area, mapped on **Figure 3,** consist only of a relatively small amount of prime farmlands.

3.2 AVOIDANCE AREAS

In accordance with NDAC Section 69-06-08-01(3) and (4), geographical areas listed in **Table 3-2** 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, PSC may consider, among other factors, proposed management of adverse impacts, orderly siting of facilities, system reliability and integrity, efficient use of resources, and alternative sites. Avoidance areas (illustrated on **Figure 4**) include wetlands and wooded areas.

Table 3-1. 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.	None	Not applicable (N/A)	7.8, 7.9, 7.15, 7.17
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.	None	N/A	7.8, 7.9, 7.15, 7.17, **Figure 3**
County parks and recreational areas; municipal parks; parks owned or administered by other governmental subdivisions; hardwood draws; and enrolled woodlands.	None	N/A	7.9, 7.17
Prime farmland and unique farmland, as defined by the Land Inventory and Monitoring Division of the Soil Conservation Service, U.S. Department of Agriculture (USDA), in 7 *Code of Federal Regulations* (CFR) part 657. However, if the Commission finds that the prime farmland and unique farmland to be removed from use for the life of the facility is of such small acreage as to negligibly impact agricultural productions, such exclusion shall not apply.	Present	The Project Area includes 18,657 acres (approximately 54.2 percent) of prime farmland soils. Prime farmland has been avoided to the extent practical (based on other setbacks, avoidance areas, and landowner preferences). Permanent impacts on prime farmland soils from built Project facilities (see **Table 1-4**) are estimated to encompass approximately 70 acres—less than 1 percent of the Project Area.	7.10, 7.11, **Figure 3**
Irrigated land	None	N/A	7.10
Areas critical to threatened or endangered animal or plant species	None	The Project Area is outside the whooping crane migration corridor; no designated critical habitat for any federally protected species is present within the Project Area.	7.16, 7.17
Areas where animal or plant species that are unique or rare to this State would be irreversibly damaged.	None	N/A	7.15, 7.16, 7.17

Areas within 1,200 feet of the geographic center of an intercontinental ballistic missile (ICBM) launch or launch control facility.	None	N/A	7.4
Wind-energy specific exclusion areas	N/A	The proposed Project complies with the following exclusion areas: 1.1 x height of turbine from interstate and state road rights-of-way 1.1 x height of turbine plus 75 feet from centerline of county or maintained township roadways 1.1 x height of turbine from railroad right-of-way 1.1 x height from 115kV or higher transmission lines 1.1 x height from property line of non-participating landowners	4.1.1, **Table 4-1**

Table 3-2. Avoidance Areas

Avoidance Areas	Present within Project Area?	Description and Proposed Buffer	Section Addressed
Historical resources not designated as exclusion areas	Present	Glacier Ridge has completed a Class I Cultural Resource File Search for the Project and Study Areas. A Class III Cultural Resource Inventory for archaeology for all Project facilities (see **Table 1-3**) is underway. A Class III Cultural Resource Inventory for architecture for all structures over 50 years old and within 2 miles of the proposed turbine array is underway. Cultural resource sites will be avoided, and construction setbacks will be implemented. An Unanticipated Discoveries Plan has been developed for unidentified resources encountered during construction, and will be submitted to the State Historical Society of North Dakota (SHSND) for approval.	7.8
Areas within the city limits of a city or the boundaries of a military installation	None	N/A	7.3, **Figures 1 and 2**

Areas within known floodplains as defined by the geographical boundaries of the 100-year flood	None	No 100-year floodplains have been documented within the Project Area.	7.13
Areas that are geologically unstable	None	N/A	7.12
Woodlands and wetlands	Present	Wetlands are present within the Project Area. Small wooded areas and shelter belts are also present. Permanent impacts on jurisdictional wetlands will be avoided and minimized as practicable. Few woodland impacts are anticipated, and all trees removed will be replaced at a 2 to 1 ratio, as required by PSC.	7.14, 7.15, **Figure 4**
Areas of recreational significance not designated as exclusion areas	None	N/A	7.9
Geographic area where, due to operation of the facility, sound levels within 100 feet of an inhabited residence or a community building would exceed 50 decibels (dBA).	None	Acoustic modeling results indicated that received sound levels are all below 50 dBA within 100 feet of an inhabited residence.	7.6

3.3 SELECTION CRITERIA

In accordance with NDAC Section 69-06-08-01(5), a site shall be approved in an area only when it is demonstrated to PSC by the applicant that any significant adverse effects resulting from location, construction, and operation of the facility in that area, as these relate to the criteria listed in **Table 3-3**, will be at an acceptable minimum, or that those effects will be managed and maintained at an acceptable minimum.

Table 3-3. Selection Criteria

Selection Criteria	Potential Adverse Effects	Section Addressed
Impact on agriculture:		
Agricultural production	Up to 1,012 acres of land would be disturbed during construction of Project facilities (see **Table 1-4**). Approximately 92 percent of the area (920 acres) would be temporarily disturbed and would be reclaimed upon Project completion. Approximately 92 acres would undergo permanent disturbance due to Project facilities (see **Table 1-4)**. These impacts represent a minor portion of the land area available for agricultural production. Landowner agreements include compensation for crop damage, if any, during surveys and	1.3.1, 7.3, 7.10

	construction. As a result, the proposed Project would not result in significant impacts on agricultural production.	
Family farms and ranches	The proposed Project will comply with state, county, and other voluntary setbacks. Although some land area would be converted to wind turbine foundations and pads and access roads, wind easement payments to farmers would provide a supplemental source of income. As stated above, landowner agreements also include compensation for crop damage, if any, during surveys and construction.	4.1.1, 7.2, 7.3, 7.10, **Table 4-1**
Land which the owner demonstrates has soil, topography, drainage, and an available water supply that render the land economically suitable for irrigation	Participating landowners have not expressed concerns related to economically suitable irrigation on their land. Currently, no irrigation is occurring within the Project Area.	7.10, 7.11
Surface drainage patterns and groundwater flow patterns	A wetlands and waters survey is underway and will be completed in summer 2016 as weather and land access permit. Project infrastructure will be built to avoid impacts on surface waters to the extent practicable, and 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. Temporarily disturbed areas will be returned to their original contours.	7.14, **Figure 4**
Agricultural quality of cropland	Minimal impacts on agricultural quality of cropland are anticipated. Landowner agreements include compensation for crop damage, if any, during surveys and construction. If compaction of soils occurs during construction, Glacier Ridge will work with the landowners to alleviate the compaction.	7.10, 7.11, **Figure 3**
Impacts on availability and adequacy of:		
Law enforcement	No adverse impacts on law enforcement are anticipated.	7.4
School systems and education programs	No adverse impacts on school systems and education programs are anticipated. The Project will provide revenue for local school districts.	7.4
Governmental services and facilities	No adverse impacts on governmental services and facilities are anticipated.	7.4
General and mental health care facilities	No adverse impacts on general and mental health care facilities are anticipated.	7.4
Recreational programs and facilities	No recreational programs or facilities would be directly affected by the Project. Recreational impacts would be auditory and visual, and limited to individuals using public or private property in and near the Project Area for hunting, fishing, or nature observation.	7.4, 7.9
Transportation facilities and networks	An increase in vehicle trips per day is anticipated over the duration of construction, but is expected to be temporary and not significant. During facility operation, no significant impacts are anticipated.	7.4
Retail service facilities	No adverse impacts are anticipated. Business at local services such as hotels, restaurants, and convenience stores is likely to increase during construction.	7.2, 7.4

Utility services	The proposed Project would utilize station service from Cass County Electric Cooperative, which will suggest appropriate configurations for the electrical system; Glacier Ridge will abide by those recommendations to prevent impacts on the distribution system.	1.0, 2.0, 6.0, 7.4
Impacts on:		
Local institutions	No adverse impacts are anticipated.	7.4
Noise-sensitive land uses	Noise-sensitive land uses within the Project Area would affect residences near turbine locations. Sound impacts from the proposed Project turbines would be within the PSC limit at inhabited residences.	7.6
Rural residences and businesses	The proposed Project will comply with state and local setbacks.	4.1.1, 7.2, 7.3
Aquifers	Based on the small increase in impervious surface area that proposed Project components would create relative to the size of the entire Project Area, and the separation of these components, the proposed Project likely would minimally impact regional groundwater recharge.	7.12
Impacts on:		
Human health and safety	No impacts on human health and safety are anticipated based on implementation of the mitigative measures discussed in Section 7.5.3 and maintenance schedules.	6.3, 7.5
Animal health and safety	No impacts on livestock are anticipated from construction or operation of the facility. Based on results of avian surveys to date, mean raptor use was generally low compared to other wind facilities. For other avian species, fatalities from the proposed Project, if any, are not anticipated to exert population-level effects. Glacier Ridge will implement measures to avoid and minimize effects on wildlife by siting facilities away from active raptor nests and wetlands to the extent practicable. A Bird and Bat Conservation Strategy (BBCS) will be prepared for the proposed Project. In addition, Glacier Ridge will implement 1 year of post-construction bird and bat mortality monitoring for the proposed Project to monitor avian/turbine interaction.	7.16, 7.17
Plant life	The proposed Project will result in up to 92 acres of permanent impact. Land where the turbines will be sited is primarily agricultural cropland. High-quality native prairie is not present within the Project Area. Trees and shrubs will be replaced consistent with PSC requirements.	7.15, **Figure 5**
Temporary and permanent housing	Existing temporary housing, such as hotels, will be utilized during construction. No adverse impacts are anticipated.	7.2
Temporary and permanent skilled and unskilled labor	No adverse effects are anticipated. Local contractors employed for construction would benefit the local economy.	7.2
Cumulative effect of location of the facility in relation to existing and planned facilities and	Anticipation is that wind energy development will exert positive cumulative impacts on air quality, and minimal impacts on 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 are diversified. Wind energy	7.18, 10.11

other industrial development	development removes less total land from agricultural use than other forms of energy generation development.	

3.4 POLICY CRITERIA

In accordance with NDAC Section 69-06-08-01(6), PSC may give preference to an applicant that would maximize benefits resulting from adoption of policies and practices listed in **Table 3-4**, and may require adoption of such policies and practices as appropriate.

Table 3-4. Policy Criteria

Policy Criteria	Suitable Policy or Practice of Applicant	Section Addressed
Recycling of conversion byproducts and effluents	Not applicable.	N/A
Energy conservation through location, process, and design	Glacier Ridge is developing the site to maximize energy output, and will develop a site layout that optimizes wind resources while minimizing impacts on land resources and any potentially sensitive areas.	4.1, 4.2
Training and utilization of available labor in this State for the general and specialized skills required	Glacier Ridge will use local labor to the extent practicable.	7.2
Use of a primary energy source or raw material located within the State	Energy generated at the site will utilize the wind resources of the State of North Dakota.	5.2, 5.3
Non-relocation of residents	No residents will be relocated as a result of the proposed Project.	7.2.2
Dedication of an area adjacent to the facility to land uses such as recreation, agriculture, or wildlife management	The proposed Project will not interfere with adjacent land uses. Dedication of areas adjacent to the Project Area to recreation, agriculture, or wildlife management is not anticipated, although much of the Project Area is already used for agriculture, and hunting areas exist within the proposed Project Area; these uses could continue once the Project is constructed.	7.3, 7.9, 7.10, 7.16
Economies of construction and operation	Glacier Ridge will utilize local contractors to the extent practicable.	1.0, 1.2, 1.3, 7.2
Secondary uses of appropriate associated facilities for recreation and enhancement of wildlife	None.	N/A

Use of citizen coordinating committees	Glacier Ridge has coordinated with County officials on the location of the proposed Project, and is consulting with participating landowners on the proposed Project.	1.0, 8.0
A commitment of a portion of the energy produced for use in this State	Energy generated by the Project will likely be delivered to the 345 kV Buffalo Substation, and will be injected into MISO's transmission system. MISO's service area includes North Dakota.	1.0, 4.0
Labor relations	Glacier Ridge will utilize local contractors to the extent practicable.	6.4, 7.2
Coordination of facilities	None.	1.0, 1.2, 1.3, 1.4, 3.0, 3.6
Monitoring of impacts	Glacier Ridge and the EPC contractor will employ best management practices during construction to monitor soil impacts and segregate topsoil. A stormwater prevention plan will be prepared for the proposed Project. Glacier Wind will conduct 1 year of post-construction bat and bird fatality monitoring.	7.11, 7.12, 7.13, 7.15, 7.16, 7.17

3.5 DESIGN AND CONSTRUCTION LIMITATIONS

Key design and construction limitations when building any wind farm are wind resources, landowner easements, regulatory setbacks (local and state), and available transmission. The wind resource is essential to selection and design of a wind farm. Glacier Ridge 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 are also critical to the proposed Project. Glacier Ridge previously negotiated land agreements with landowners necessary to develop the proposed Project. The proposed Project complies with all applicable county setbacks and PSC exclusion areas (see **Section 4.1.1**).

3.6 ECONOMIC CONSIDERATIONS

Economics were considered when selecting a location for the proposed Project. As discussed above, it is important to select a site with a wind resource capable of generating 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 5.2 and 5.3**.

One of the most important economic considerations related to the proposed Project is need to qualify for the Federal PTC. The PTC is an income tax credit of 2.3 cents per kilowatt-hour produced by wind turbines. This incentive was created under the Energy Policy Act of 1992, and has been renewed and expanded many times, most recently in the 2016 spending package passed by Congress on December 18, 2015. The wind energy PTC will now be extended through 2016, and then continue at a decreased value through 2019. Wind projects qualify for the PTC if construction begins before the end of 2019 (American

Wind Energy Association [AWEA] 2015a), but projects that start construction before the end of 2016 qualify for 100 percent of the value of the PTC. For Glacier Ridge to be economically competitive in the 2017-2020 timeframe—and to provide the lowest cost power for the ratepayers of North Dakota—it is critical that the Project qualify for 100 percent of the PTC by starting construction in 2016.

4.0 GENERAL DESCRIPTION OF THE PROPOSED FACILITY

4.1 WIND POWER TECHNOLOGY

As the wind passes over the blades of a wind turbine, it creates lift and causes the rotor to turn. The rotor is connected by a hub and main shaft to a system of gears, which are connected to a generator. Exact turbine models are subject to change to ensure selection of a cost-effective turbine that optimizes land and wind resources. Glacier Ridge proposes to install up to 87 wind turbines totaling 300.15 MW of nameplate capacity. The current layout includes Vestas V126 3.45 MW turbines. Glacier Ridge is seeking flexibility from PSC to select the most appropriate technology for the proposed Project at the time of construction to ensure optimization of wind and land resources and cost efficiency.

The Vestas V126 3.45 MW utility-grade wind turbine has a nominal nameplate rating of 3.45 MW. Each turbine will have a 285-foot hub height and a 413-foot rotor diameter. Turbines begin operation in wind speeds of 6.7 miles per hour (mph), and are designed to operate in wind speeds of up to 50.3 mph. The 3.45 MW turbine is designed to reach its rated capacity at wind speed of 29 mph.

Each tower will be secured by a concrete foundation that can vary in design depending on soil conditions. A control panel inside the base of each turbine tower houses communication and electronic circuitry. Each turbine is equipped with a wind speed and direction sensor that communicates with the turbine's control system to signal when sufficient winds are present for operation. Turbines feature variable-speed control and independent blade pitch to ensure aerodynamic efficiency.

Electricity generated by each turbine is raised (stepped up) to power collection line voltage of 34.5 kV. Electricity is collected by a system of underground power collection lines within the Project Area. Both power collection lines and communication cables will be buried on private property or public right-of-way.

Each wind turbine will be accessible via all-weather, aggregate-surfaced roads 20 feet in width that will connect with public roads. At the point where the access and public roads meet, communication and power lines will continue as underground feeder lines. The feeder system distributes power to the Project substation facility. Power will be transformed to 345 kV at substation facilities that will be within the proposed substation for the Project, in the northwest quarter of Section 12 of Township 141 North, Range 57 West. The associated transmission line will be permitted separately in another future application to PSC.

4.1.1 Wind Turbines

Glacier Ridge has designed a wind farm layout that optimizes the wind resource while minimizing impacts on land resources and any potentially sensitive areas. Wind-powered electric generation depends entirely on availability of the wind resource at a specific location. Energy available from the wind increases by the third power with increase in wind speed—for example, doubling of wind speed would increase available energy by a factor of 8. Analysis of wind direction data suggests that optimal turbine string alignments are generally from southwest to northeast. Appropriate design of the turbine array and collection system will minimize energy loss due to wind turbine wake (e.g., adverse impacts of one turbine on an adjacent turbine) and turbulence, and electrical line losses.

Setbacks specified in design of the proposed Project are the most restrictive of those required among Barnes County, PSC, Vestas, or RES Americas' internal standards. **Table 4-1** lists setbacks utilized in designing the proposed Project layout. Distances are based on the Vestas V126 3.45 MW turbine, which has total turbine height (from the bottom of the turbine tower to the top of the blade when vertical) of 492 feet. Barnes County land use regulations specify that the proposed Project turbines must not be within 1,400 feet of occupied dwellings or commercial buildings or publicly-used structures or facilities, or within 1,400 feet of public roads (although a variance for setback to roads may be granted).

Glacier Ridge will comply with applicable Barnes County and PSC setbacks (although a variance will be sought for the 1,400-foot Barnes County setback for roads), and in many cases will exceed minimum setback distances by using RES Americas' internal setback distances[2] (**Table 4-1**).

Table 4-1. Setback Distances for Wind Turbines

Setback Type	Distance
PSC Exclusion Areas Per Section 69-06-08-01 (2)	
Interstate or state road right-of-way	1.1 x tip height (541 feet)
County or maintained township road center line	1.1 x tip height plus 75 feet (616 feet)
Railroad right-of-way	1.1 x tip height (541 feet)
Overhead transmission lines, 115 kV or higher	1.1 x tip height (541 feet)
Property line of nonparticipating landowner	1.1 x tip height (541 feet) unless waiver is granted
Barnes County Setbacks	
Habitable house or community building	1,400 feet

[2] RES Americas' internal setback distances that are more conservative that the PSC or County setbacks will be applied where possible, but may be reduced in some instances (landowner input, other constraints, etc.).

Public roads	1,400 feet, although a variance may be granted
Manufacturer	
Vestas-provided setback from barns, abandoned houses, and roads (more conservative than PSC setback)	1.5 x tip height (680 feet)
RES Americas	
Uninhabitable house or structures	1.5 x tip height (738 feet)
Road (interstate or state)	1.5 x tip height (738 feet)
Road (maintained county or township)	1.5 x tip height (738 feet)
Railroad	1.5 x tip height (738 feet)
Overhead transmission lines	1.5 x tip height (738 feet)

4.2 ASSOCIATED FACILITIES

In addition to turbines, the proposed Project includes electrical collection lines, access roads, MET towers, O&M building, and substation. Electricity generated by each turbine is stepped up to a power collection line voltage of 34.5 kV via a transformer within the nacelle of each turbine. Electricity generated at each turbine will be collected by a system of underground power collection lines and brought to the substation. One temporary and up to four permanent MET towers will be installed for the proposed Project. Locations of permanent Supervisory Control and Data Acquisitions (SCADA) MET towers have not yet been determined.

Equipment will be added within the proposed 10-acre footprint of the proposed Project's O&M facility and substation to accommodate Project needs. Temporary laydown areas have not been determined.

4.3 LAND RIGHTS

Glacier Ridge previously negotiated easements in Barnes County for the proposed 300.15 MW Project with the project landowners. Notably, 100 percent of landowners of properties proposed as turbine sites are also owners of Peak. These previous easements have since expired; however, renewals of these easements are underway, with anticipated completion by the end of July 2016. Land rights will encompass the proposed wind farm and all associated facilities, including but not limited to wind and buffer easements, wind turbines, access roads, underground collection lines, and MET towers.

5.0 PROPOSED SITE

5.1 IDENTIFICATION OF PROJECT AREA

Glacier Ridge selected the Project Area based on its wind resource, presence of willing landowners, access to transmission facilities, and low presence of environmentally sensitive features. The Project Area boundary surrounds an area of 34,450 acres (54 square miles) (**Figure 1**). However, the land occupied by turbines and other wind farm infrastructure during operation will be less than 1 percent of this area. As much as 92 acres of permanent land use for Project facilities during operation is expected, as described in **Tables 1-3 and 1-4**. As much as 920 acres of land temporarily disturbed during construction of the proposed Project is expected (**Table 1-4**). See **Section 1.3.1** and **Section 7** for a detailed description of impacts on the Project Area.

5.2 WIND CHARACTERISTICS IN PROJECT AREA

The U.S. Department of Energy's Wind Program and the National Renewable Energy Laboratory published a wind resource map of the State of North Dakota. This resource map shows wind speed estimates at approximately 263 feet above ground, and depicts the resource that could be used for utility-scale wind development. Areas with annual average wind speeds around 14.5 mph at greater at 263 feet above ground are generally considered suitable for wind energy development (USDOE 2015). The map indicates that good-to-excellent wind resource areas are present throughout North Dakota; based on this map, the Project Area has annual average wind speeds around 16.7 to 17.9 mph (USDOE 2015).

Glacier Ridge has utilized wind data from the MET tower in the Project Area for a more detailed wind resource assessment. Long-term predicted wind speeds at the on-site MET tower in the Project Area range from about 15.9 to 17 mph. Quality-controlled data from this tower correlated to the best long-term references—in this case, weather and climate data from the National Aeronautics and Space Administration, from Michigan Energy and Resources Research Association (MERRA), and from other local MET towers. Using the shear measured on the MET tower in combination with RES Americas' proprietary topographical models, Glacier Ridge was able to extrapolate predictions of wind speeds at MET tower locations at the 285-foot hub height of the proposed Project turbines. Average estimated wind speed at the proposed turbine hub height is approximately 17.9 mph.

6.0 ENGINEERING AND OPERATIONAL DESIGN ANALYSIS

This section summarizes the proposed Project, including descriptions of the proposed Project layout, turbines, electrical system, and associated facilities. Additional design components addressed in this section are proposed Project construction, schedule, operation, and decommissioning of the site. Other feasible turbines for the Project Area are available from various manufacturers, and Glacier Ridge wants to reserve the right to select alternative turbines representative of the 3.45 MW class of wind turbines. Turbine type may affect number and configuration of the turbine array. Details about Vestas V126 3.45 MW turbines appear below.

6.1 PROPOSED PROJECT LAYOUT AND ASSOCIATED FACILITIES

The proposed Project will consist of an array of wind turbines and transformers. The turbines will be interconnected by 34.5 kV power collection cables and co-located fiber optic communication cables within the wind farm.

Land will be graded on site for the turbine pads. Drainage systems, access roads, storage areas, and construction laydown/turbine storage areas will be installed as necessary to fully accommodate all aspects of construction, operation, and maintenance.

Details regarding electrical system design and interconnection will result from studies and discussions with Peak. The proposed Project includes the computer-controlled communications system, SCADA, which permits automatic independent operation and remote supervision, thus allowing simultaneous control of many wind turbines. Glacier Ridge will be responsible for O&M over the life of the proposed Project, and will contract with an appropriate supplier of O&M services at the time of operation to ensure timely and efficient operations.

6.2 DESCRIPTION OF WIND TURBINES

The proposed Project is currently designed to include a total of 87 Vestas V126 3.45 MW turbines. Glacier Ridge is seeking flexibility from PSC to select the most appropriate technology for the proposed Project at the time of construction to ensure optimization of wind and land resources and cost efficiency.

6.2.1 Turbine

The selected turbine model will have a hub height of 285 feet and will measure 492 feet from the base of the tower to the tip of the upright blade.

The turbines have active yaw and pitch regulation and asynchronous generators; they function according to a bedplate drive train design whereby all nacelle components are joined on common structures to improve durability.

The turbines have 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 simultaneous control of many wind turbines. Operations, maintenance, and service for the proposed Project will be structured to achieve timely and efficient operations. The computerized data network will provide detailed operating and performance information about each wind turbine. Glacier Ridge will maintain a computer program and database for tracking each wind turbine's operational history.

6.2.2 Rotor

The rotor consists of three blades mounted to a rotor hub. The hub is attached to the nacelle, which houses the gearbox, generator, brake, cooling system, and other electrical and mechanical systems. The 3.45 MW turbines have a 413-foot rotor diameter, with a swept area of 134,215 square feet and a rotor speed between 5.9 and 16.3 revolutions per minute (rpm).

6.2.3 Turbine Tower

The turbine towers will all be conical tubular steel with a hub height of up to 285 feet. The portion of the foundation above ground will be 15 to 16 feet wide at the base of the tower. The turbine towers, on which the nacelle is mounted, will consist of three to four sections manufactured from certified steel plates. All welds will be made by automatically controlled, power welding machines, and will be ultrasonically inspected during manufacturing per American National Standards Institute specifications. All surfaces will be sandblasted and multi-layer coated for protection against corrosion. Access to the turbine will be via a lockable steel door at the base of the tower.

6.2.4 Lightning Protection

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

6.3 DESCRIPTION OF ELECTRICAL SYSTEM

Within the nacelle of each turbine, a step-up transformer will be installed to step up voltage to the power collection line voltage of 34.5 kV. Power from these transformers will be run through an underground collection system consisting of various-sized buried cables. Collection lines will be buried to greater than 42-inch depth and will not affect farming equipment. All collection system cables will terminate at the proposed Project substation, where additional substation equipment will be installed to accommodate the proposed Project. The substation will include power transformers to step up voltage from 34.5 to 345 kV and provide necessary protection and control for interconnection to the transmission grid. Proposed location of the Project substation is along 125^{th} Avenue SE in the northwest quarter of Section 12 in Township 141 North, Range 57 West.

All utility protection and metering equipment will meet Glacier Ridge and National Electrical Safety Code standards for parallel operations. The construction manager will ensure establishment of proper interconnection protection.

6.4 SCADA METEOROLOGICAL EVALUATION TOWERS

Up to four SCADA MET towers will be installed during the construction phase of the proposed Project, and will remain in place over the life of the Project. The purpose of the SCADA MET tower is to monitor real-time wind data during operation of the Project to ensure generation of electricity at expected levels. Locations of SCADA MET towers have not yet been determined.

Each SCADA MET tower will stand at the hub height of the chosen turbine (approximately 285 feet), will sit on a single caisson foundation, and will be self-supporting (i.e., no guy wires). Additional engineering details will depend on owner and supplier requirements not known at this time. Given the heights of the SCADA MET towers, Glacier Ridge is required to file with the Federal Aviation Administration (FAA). Artificial lighting for MET towers is anticipated to ensure nighttime visibility of these.

6.5 PROPOSED PROJECT CONSTRUCTION

Several activities must be completed prior to the proposed commercial operation date. Most of these activities relate 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 proposed Project. Pre-construction, construction, and post-construction activities for the proposed Project include:

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

Private turbine access roads will be built adjacent to the turbine towers, allowing access to the turbines during and after construction. Once construction is complete, access roads will typically be up to 20 feet wide (including shoulders), will have an aggregate surface as cover, and will be adequate to support sizes and weights of maintenance vehicles. The specific turbine placement will determine the amount of private roadway to be constructed for the proposed Project.

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 construction personnel. Glacier Ridge estimates approximately 500 additional trips per day in the area during peak construction periods, when most road, foundation, and turbine tower assembly will occur. At completion of each construction phase, equipment items will be removed from the site or reduced in number.

6.5.1 Construction Management

RES Americas will likely perform the initial engineering and will serve as general contractor for construction of the Project. Services of local contractors will be used, where possible, to assist in construction. The general contractor, in coordination with local contractors, will undertake the following activities:

- Securing building, electrical, grading, road, and utility permits
- Perform detailed civil, structural, and electrical engineering
- Schedule execution of construction activities
- Forecast labor requirements and budgeting.

The general contractor will also serve as key contact and interface for subcontractor coordination, and will oversee installation of communication and power collection lines, as well as substation modifications. The general contractor will also oversee installation of roads, concrete foundations, turbine towers, and blades, as well as coordination of materials receiving, inventory, and distribution. Construction of the Project will proceed under direct supervision of an on-site construction manager with assistance of local contractors. Project construction consists of the following tasks:

- Site development, including roads
- Foundation excavation
- Concrete foundations
- All electrical and communications installation
- Turbine tower assembly and machine erection
- System testing.

The construction team will be on site to handle materials purchasing, construction, quality control, testing, and start-up. The general contractor will manage local subcontractors to ensure completion of all aspects of construction. Throughout the construction phase, ongoing coordination will occur among the construction teams to facilitate proposed Project development. The on-site Project construction manager will help coordinate all aspects of the proposed Project, including ongoing communication with local officials, citizens groups, and landowners. Even before the proposed Project becomes fully operational, the O&M staff will be integrated into the construction phase of the proposed 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.

6.5.2 Foundation Design

Each wind turbine's freestanding, 285-foot tubular tower will be connected by anchor bolts to an underground concrete foundation. Geotechnical surveys, turbine tower load specifications, and cost considerations will dictate final design parameters of the foundations. Foundations for similar-sized turbines are generally octagonal, approximately 65 to 70 feet across at the base, and extend 7 to 10 feet below grade. The wind turbine foundation design will be developed by a registered professional engineer licensed to practice in the State of North Dakota.

6.5.3 Civil Works

Completion of the proposed 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 electricity collection/metering location
- Installation of any site fencing and security
- Restoration and revegetation of disturbed land after completion of construction activities.

Any improvements to existing public access roads would consist of re-grading and filling 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 Peak and local landowners, and will conform to local building requirements where these roads intersect with public roads.

Turbine access roads will be located to facilitate both construction (cranes) and continued O&M. Siting roads in areas with unstable soil will be avoided wherever possible. All roads will include appropriate drainage and culverts while still allowing for crossing of farm equipment. Once construction is complete, the roads will be up to 20 feet wide and will be covered with road base designed to allow passage under inclement weather conditions. The roads will consist of graded dirt and will be covered with an aggregate surface, and cement stabilization techniques may be applied. Upon completion of construction, the roads will be re-graded, filled, and dressed as needed.

6.5.4 Commissioning

The proposed Project will be commissioned after completion of the construction phase. The proposed Project will undergo detailed inspection and testing procedures prior to final turbine commissioning. Each component of the wind turbines will be inspected and tested, as will the communication system, MET system, obstruction lighting, high-voltage collection and feeder system, and the SCADA system.

6.5.5 Proposed Project Operation and Maintenance

Glacier Ridge will operate the wind energy facility over the life of the proposed Project. Approximately 6 to 12 people will be employed on site to operate and maintain the facility. The O&M staff will have full responsibility for the facility to ensure O&M will be consistent with the applicable permits, prudent industry practice, and equipment manufacturer recommendations regarding the turbines.

The SCADA system offers access to wind turbine generation or production data; availability, MET, and communications data; and alarms and communication error information. Performance data and parameters for each machine (generator speed, wind speed, power output, etc.) can also be viewed, and machine status can be changed. Also, a “snapshot” facility collects frames of operating data to aid in diagnostics and troubleshooting of problems.

Primary functions of the SCADA system are to:

- Monitor wind farm status
- Allow for autonomous turbine operation
- Alert operations personnel about wind farm conditions requiring resolution
- Provide a user/operator interface for controlling and monitoring wind turbines
- Collect MET performance data from turbines
- Monitor field communications
- Provide diagnostic capabilities of wind turbine performance for operators and maintenance personnel
- Collect wind turbine and wind farm material and labor resource information

- Provide information archive capabilities
- Provide inventory control capabilities
- Provide information reporting on a regular basis.

Maintenance Schedule

Glacier Ridge's on-site operations staff will be responsible for daily maintenance of the proposed Project. This monitoring will be accompanied by visual inspections by the on-site operating staff. Several daily checks will occur during the first 3 months of commercial operation to verify that the proposed Project is operating within expected parameters. Following installation, proposed Project service and maintenance is carefully planned and divided into the following intervals:

1. **First Service Inspection**. The first service inspection will occur 1 to 3 months after the turbines have been commissioned. At this inspection, particular attention will focus on tightening all bolts by 100 percent, a full greasing, and filtering of gear oil.

2. **Semiannual Service Inspection**. Regular service inspections will commence 6 months after the first inspection. The semiannual inspection consists of lubrication and a safety test of the turbine.

3. **Annual Service Inspection**. The annual service inspection will consist of a semi-annual inspection plus a full component check. Bolts will be checked by use of a torque wrench. The check will cover 10 percent of every bolt assembly. If any bolts are found to be loose, all bolts in that assembly will be tightened 100 percent, and the finding will be recorded.

4. **Two-Year Service Inspection**. The two-year service inspection will consist of the annual inspection, plus checking and tightening of terminal connectors.

5. **Five-Year Service Inspection**. The five-year inspection will consist of the annual inspection, an extensive inspection of the wind braking system, checking and testing of oil and grease, a balance check, and a check of tightness of terminal connectors.

6.5.6 General Maintenance Duties

O&M field duties listed below include performing all scheduled and unscheduled maintenance—including periodic operational checks and tests, and regular preventive maintenance on all turbines, related plant facilities and equipment, safety systems, controls, instruments, and machinery:

- Maintenance of the wind turbines and of the mechanical, electrical power, and communications system
- Performance of all routine inspections

- Maintenance of all oil levels and changing of oil filters
- Maintenance of the control systems, all proposed Project structures, access roads, drainage systems, and other facilities necessary for Project operation
- Maintenance of all O&M field maintenance manuals, service bulletins, revisions, and documentation for the proposed Project
- Maintenance of all parts, price lists, and computer software
- Maintenance and operation of Project substation facilities
- Provision of all labor, services, consumables, and parts required to perform scheduled and unscheduled maintenance on the wind farm—including repairs and replacement of parts, and removal of failed parts
- Cooperation with avian and other wildlife studies as may be required, to include reporting and monitoring
- Management of lubricants, solvents, and other hazardous materials as required by local and/or state regulations
- Maintenance of appropriate levels of spare parts to maintain equipment; ordering and maintenance of spare parts inventory
- Provision of all necessary equipment including industrial cranes for removal and reinstallation of turbines
- Hiring, training, and supervision of a work force necessary to meet the general maintenance requirements
- Application of appropriate security methods.

6.6 DECOMMISSIONING AND RESTORATION

Glacier Ridge will develop a Decommissioning Plan in accordance with NDCC 49-02-27 and NDAC 69-09-09. Additionally, Glacier Ridge has a contractual obligation to the landowners to remove the wind facilities, including foundations to depth of 3 feet below ground, when the wind easement expires. Glacier Ridge also reserves the right to explore alternatives regarding decommissioning at the end of the proposed Project's Certificate term. For example, 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.

7.0 ENVIRONMENTAL ANALYSIS

This section describes environmental conditions 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 selection and design of the site. To support this siting process, maps of the Project Area were generated that indicate presence or absence of many criteria highlighted in NDCC 69-06-08-01.

7.1 DESCRIPTION OF ENVIRONMENTAL SETTING

The proposed Project Area is within northeastern Barnes County in eastern North Dakota, a primarily rural agricultural area approximately 5 miles northeast of Valley City, North Dakota.

7.2 SOCIOECONOMICS

7.2.1 Description of Resources

The proposed Project is in a primarily rural agricultural region in the northeastern portion of Barnes County, North Dakota. The Project Area is between County Road 21 to the west and State Highway 32 to the east. No incorporated communities are within the Project Area. The Project Area is northeast of Valley City (population 6,734) (U.S. Census Bureau 2016). The unincorporated communities of Pillsbury (population 21) and Oriska (population 83) are northeast and southeast of the Project Area, respectively, in Barnes County (U.S. Census Bureau 2016). Within the Project Area are approximately 47 inhabited residences and several agricultural operations, but no indication of new residential construction.

Barnes County

Barnes County had a population of 11,096 persons in 2014, a decrease of 0.06 percent from the population in 2000 (U.S. Census Bureau 2016), but a slight increase from 2013 estimates (11,085). The County encompasses 1,513 square miles of land, with a density of approximately 7.4 persons per square mile. Most of the county population resides in Valley City (U.S. Census Bureau 2016). Approximately 95 percent of the population of Barnes County is composed of white persons who are not of Hispanic or Latino origin. As of 2014, an estimated 20 percent of the county population was 65 years or older, while approximately 5 percent of the population was under 5 years of age (U.S. Census Bureau 2016).

According to the 2014 U.S Census Bureau American Community Survey (U.S. Census Bureau 2016), over 25 percent of the Barnes County workforce worked in education, health, and social assistance, and over 11 percent worked in agriculture, forestry, fishing and hunting, and mining. Retail trade accounted for approximately 10 percent of the jobs in the County. Per capita income estimated in 2014 was $32,698, and the median household income was $54,009 (U.S. Census Bureau 2016). In 2014, approximately 7.4 percent of the county population lived below the poverty level (U.S. Census Bureau 2016), compared to 15.6 percent nationwide (U.S. Census Bureau 2016).

Agriculture continues to play a significant role in the County’s land use and economy. In 2012, 855 farms were in Barnes County, taking up approximately 98.1 percent of land area within the County. According to the 2012 Census of Agriculture (U.S. Department of Agriculture [USDA] 2012), total market value of agricultural products produced in Barnes County was $376,350,000, 97.5 percent of which was from crops and 2.5 percent from livestock sales. Cattle are the primary livestock, and the principal crops include wheat and corn. Soybeans and barley are also grown.

7.2.2 Impacts

No residents will be displaced by the proposed Project. The proposed Project will exert positive economic impacts on the local population, including easement and royalty payments for participating landowners, employment, and tax revenue. In addition, as described above, RES Americas’ development partner Peak is composed of Project landowners. Peak has provided development services to the Project, which has offered participating landowners opportunity for additional economic participation in the Project.

Glacier Ridge estimates that the proposed Project will provide over $19.3 million in property tax revenue to Barnes County over 20 years. In addition, the proposed Project will create approximately 300 construction jobs for approximately 14 months for construction of the proposed Project, and up to 12 permanent full-time jobs. The proposed Project will also provide approximately $18 million in payments to participating landowners over 20 years, which will benefit the local economy as well because those landowners will reinvest that money in local goods and services.

Up to 92 acres (less than 1 percent) of the total Project Area would be permanently affected due to conversion to Project facilities. Landowner compensation has been established under individual easement agreements, and includes compensation for crop damage during surveys and construction. Farming within most agricultural areas surrounding each turbine will still be possible. Moreover, in an environment of uncertain agricultural prices and yields, the supplemental income provided to farmers from wind energy easements is expected to provide stability to farm incomes, and thus help ensure continued viability of farming within the Project Area. Proposed Project construction would not result in additional impacts on leading industries within the Project Area. No concentration of any minority or low-income population in any one area of the proposed Project is evident; nor would the wind turbines 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 Barnes County will contribute to the total personal income of the region. Additional personal income will be generated for residents in the counties by circulation and recirculation of dollars paid out by the Applicant as business expenditures, and additional state and local taxes will benefit the State and local political units. Expenditures for equipment, energy, fuel, operating supplies, and other products and services will benefit businesses in the County and the State.

Up to 300 construction workers are expected to be required for approximately 14 months for construction of the proposed Project. General labor likely will be available either within the County or the State to serve basic infrastructure and site development needs of the proposed Project. Specialized labor will be required for certain components of wind farm development. This labor likely 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 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 and around Valley City. O&M of the facility is anticipated to require 6 to 12 full-time employees, most of whom are expected to reside locally. Sufficient permanent housing is available within the host and surrounding counties to accommodate these new employees.

Long-term beneficial impacts on the County's tax bases as a result of construction and operation of the wind farm will contribute to improving the local economy in this area of North Dakota. Development of wind energy in this region has been important in diversifying and strengthening the economic base of eastern North Dakota. In addition, establishing the central region of North Dakota as an important producer of renewable energy, such as wind, has spurred development of wind-related businesses in the area, and in turn has contributed to economic growth within the region; at least four wind energy-related manufacturing facilities are present in North Dakota (AWEA 2015b).

7.2.3 Mitigative Measures

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

7.3 LAND USE

7.3.1 Description of Resources

The land in Barnes County within the Project Area is primarily agricultural with occasional farmstead residences. The proposed Project will be on privately owned land in northeastern Barnes County, approximately 5 miles northeast of Valley City. Glacier Ridge proposes to install an approximately 300.15-MW wind generating facility, consisting of up to 87 wind turbines within an approximately 34,450-acre (54-square mile) Project Area. Current land use within the Project Area is primarily agricultural, supporting both crops and livestock grazing. No city limits are within the Project Area. The Project Area is not within any known military installation (**Appendix B**) or near an intercontinental ballistic missile (ICBM) launch or launch control facility.

Natural resource development in the Project Area consists primarily of agriculture. Agricultural production is anticipated to continue in the future.

Table 7-1 and **Figure 5** identify land cover as an indicator of land uses in the Project Area based on 2011 U.S. Geological Survey (USGS) National Land Cover Database (NLCD). Land cover in the Project Area is dominated by cultivated crops (84 percent), followed by emergent herbaceous wetlands (4.5 percent). Developed, open space land (3.7 percent), pasture/hay land (3.2 percent), and grass/herbaceous land (2.5 percent) are also present in the Project Area, but in limited quantities. Open water, forest (deciduous, evergreen, and mixed), woody wetlands, and developed (low and medium intensity) categories each take up less than 1 percent of the Project Area. Photographic documentation of land uses and landforms appears on **Figure 6**.

Table 7-1. Land Cover within the Project Area

Land Cover	Acreage	Percent of Project Area
Cultivated Crops	28,978	84%
Emergent Herbaceous Wetlands	1,582	4.5%
Developed, Open Space	1,266	3.7%
Pasture/Hay	1,113	3.2%
Grassland/Herbaceous	862	2.5%
Open Water	292	<1%
Deciduous Forest	133	<1%
Evergreen Forest	82	<1%
Mixed Forest	72	<1%

Woody Wetlands	50	<1%
Developed, Low Intensity	16	<1%
Developed, Medium Intensity	4	<1%
TOTAL	**34,450**	

Source: Homer and others 2011.

The National Resource Conservation Service (NRCS) administers a number of conservation-based programs for private landowners. The Conservation Reserve Program (CRP), administered by the USDA Farm Service Agency (FSA) in coordination with NRCS, provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The 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 authorization of NRCS. FSA does not communicate locations of CRP lands without written authorization. According to USDA FSA, approximately 56,174 acres of land in Barnes County was active in the CRP program as of 2014 (USDA FSA 2015a). Glacier Ridge will confirm enrollment of lands within the proposed Project footprint in the CRP or other NRCS easement programs with participating landowners.

North Dakota Department of Trust Lands (NDDTL) (School Trust Lands) are not present within the Project Area, although NDDTL does own mineral rights to seven parcels within the Project Area (**Figure 8**).

7.3.2 Impacts

Development of the proposed Project would not result in significant change in land use, and would not displace any residents or existing or planned industrial facilities. Wind turbines will be sited a minimum of 1,400 feet from occupied inhabited residences. The area would largely retain the rural characteristics of the vicinity. At other wind developments in North Dakota, landowners frequently plant crops and/or graze livestock to the edge of the access roads and turbine pads. The access roads will be up to 30 feet wide and low profile to allow cross-travel by farm equipment. Glacier Ridge 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 impacts on current or future row crop agriculture and environmentally sensitive areas. During construction of wind power facilities, additional areas may be temporarily disturbed for use as contractor staging areas and for installation of underground power lines. These areas will be graded to original contour and, if necessary, reseeded with appropriate vegetation.

Installations of up to 87 turbines and the associated access roads and MET towers would result in permanent conversion of up to 92 acres of land. An additional estimated 920 acres would be temporarily disturbed during the construction phase of the proposed Project, and would be reclaimed. These temporary disturbances would occur primarily for installation of turbines, road construction, collection line trenching, and four permanent MET towers. Because no Project facilities are proposed on properties with surface rights owned by School Trust Lands, no impacts on School Trust Land are anticipated. If mineral resources under or near Project facilities would be extracted in the future, the Project would have to accommodate the mineral rights developer.

7.3.3 Mitigative Measures

Glacier Ridge is working closely with landowners and Peak, and seeking input from local, state, and federal agencies regarding locations of wind turbines and access roads that would minimize land use disruptions and impacts on environmentally sensitive areas. Operation of the wind farm would not change land use on the vast majority of land within the Project Area. The proposed land use will not involve any ongoing industrial use of non-renewable resources or emissions into the environment.

7.4 PUBLIC SERVICES

7.4.1 Description of Resources

Local Government Services

The Project Area is within a rural, lightly populated area in eastern North Dakota. An established transportation and utility network provides access and necessary services to small cities, homesteads, and farms near the Project Area. No incorporated communities are within the Project Area (see Section 7.2). Valley City provides sanitary sewer, water, utility services, educational facilities, and recreational facilities and parks to its residents and visitors. Valley City's local services include a police department, a fire department, a landfill, a water treatment plant, and floodplain protection. Barnes County provides a sheriff and some public health and safety services for homes in the Project Area. The Project Area includes multiple school districts.

Electrical Service

Rural electrical service in the Project Area is provided by Cass County Electric Cooperative.

Roads

County and township (section line) roads characterize the existing roadway infrastructure in and around the Project Area. The Project Area is accessed via Interstate-94 and State Highway 32, and other local two-lane paved and gravel county roads.

Traffic

Table 7-2 lists current traffic volumes on the area's major roadways, based on 2015 and 2016 North Dakota Department of Transportation (NDDOT) traffic counts. Determining the specific capacity of any highway is a complex process. However, general estimates are useful 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, but no vehicle count data are available regarding these roads. NDDOT indicated that most 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 counts on routes for which count data are available.

Table 7-2. 2015 and 2016 Daily Traffic Levels on Monitored Roadways

Roadway Segment	Existing AADT/Commercial Truck Traffic
State Highway 32 north of Project Area	540/170
State Highway 32 south of Project Area	625/110
State Highway 32 at I-94, northbound	840/140
State Highway 32 at I-94, southbound	715/not available
I-94 west of State Highway 32, westbound	495/60
I-94 west of State Highway 32, eastbound	280/40
I-94 between Valley City and State Highway 32	12,150/3,260*

Source: NDDOT 2016.
*2016 Traffic Data

Water Supply

The Project Area is entirely within an unincorporated, rural portion of Barnes County. Provision of water is assumed primarily from private groundwater wells. Drillers' logs from the North Dakota State Water Commission (NDSWC) indicate presence of 10 wells in the Project Area: 1 domestic well in the west-central portion of the Project Area, 7 observation wells in the west-central portion of the Project Area, 1 test hole in the west-central portion of the Project Area, and 1 test hole in the northern portion of the Project Area (NDSWC 2016).

Communications

Telecommunications infrastructure and services in the Project Area include underground telephone and fiber optic cables, communication towers, AM and FM radio broadcasts, off-air television, federal and non-federal microwaves, and land mobile radio. Locations of underground communication cables in the Project Area will be identified by the respective utility companies prior to Project construction.

In May 2016, Glacier Ridge contracted Comsearch to conduct telecommunication studies for the Project (**Appendix B**). Comsearch identified 20 land mobile and emergency sites in the vicinity of the Project Area. Comsearch identified one AM station and five FM stations within 18.6 miles of the Project Area. Nine tower structures and 27 communication antennas were identified in the vicinity of the Project Area; 33 off-air television stations were identified within 75 miles of the Project Area, including 5 full-power digital stations. Comsearch identified three Federal Communications Commission (FCC)-licensed, non-federal beam paths that intersect the Project Area (**Appendix B**).

7.4.2 Impacts

The proposed Project is expected to minimally affect existing services and infrastructure. The following is a brief description of impacts that may occur during construction and operation of the proposed Project:

Local Government Services

No impact on local services is expected.

Electrical Service

The proposed Project will require station service from the local electric provider when the Project is not generating electricity.

Roads

Construction of the proposed Project will require approximately 46.8 miles of new aggregate-surfaced access roads. During operation of the proposed 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 turbine towers, offset as necessary to allow for adequate crane access. One road will be required for each string of turbines. Although a larger temporary disturbance area is likely during construction, the permanent access roads will primarily be up to 20 feet wide and low profile to allow cross-travel by farm equipment.

Traffic

Truck traffic will temporarily increase during construction activities. The maximum construction workforce is expected to generate approximately 500 additional vehicle trips per day on roads where construction is active within the proposed Project Area. Usage of several combinations of state and county highways and other township roads throughout the Project Area is expected to result in negligible traffic impacts. Approximately 30 concrete trucks will be required to pour the foundation for each turbine. This is typically completed within 2 days. Despite some noticeable increase in heavy vehicle traffic at discrete locations for limited amounts of time, within the Project Area as a whole, impacts on capacity of route and level-of-service to the traveling public will be negligible because of usage of several combinations of state and county highways and other township roads throughout the Project Area. Operating permits will be acquired from the State and County as necessary.

Truck access to the proposed Project site is anticipated to be via Highway 32, which runs north and south east of the Project Area. Specific additional truck routes will be dictated by delivery location. Additional operating permits will be issued by the State or County for over-sized truck movements.

Water Supply

Construction and operation of the proposed Project will not significantly impact local water supply. Acquisition of water required to construct foundations and to implement dust control is anticipated via transport to the site by trucks or use of a new or existing on-site pump. Abandonment of wells is not required for the proposed Project. The Applicant has mapped locations of documented wells to ensure that private water wells are not directly or indirectly impacted by the proposed Project. The proposed Project will not require appropriation of surface water or permanent dewatering. Temporary dewatering of groundwater may be required during construction of turbine foundations. If advancement of a new well is required for either construction of the Project or the O&M facility, this will conform to NDAC 33-18-01, water well construction rules.

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. No impacts are anticipated on land mobile and emergency service communications.

Interference by wind turbines with AM and FM radio and television signals has gradually diminished over the past decade due to advances in turbine manufacturing and transmitter/receiver antenna design. This has reduced effects on AM and FM radio systems to the point where only small degradation of signal is noticed a few yards from a turbine location. The Project is not expected to affect coverage of AM and FM radio services because turbines will be constructed a sufficient distance from each station and dwelling.

With the switch to digital television in 2009 throughout the United States, ghost images and flickering possibly caused by wind turbine interference with analog signals is no longer an issue. Both cable service and direct broadcast satellite service will be unaffected by presence of wind turbines.

No impacts on FCC-licensed microwave beams are anticipated from the proposed Project turbines because a beam path setback of blade length (207 feet for the Vestas V126 turbines) plus 33 feet (total 240 feet) has been incorporated in the turbine layout.

Glacier Ridge contacted the National Telecommunications and Information Administration (NTIA) regarding the proposed Project in May 2016; a response is anticipated by the end of July 2016. The request for review is included in **Table 8-1**.

7.4.3 Mitigative Measures

Construction and operation of the proposed Project will accord with all applicable local, state, and federal permits and laws, as well as industry construction and operation standards.

Local Government Services

No impact on local services is anticipated, and no mitigation is required.

Electrical Service

Glacier Ridge will purchase station service from Cass County Electric Cooperative, which will suggest appropriate configurations for the electrical system that Glacier Ridge will abide by to prevent impacts on the transmission system. Glacier Ridge has established a setback of 738 feet (1.5 x tip height) from existing overhead transmission lines (**Table 4-1**). No additional mitigation is necessary.

Roads

Glacier Ridge is working closely with local landowners to locate access roads so as to minimize land-use disruptions to the extent possible.

Traffic

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

Water Supply

Although abandonment of wells is not an anticipated requirement for the proposed Project, in the event wells are abandoned, they will be sealed as required by North Dakota law. If temporary dewatering of groundwater is required during construction activities, discharge of dewatering fluid will comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit and Stormwater Pollution Prevention Plan (SWPPP).

Communications

Electrical collection and telecommunication lines will be buried underground to avoid collisions, to the extent practicable. An underground utilities locator company will be contacted prior to construction to locate and avoid underground facilities. To the extent proposed Project facilities cross or otherwise affect existing communications systems, Glacier Ridge will enter into agreements with service providers as necessary to avoid interference with their facilities. In the unlikely event that television interference is observed, directional antennas could be added to the homes to mitigate the interference.

7.5 HUMAN HEALTH AND SAFETY

7.5.1 Description of Resources

Air Traffic

One public airport and no private airports/airstrips are within 5 nautical miles of the Project Area. “Nautical miles” is the standard measure for aviation; 1 nautical mile equals 1.15 statute miles. The nearest airport certified for commercial carrier operations is the Barnes County Municipal Airport, northwest of Valley City and approximately 4.5 nautical miles west of the southwestern corner of the Project Area.

Federal Radar Interference

Wind turbines may interfere with radar systems and airspace navigation. A query of the online Department of Defense (DoD) Preliminary Screening Tool was conducted to obtain a preliminary review of potential impacts on Long Range Radar (FAA 2016) and the National Weather Service’s NEXRAD radar systems. Latitude and longitude of a polygon encompassing the Project Area was submitted for review (**Appendix B**).

FAA reviews potential impacts on DoD radar as part of its aviation hazard review of structures that file a Notice of Proposed Construction or Alteration (FAA Form 7460-1). FAA will request that DoD and the U.S. Department of Homeland Security (DHS) review the filing, and may issue a Notice of Presumed Hazard if DoD and DHS determine that impacts on radar are considered significant. Effect of a wind energy project on radar systems primarily depends on distance to the radar, and number and configuration of turbines.

Electromagnetic Fields

Use of electricity in our everyday lives creates electromagnetic fields (EMF). EMFs occur both naturally and from man-made sources. Power lines and utility facilities are among several sources of EMFs. People are exposed to EMFs from many sources at many different levels and durations throughout their daily environments. These sources include kitchen and home appliances, wiring in buildings, power lines and utility facilities, and electrical equipment and devices used at workplaces. Examples of natural sources of EMFs include static electricity and the earth’s static magnetic field, which guides a compass needle.

Hazardous Materials / Hazardous Waste

The site is within 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 farm dumps and agricultural chemicals. A Phase I Environmental Site Assessment of the Project Area will occur prior to construction to identify any recognized environmental conditions.

Potentially hazardous materials associated with the proposed Project include fluids found in association with turbines and substation/transformer equipment. Three types of fluids, all petroleum products, will be critical to operation of the wind turbines: gear box oil, hydraulic fluid, and gear grease. The transformers contain mineral oil.

Security

The Project Area is within an area of low population density. Construction and operation of the proposed Project would minimally affect security and safety of the local communities.

7.5.2 Impacts

Air Traffic

Installation of wind turbines creates potential for air traffic collisions. The wind turbines and MET towers will have lighting and markings that comply with FAA requirements, and FAA’s review will include evaluation of any potential interference with air traffic. Glacier Ridge will submit Notices of Proposed Construction or

Alteration to FAA for all proposed Project turbines. FAA's review will include evaluation of any potential interference with air traffic. The wind turbines and MET towers will have lighting and markings that comply with FAA requirements.

Federal Radar Interference

According to the DoD Long Range Radar screening tool, the proposed Project will likely impact Air Defense and Homeland Security radars. Results of the Preliminary Screening Tool indicate that the Project Area primarily appears yellow, indicating possible impact on Air Defense and Homeland Security Radars, although the study by the Capitol Airspace Group indicates that this may be a concern only for turbines taller than 575 feet. Some areas of the Project Area are depicted as green, indicating no impact on Air Defense and Homeland Security Radars (**Appendix B**).

National Weather Service Radar

According to the DoD NEXRAD screening tool, the proposed Project is not likely to impact Weather Surveillance Radar—1988 Doppler (WSR-88D) weather radar operations. The National Oceanic and Atmospheric Administration will not perform a detailed analysis, but that agency requested that they be made aware of the proposed Project. The entire search area appears as green (no impact) on the map produced by the screening tool (**Appendix B**).

Military Training Routes and Special Use Airspace

According to results of the Military Operations screening tool, military airspace and training routes do not overlap with the proposed Project; therefore, impacts on military airspace are unlikely (**Appendix B**).

Electromagnetic Fields

Thousands of scientific studies have addressed EMFs. One of the largest EMF research and evaluation programs ($45 million) was established by the U.S. Congress in 1992, and was completed by the U.S. National Institute of Environmental Health Sciences (NIEHS) in 1999. None of these organizations has found that exposure to power frequency EMF causes or contributes to cancer or any other disease or illness. Low-level power frequency EMF will occur around the wind turbine generators (in the nacelles), around the generator step-up unit (GSU) transformers, along the collection lines, and at the proposed Project substation equipment. All proposed Project facilities will be set back from residences as required by state and county regulations. At these distances, EMF levels will not be above background levels. The only exposure would be brief exposure to maintenance workers, primarily at the substation. Based on the above, no significant adverse impacts are anticipated.

Hazardous Materials/Hazardous Waste

A Phase I Environmental Site Assessment will occur, and results will be used to minimize risk associated with recognized environmental conditions that may pose a threat to human health and safety. Significant findings are not anticipated, considering the known historical uses of the site.

As with any construction activity, accidentally spilling fuel, hydraulic fluid, or other hazardous substances is possible during construction of the proposed Project. Potential for such events would be minimized through implementation of a Spill Prevention, Control, and Countermeasures plan, which would include the following:

- Construction equipment will include spill cleanup kits.
- Equipment refueling will take place at secure areas, away from wetlands or drainages.
- Workers will be trained in spill cleanup and use of spill cleanup kits.

These measures will help ensure that surface and groundwater quality would not be degraded through inadvertent spillage of contaminants.

Security

Proposed Project construction and operation would minimally affect security and safety of the local communities.

7.5.3 Mitigative Measures

Air Traffic

Glacier Ridge will submit Form 7460-1 to FAA for each turbine to determine whether the proposed Project layout and lighting would impact navigable airspace or communications technology used in aviation operations. The response from FAA will be submitted to PSC when received. Wind turbines and MET towers will have lighting and markings according to FAA requirements that minimize any potential for air traffic impacts.

Federal Radar Interference

To determine whether the Project will affect Air Defense and Homeland Security Radars, an aeronautical study will be conducted when proposed turbine locations are submitted to FAA.

Electromagnetic Fields

Because no significant adverse impacts are anticipated, no mitigative measures are proposed at this time.

Hazardous Materials / Hazardous Waste

Because 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 turbine towers will be placed at least 738 feet from road right-of-way and 1,400 feet from inhabited residences. 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 construction and operation of the proposed 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 turbine tower is only through a solid steel door that will be locked when not in use.
- Where necessary or requested by landowners, Glacier Ridge will construct gates or fences such as those around the collection substation.

7.6 SOUND

7.6.1 Description of Resources

The Project Area is primarily rural and agricultural. The acoustic environment is defined primarily by farming equipment and local traffic, as well as State Highway 32, which runs north-south to the east of the Project Area. In addition to anthropogenic sound sources, windy conditions of this site define a somewhat elevated ambient sound level, which increases with wind speed. Windy conditions can generate sound caused by rustling of grass and tree leaves.

7.6.2 Impacts

PSC's rules (NDAC 69-06-08-01(4)) specify that sound levels from a wind facility may not exceed 50 dBA within 100 feet of an inhabited residence or a community building, unless waived in writing by the owner. According to Section 6.10 of the Barnes Development Code, sustained noise of over 75 dBA during the day and 65 dBA at night is prohibited.

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

In July 2016, updated acoustic modeling was conducted to estimate anticipated sound levels for the Project (Appendix B). CadnaA 4.2 was used to develop anticipated sound levels from addition of the proposed turbines at 49 receptors within 5,249 feet of the proposed turbine locations. The model included the Vestas V126 sound specifications and the proposed substation location. All 99 proposed turbine locations were included in the model, although only up to 87 turbines will be installed.

The sound modeling results indicated that received sound levels at the 49 occupied receptors were all below the North Dakota sound requirement (Chapter 69-06-08-01(4)), which prescribes a limit of 50 dBA within 100 feet of an inhabited residence. The highest modeled sound level for an inhabited residence was 48.2 dBA (**Appendix B**). Notably, the acoustic model conservatively predicts outdoor sound levels and assumes no shielding or attenuation by trees or other vegetation.

Project construction may cause short-term but unavoidable sound impacts. Once construction is complete, sound impacts from O&M traffic and activities are expected to be negligible.

7.6.3 Mitigative Measures

The primary measure of mitigation of sound from wind turbines is setback distance. Setback requirements set by PSC and Barnes County are listed in **Table 4-1**. Glacier Ridge has applied a minimum 1,400-foot setback distance from all existing inhabited residential structures, which meets the setback requirement of Barnes County (Barnes County Development Code Section 6.17[6]). Reasonable efforts will be made to minimize effects of sound resulting from construction activities.

7.7 SHADOW FLICKER

7.7.1 Description of Resources

Shadow flicker impacts are not regulated in applicable county, state, or federal law, and no permitting threshold has been established regarding hours per year of anticipated impacts on a receptor from a wind energy project. DNV KEMA Renewables, Inc. (DNV GL) conducted an analysis of potential shadow flicker impacts from the proposed Project turbine layout (**Appendix B**). All 99 proposed turbine locations were included in the model, although only up to 87 turbines will be installed. The modeling analysis was conducted to determine shadow flicker effects under realistic impact conditions (actual expected shadow flicker, which takes into account historical sunshine probability, wind speed, and wind direction). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker could occur at the 47 receptors out to 4,921 feet. The analysis assumes that all receptors have direct in-line views of incoming shadow flicker sunlight, and does not account for trees or other obstructions that may block sunlight.

7.7.2 Impacts

A total of 47 occupied structures were identified within 4,921 feet of proposed Project turbines, and were considered potential shadow flicker receptors for the purpose of this analysis. All 99 potential turbine locations were included in the analysis, although only 87 turbines will be installed. At all but four receptors, predicted shadow flicker impacts are less than 30 hours per year (the industry's generally accepted standard and the standard that has been used by PSC). Of the four receptors, three are participating in the Project. Taking into account cloud cover and wind direction at the site of the non-participating receptor, the maximum predicted shadow flicker there was 44 hours per year. **Table 7-3** summarizes shadow flicker modeling results. See **Appendix B** for further information.

Table 7-3. Predicted Shadow Flicker Impacts from the Project.

Predicted Shadow Flicker (Hours/Year)	Number of Residences	Percent of Total Residences
0	7	15
1-10	21	45
11-20	10	21
21-30	5	11
31-40	3	6
41-45	1	2

Total	**47**	**100**

7.7.3 Mitigative Measures

Initial discussions with the non-participating owner of the residence for a waiver have been very positive. If the turbine (T76) causing more than half of the predicted shadow flicker hours is ultimately used, mitigation measures will be employed to reduce shadow flicker to 30 hours per year or less at the affected residence, if necessary.

7.8 CULTURAL RESOURCE IMPACTS

7.8.1 Description of Resources

Archaeological Resources

Tetra Tech performed a Class I Literature Review of archaeological resources within the Survey Corridor (anticipated construction footprint) and a 1-mile buffer around the Survey Corridor (i.e., the Archaeological Study Area) (**Figure 7**). The file review was completed at the State Historical Society North Dakota (SHSND) in May 2016. This file review included identification of archaeological sites recorded during previous surveys within the Survey Corridor and within the Archaeological Study Area.

The literature review identified no previously recorded archaeological resources within the Survey Corridor **(Table 7-4)** and five previously recorded archaeological site leads within the Archaeological Study Area (**Table 7-4**). "Site leads" refer to resources about which sufficient information is lacking to fully record and complete all necessary data fields on North Dakota Cultural Resources Survey site forms. Examples of site leads include: (1) a location recorded from various historical documents; (2) a location reported by a landowner or other non-professional; (3) an "isolate," a location with five or fewer surface visible artifacts which, in the professional judgment of the archaeologist, is likely to be a limited surface expression of a former occupation area where most of the artifacts are still buried; and (4) a location recorded by a cultural resource specialist outside of project area(s), and thus not fully recorded.

The five site leads include one Native American mound, one Native American isolated find, two Euro-American historically documented resources (unknown type), and one Euro-American abandoned church with a cemetery (**Table 7-4**).

Table 7-4. Previously Recorded Archaeological Resources within the Archaeological Study Area

Smithsonian Number	Cultural Affiliation	Description	Recommendation
32BAx0089	Euro-American	Former Church and Cemetery	Avoid direct impacts on site
32BAx0102	Euro-American	Unknown	Avoid direct impacts on site
32BAx0134	Native American	Mound	Avoid direct impacts on site
32BAx0138	Euro-American	Unknown	Avoid direct impacts on site
32BAx0279	Native American	Isolated Find	No further management necessary

Architectural Resources

Tetra Tech performed a Class I Literature Review of architectural resources within the Survey Corridor (construction easement) and a 2-mile buffer around proposed turbine locations (i.e., Architectural Study Area) (**Figure 7**). The Class I Literature Review identified no architectural resources within the Survey Corridor. However, one property (32BA0208 – Salem Church and Cemetery) was identified within the Architectural Study Area (**Table 7-5**). The church and cemetery are unevaluated for listing on the National Register of Historic Places (NRHP).

Table 7-5. Previously Recorded Architectural Resources within the Architectural Study Area

Smithsonian Number	Resource Type	Description	Recommendation
32BA0208	Euro-American – circa(ca) 1896 to Present	Salem Church and Cemetery	Avoid direct impacts on site

Class III Cultural Resources Inventory of Architectural Resources

On June 8, 2016, SHSND recommended a survey of architectural resources at all areas within 2 miles of proposed Project turbines (**Appendix C**). The survey will be completed in July 2016. Once complete, the Class III Cultural Resources Inventory Report will be submitted to SHSND for review and concurrence, and will also be provided to PSC.

Class III Cultural Resources Inventory of Archaeological Resources

On June 8, 2016, SHSND recommended a pedestrian survey of archaeological resources within all areas that the Project would directly impact (**Appendix C**). A Class III Cultural Resources Inventory of the Survey Corridor is underway to identify archaeological resources. Once complete, the Class III Cultural Resources Inventory Report will be submitted to SHSND for review and concurrence, and will also be provided to PSC.

Native American Consultation

In May 2016, Glacier Ridge sent a letter to the North Dakota Indian Affairs Commission notifying the agency about the proposed Project and preparation of this application for a Certificate; no response has been received to date.

7.8.2 Impacts

Architectural Resources

If properties documented in the Architectural Study Area are recommended as potentially eligible for listing in the NRHP and determined to be adversely visually impacted by the Project, Glacier Ridge will work with SHSND to develop an appropriate mitigation plan.

Archaeological Resources

Glacier Ridge is committed to avoidance of all archaeological resources potentially eligible for listing in the NRHP, sites deemed culturally sensitive, or sites that have not been evaluated for eligibility following the guidelines outlined by SHSND. Avoidance buffers will placed around archaeological resources that fall within these categories to ensure that the Project exerts no adverse impacts on these resources.

7.8.3 Mitigative Measures

Any sites that will be avoided during construction will be fenced along the avoidance buffer perimeter to reduce potential that they would be inadvertently disturbed. An Unanticipated Discovery Plan will be prepared for the proposed Project outlining the procedure to follow in order to prepare for and address any unanticipated discoveries of cultural resources, including previously undiscovered archaeological sites and possible human remains. This plan will provide direction to on-site personnel and their contractors as to proper procedure to follow if unanticipated discoveries occur during construction of the Project. Therefore, no significant impacts on cultural resources are anticipated from the Project.

If human remains are identified during construction of the Project, work would immediately halt within a minimum of 100 feet of the site, and the site would be protected until SHSND and the North Dakota Indian

Affairs Commission are consulted, in addition to any involved Tribes that express interest in the proposed Project and identify a potential impact.

If confirmed or potential human skeletal remains are discovered, the Barnes County Sheriff's office will be contacted. The Sheriff will call the North Dakota State Forensic Examiner to determine whether the remains are associated with a crime scene. If the remains are determined not to be part of an active crime scene or investigation, the North Dakota Chief Archaeologist will be contacted.

7.9 RECREATIONAL RESOURCES

7.9.1 Description of Resources

Recreational opportunities in Barnes County include boating, swimming, fishing, camping, hunting, and wildlife observation. No registered national wildlife refuges, state game refuges, game management areas, nature preserves, county parks, or formal recreational areas are present within the Project Area.

Lake Ashtabula/Sheyenne River is approximately 5.5 miles west of the Project Area and approximately 5.7 miles west of the nearest proposed turbine. The U.S. Army Corps of Engineers (USACE) owns and operates the Baldhill Dam, constructed in 1950 approximately 10 miles north of Valley City for irrigation water storage and flood control. USACE also manages seven recreation areas and 14 wildlife areas at Lake Ashtabula, the reservoir created by the dam (USACE 2016).

Three state Wildlife Management Areas (WMA) are within 4 miles of the Project Area. WMAs are open to a variety of public uses, including but not limited to, hunting, fishing, and trapping.

Eight units of USFWS waterfowl production areas (WPA) are within 4 miles of the Project Area. None is within the Project Area, but one unit of the Barnes County WPA (Burdick Unit) is within the Study Area and adjacent to the Project Area boundary (**Figure 9**). WPAs are part of the National Wildlife Refuge System, and preserve wetlands and grasslands.

The Sheyenne River Valley National Scenic Byway is approximately 4 miles west of the Project Area. Winding 63 miles, it proceeds along State Highways 17 and 19 through Valley City and south on State Highway 21 to Ransom County Highway 13. The byway is oriented north to south and intersects Interstate 94 in Valley City. Twenty-seven interpretive sites along this Scenic Byway describe Native American, Viking, and pioneer lore (US DOT 2016). National Scenic Byways are designated by the U.S. Secretary of Transportation and the North Dakota Scenic Byways and Backways Program, and these 27 sites are included in a tourism program managed by the North Dakota Parks and Recreation Department and NDDOT.

The North Dakota Game and Fish Department (NDGF) administers and regulates the Private Lands Open to Sportsmen (PLOTS) program to allow hunting access on private lands through lease agreements with landowners. PLOTS allows for walk-in hunting during legal hunting seasons. Four PLOTS parcels are within 4 miles of the Project Area, but none is within or adjacent to the Project Area.

7.9.2 Impacts

No recreational resources will be directly affected by the proposed Project. Recreational impacts would be auditory and visual, and limited to individuals using public or private property in and near the Project Area for hunting, fishing, or nature observation. Photographs of typical landscape within the Project Area appear on **Figure 6**. The Project would not introduce a new visual element into the landscape. Three wind farms are within approximately 10 miles of the Project Area, including the Ashtabula Wind Energy Center and the Ashtabula III Wind Energy Center that are adjacent to the western border of the Project. The Ashtabula and Ashtabula III wind energy facilities are between the proposed Project and potential viewers on or near Lake Ashtabula and the Sheyenne River Valley National Scenic Byway. Proposed Project components are not anticipated to be noticeable to the casual observer from these viewing locations because of distance and existing infrastructure.

7.9.3 Mitigative Measures

Because the proposed Project is not anticipated to result in significant adverse impacts on recreational resources, no mitigative measures are proposed.

7.10 EFFECTS ON LAND-BASED ECONOMIES

7.10.1 Description of Resources

Most of the Project Area is cropland (**Figure 5**). Principal crops include wheat and corn; soybeans and barley are also grown.

Agriculture has historically dominated the local economy, and continues to play a significant role in the County's land use and economy. In 2012, 855 farms were in Barnes County, taking up approximately 98.1 percent of the land area; approximately 84 percent of land on these farms was cropland, and 3.2 percent was pasture. According to the 2012 Census of Agriculture (USDA 2012), total market value of agricultural products produced in Barnes County was $376,350,000, 97.5 percent of which was from crops and 2.5 percent from livestock sales. Cattle are the primary livestock, and the principal crops include wheat and corn.

Prime farmland is land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. NRCS also identifies farmland of statewide and local importance, which is land important for 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 economically when treated and managed according to acceptable farming methods. Some may produce a yield as high as prime farmland if conditions are favorable. **Table 7-6** lists soils within the Project Area, including those considered prime farmland and soils of statewide or local importance. **Figure 3** shows prime farmland soil distribution within the Project Area.

Ten prime farmland soils occur within the Project Area, taking up 18,658 acres or 54.2 percent of the Project Area; eight soil types are considered farmland of statewide importance, totaling 1,603 acres or 5 percent of the Project Area.

Woodlands

Economically important forestry resources are not present within the Project Area. Trees and shrubs in the Project Area are sparse, and limited to windbreaks around residential properties and between fields, or those found in and along drainages and wetlands. Trees observed on site include, but are not limited to, black willow (*Salix nigra*), boxelder/ashleaf maple (*Acer negundo*), eastern cottonwood (*Populus deltoids*), green ash (*Fraxinus pensylvanica*), and Siberian elm (*Ulmus pumila*).

7.10.2 Impacts

Agriculture/Farming

Wind energy development removes less total land from agricultural use than other forms of development. No impacts are anticipated on animal health and safety due to construction or operation of the wind farm and associated facilities. Except for physical locations of turbines, and access roads, all land surrounding proposed Project facilities will be available for grazing. Cattle have been observed using shade from turbines as a refuge at other wind energy projects.

Permanent impacts from the Project are anticipated on approximately 92 acres, primarily from turbine foundations and access roads (**Table 1-3**). Because some of this land may not be used for agricultural purposes, impacts on agricultural production cannot be determined until turbine and road locations are finalized.

The proposed Project would permanently disturb approximately 70 acres of soils classified as prime farmland and approximately 6 acres of farmland soils of statewide importance. This would exert a negligible impact on agricultural production in the County. As noted earlier, wind easement payments will provide farmers with a supplemental source of income, helping ensure that farmers can continue to operate financially viable farms, and thus helping to assure continuation of farming in Barnes County.

No turbines will be placed within 1,400 feet of inhabited residences. Other impacts on residences are discussed throughout **Section 7**. Family farms will be affected due to loss of land associated with construction of turbines and access roads. Extent of impacts will not be known until final turbine locations are determined in conjunction with the landowners.

Woodlands

No significant impacts on woodlands are anticipated.

7.10.3 Mitigative Measures

Agriculture/Farming

Wind turbines and access roads will be located so that the most productive farmland (prime farmland) would be avoided as much as practicable (based on setbacks, avoidance areas, and landowner input). Only land for the turbines, access roads, substation, and O&M building will be unavailable for crop production. Glacier Ridge will work with landowners to minimize impacts on their land. Following construction of the wind turbines, all land surrounding the turbines can be farmed. All construction areas will be separated from grazing animals by temporary or permanent fencing.

Woodlands

If trees are removed as part of the proposed Project, Glacier Ridge will replace those trees per PSC's Tree and Shrub Mitigation Specifications.

7.11 SOILS

7.11.1 Description of Resources

USDA has mapped over 35 soil map units within the Project Area (USDA 2016). These soils include well-drained loams on elevated landforms and poorly drained loams in depressions and low-lying areas. These soils derive from glacial till. Four soil map units comprise approximately 69 percent of the Project Area, including the Barnes-Buse-Langhei loams (8 percent of the Project Area), Barnes-Svea loams (20 percent of the Project Area), Hamerly-Tonka complex (20 percent of the Project Area), and Banes-Buse loams (21 percent of the Project Area). **Table 7-6** summarizes soil map units within the Project Area, including acreages and percentages of the Project Area.

Table 7-6. Soil Map Units within the Project Area

Map Unit Name*	Area (acres)	Percentage of Project Area	Farmland Classification
Balaton-Wyard loams	1,458	4	All areas are prime farmland
Barnes-Buse loams	7143	21	All areas are prime farmland
Barnes-Buse-Langhei loams	2692	8	Not prime farmland
Barnes-Buse-Parnell complex	36	<1	Farmland of statewide importance
Barnes-Cavour loams	7	<1	Farmland of statewide importance
Barnes-Sioux complex	1118	3	Farmland of statewide importance
Barnes-Svea loams	6960	20	All areas are prime farmland
Buse-Barnes loams	65	<1	Not prime farmland
Buse-Barnes-Darnen loams	69	<1	Farmland of statewide importance
Buse-Barnes-Parnell complex	26	<1	Farmland of statewide importance
Buse-Sioux complex	203	1	Not prime farmland
Divide loam	33	<1	All areas are prime farmland
Fordville loam	9	<1	All areas are prime farmland
Hamerly-Tonka complex	6852	20	Prime farmland if drained
Hamerly-Wyard loams	1718	5	All areas are prime farmland
Kranzburg-Lismore silty clay loams	739	2	All areas are prime farmland
Lanona-Buse complex	126	<1	Farmland of statewide importance
Lismore-Kranzburg silty clay loams	272	1	All areas are prime farmland
Lowe loam	86	<1	Not prime farmland
Lowe-Fluvaquents, channeled complex	1020	3	Not prime farmland
Marysland loam	10	<1	Prime farmland if drained
Overly-Nahon silt loams	4	<1	Farmland of statewide importance
Parnell silty clay loam	563	2	Not prime farmland
Renshaw loam	131	<1	Not prime farmland
Renshaw-Sioux complex	40	<1	Not prime farmland
Sioux-Arvilla-Renshaw complex	77	<1	Not prime farmland
Southam silty clay loam	236	1	Not prime farmland

Svea-Cavour loams	217	1	Farmland of statewide importance
Swenoda-Barnes complex	312	1	All areas are prime farmland
Swenoda-Barnes fine sandy loams	14	<1	All areas are prime farmland
Tonka silt loam	69	<1	Prime farmland if drained
Vallers loam	14	<1	Prime farmland if drained
Vallers loam, saline	1489	4	Not prime farmland
Vallers, saline-Parnell complex	642	2	Not prime farmland

Source: USDA 2016.

* Where possible, soil map units with different slope ranges and the same name were combined.

7.11.2 Impacts

Permanent impacts on soils within the Project Area will be limited to areas removed from agricultural production by occupancy of proposed Project facilities, and will mainly include turbines and access roads. Construction disturbance activities including grading for roads and turbine footprints, and excavating for turbine foundations, underground lines, and other infrastructure could contribute to soil erosion through exposure of soils previously vegetated or stable. If cuts occur during construction, topsoil will be segregated and reapplied after final contours will have been graded.

7.11.3 Mitigative Measures

Wind and water erosion are potential hazards for soils within the Project Area. To minimize erosion during and after construction, best management practices (BMP) for erosion and sediment control will be implemented. Sediment control practices at construction sites will accord with the SWPPP. A Project-specific erosion control protocol based on the SWPPP will be developed to treat disturbed and exposed soil surfaces, prevent erosion, and avoid contamination of natural water resources. Turbine towers will be located on relatively gentle slopes, and non-structural erosional control practices will be implemented, including temporary seeding, permanent seeding, mulching, filter strips, erosion blankets, and sod stabilization. In addition, during construction and operation, vehicle speed will be limited to 25 mph on proposed Project roads to minimize dust.

7.12 GEOLOGIC AND GROUNDWATER RESOURCES

7.12.1 Description of Resources

Southeastern North Dakota and the proposed Project Area lie within the Glaciated Plains physiographic province, a rolling, glaciated landscape within the Central Lowlands of North Dakota (Bluemle 2000). Gentle slopes characterize most of the Project Area, and local relief ranges from less than 100 to 300 feet (Bluemle

2000). Most of the Project Area is underlain by as much as 200 feet of unconsolidated glacial sediments of the Coleharbor Formation of Pleistocene age that were deposited from the Kensal-Oakes Moraine (Appendix C).

These unconsolidated sediments are underlain by Late Cretaceous bedrock of the Pierre, Niobrara, and Carlile formations (Bluemle 1988). The Pierre formation is mapped within western and southwestern portions of the Project Area and consists of layers of shale overlying the Niobrara formation (NDGS 2016). The Niobrara formation is mapped throughout much of the Project Area and consists of layers of calcareous shale overlying shale of the Carlile formation (NDGS 2016). The Carlile formation is mapped in the north and northeastern portion of the Project Area, and consists of layers of shale overlying sandstone of the Dakota formation (Kelly 1966). Both the Pierre and Niobrara formations occur in limited outcrops along drainages in portions of Barnes County, and have been found to exhibit slope stability problems along natural and engineered slopes throughout the Sheyenne River Valley (NDGS 2016).

According to USGS, North Dakota is within an area of low seismic risk (USGS 2014). No known active tectonic features or faults known to generate earthquakes with magnitudes of 6 or greater are in North Dakota (USGS 2015). Related geologic hazards, such as soil liquefaction, are therefore also unlikely. The NDGS landslide mapping program has not yet inventoried the Project Area for landslides, but correspondence between Tetra Tech, Inc. and NDGS (**Appendix C**) suggests that landslides in the region would be more likely near the Sheyenne River, where Late Cretaceous bedrock is exposed on or near the surface.

Although both water-table and artesian aquifers are present in Barnes County, the most common type is the “leaky” artesian aquifer, which receives water from confining overlying and underlying deposits, and is a hybrid between a confined and an unconfined aquifer. The confining layers are only semi-confining, slowing but not stopping infiltration. Gravel deposits provide preferential flow paths and groundwater storage capacity within the unconsolidated glacial deposits. Wells that do not intersect the gravel deposits recharge very slowly. Wells that do intersect the gravel deposits are productive, and most local communities and rural residences within Barnes County rely on these unconsolidated, semi-confined, leaky aquifers as a source of drinking water. Flow rates are variable within the unconsolidated aquifers, with many yielding between 3 and 5 gallons per minute up to as much as several hundred gallons per minute depending on the aquifer (Kelly 1966). Only the Pierre formation is known to yield water in significant amount to wells in Barnes County. Most wells completed in the Pierre formation are within the central portion of the County, with most yielding relatively small volumes of water (less than 5 gallons per minute). The Dakota formation is also a source of groundwater in the Project Area, although its depth (1,000 feet deep and greater) and high salinity limit its use; however, several wells completed within the Dakota formation have high yields ranging from 65 to 750 gallons per minute. Production from the Dakota formation decreases over time as hydrostatic pressure in the aquifer drops. A description of known water wells in the Project Area appears in **Section 7.4.1** (Water Supply).

Mineral trust lands are present in southern and northern portions of the Project Area (**Figure 8)**. At this time, the exact nature of these mineral trusts is unknown. NDGS maps indicate no historical, recent, prospective, or inactive sand and gravel extraction operations within the Project Area (Anderson 2010). Desktop data from the North Dakota Department of Mineral Resources (NDDMR) soil and gas database (NDDMR 2016) lists no wells in the vicinity of the Project Area.

7.12.2 Impacts

Impacts of the proposed Project on available mineral resources are likely to be very limited. In the unlikely event that a developer would want to develop mineral resources beneath Project infrastructure, the Project would have to accommodate that.

The Project Area is within a region of low seismic risk, and landslide areas are not present in the Project Area based on review of available geologic information. Consequently, geologic hazards are unlikely to impact the proposed Project, and the proposed Project is not likely to affect geologic hazards. Thus, no significant impacts on geology are anticipated.

Impacts on groundwater resources in the Project Area are anticipated to be minimal. Major withdrawals of groundwater will not be necessary because water supply needs of the proposed Project will be limited. Water required to construct foundations and to control dust is anticipated to be brought on site via trucks. If advancing a new domestic well is required for project construction or the O&M facility, this will comply with NDAC 33-18-01, water well construction rules. Considering the small amount of increased impervious surface area that will be created by proposed Project components relative to separation of these components and size of the entire Project Area, the proposed Project likely will minimally affect regional groundwater recharge. Only a small number of private wells are in the Project Area, and proposed Project construction activities such as excavation and construction of foundations are unlikely to affect groundwater quality or flow patterns. Glacier Ridge has mapped locations of documented wells to ensure that private water wells will not be directly or indirectly affected by the proposed Project. Moreover, each turbine will be located a minimal distance of 1,400 feet away from inhabited residences, thereby minimizing risk of impacts on private wells in the area, which are assumed proximate to the structures they serve.

Development of turbine foundations may require dewatering of excavations, and water would be discharged to the surrounding surface. Allowing the water to infiltrate back into the ground would require compliance with a stormwater permit.

7.12.3 Mitigative Measures

Glacier Ridge is coordinating with land owners and mineral rights owners to identify potential future development issues.

Wind turbine locations will not impact use of existing water wells because the turbines will not be sited within 1,400 feet of inhabited residences, and locations of known water wells were mapped for avoidance.

If dewatering of excavation areas becomes necessary, an application (Notice of Intent) to obtain coverage under the NPDES general permit for stormwater discharges associated with construction activity will be submitted to the North Dakota Department of Health prior to construction of the proposed Project.

7.13 SURFACE WATER AND FLOODPLAIN RESOURCES

7.13.1 Description of Resources

Surface water and floodplain resources within the Project Area were identified by reviewing USGS topographic maps, Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps, and U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data; also, surface water features were surveyed for proposed Project facilities. Numerous intermittent, unnamed tributaries occur within the Project Area (**Figure 4**). The Project Area primarily drains to the east via small unnamed intermittent streams into the Maple River. The Maple River flows southeast and then northeast into the Sheyenne River, and ultimately to the Red River.

According to electronic data from FEMA and the North Dakota State Water Commission, no 100-year floodplains are present within the Project Area (FEMA 2008, **Appendix C**). The 100-year floodplain is defined as the area that would have a 1-percent chance of inundation by a flood event in any given year.

7.13.2 Impacts

Construction of wind turbines, transformer pads, and access roads will disturb land within the Project Area. The wind turbines will be located to avoid intermittent streams/drainages. Access roads to the turbines will be built to avoid impacts on surface waters to the extent practicable.

7.13.3 Mitigative Measures

Access roads constructed adjacent to intermittent streams/drainages 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 stormwater discharges associated with construction activity will be submitted to the North Dakota Department of Health prior to construction of the proposed Project.

7.14 WETLANDS

7.14.1 Description of Resources

Wetlands are an important natural resource providing a number of critical ecosystem functions, including flood flow attenuation, streambank stabilization, discharge and recharge of groundwater, detention and removal of sediments, and detention, removal, and transformation of nutrients and contaminants. Wetlands also may provide habitat for wildlife and sites for human recreation, education, and aesthetic enjoyment.

A desktop analysis identified probable locations of wetlands and waterbodies prior to field work. Desktop analysis included review of NWI maps (USFWS 2016c, **Figure 4**), aerial photo imagery (USDA FSA 2015b), national hydrography dataset (USGS 2016d), and USFWS wetland easement locations (**Figure 9**). These data revealed presence of wetlands in the Project Area, and were used to facilitate placement of Project facilities to reduce or avoid impacts on wetlands and waterbodies.

The initial desktop analysis was followed by a site visit to microsite select turbine locations in June 2016. Wetland surveys for the proposed Project began in June 2016, and generally apply methodologies cited in the USACE Wetlands Delineation Manual (USACE 1987) and the Regional Supplement (USACE 2010). Surveyed features will be avoided where feasible. A report of findings will be provided upon completion in August 2016.

7.14.2 Impacts

Glacier Ridge has committed to minimize impacts on jurisdictional wetlands or other water of the United States (WoUS) to the extent practicable, and to avoid all impacts on USFWS wetland easements. Based on results of desktop analysis and preliminary field surveys, the proposed Project is not expected to include any “single and complete project” that would meet or exceed the 0.10-acre impact threshold that would require a preconstruction notification (PCN) to the USACE Bismarck Regulatory Office. “Single and complete project” refers to each discrete intersection between proposed Project infrastructure and jurisdictional wetlands and other WoUS. Horizontal directional drilling may be used where necessary to avoid impacts on wetlands from collection line trenching during construction.

Based on discussions with USACE, the proposed Project would likely meet the authorization criteria for a Section 404 Nationwide Permit (NWP) 12 (Utility Line Activities) and/or NWP 14 (Linear Transportation Projects). No requirement for a Section 404 written permit is anticipated as a result of construction of this proposed Project, because the proposed Project is not expected to exceed the 0.10-acre threshold for PCN for NWP 12 or NWP 14. Nevertheless, if the proposed Project does exert minor impacts (less than 0.10-acre) within jurisdictional wetlands/WoUS, compliance with general and State of North Dakota NWP requirements will occur (Appendix C).

Glacier Ridge will obtain a stormwater runoff permit from the North Dakota Department of Health prior to construction. Compliance with specifications of this permit and those of the associated SWPPP will ensure that runoff from areas disturbed by proposed Project construction activities will not adversely affect surface water.

7.14.3 Mitigative Measures

Glacier Ridge has committed to avoiding and minimizing impacts on potentially jurisdictional wetlands and other WoUS, as practicable, and avoiding all impacts on wetlands on USFWS wetland easements. Prior to construction, wetlands in close proximity to proposed Project facilities will be surveyed, and their boundaries will be flagged.

7.15 VEGETATION

7.15.1 Description of Resources

The Project Area is in a rural location where farming and related agricultural operations dominate land use. According to NLCD data, 90 percent of Project Area land use is cultivated crops (84 percent), herbaceous (3 percent), and hay/pasture (3 percent) (Homer and others 2015, **Figure 5**). An additional 6 percent of the Project Area is classified as wet—either emergent herbaceous wet (5 percent) or open water (1 percent). USFWS does have conservation easements within the Project Area (**Figure 9**; however, Project facilities may be placed within these easements (although not within mapped grassland blocks) (USFWS 2016e).

7.15.2 Impacts

Access road construction would exert greatest effects on native vegetation along selected routes, resulting in permanent loss of these habitats. Installation of proposed buried collection lines would temporarily affect native and non-native grasslands. No Project facilities will be placed in mapped grassland areas within USFWS conservation easements.

7.15.3 Mitigative Measures

Glacier Ridge will work to avoid and minimize impacts on trees and shrubs. Trees and shrubs slated for clearance will be inventoried for replacement. Tree replacement will be on a 2-to-1 basis, involving 2-year-old saplings; shrub replacement will be on a 2-to-1 basis, involving stem cuttings. Trees and shrubs will be replaced by the same species or similar species, according to PSC Tree and Shrub Mitigation Specifications.

Impacts on grassland vegetation will be mitigated by reseeding construction areas with native grasses following completion of construction activities, if approved by the landowner. Areas currently in crop will be replaced with crop in coordination with landowner preferences, when applicable. Otherwise, compensation for crop damage will be provided to affected landowners.

No Project facilities will be placed in mapped grassland areas within USFWS conservation easements.

7.16 WILDLIFE

7.16.1 Description of Resources

Although wind energy provides a clean, renewable, energy source, wind energy facilities could impact wildlife, especially birds and bats, which can be killed or injured as a result of colliding with turbine blades. Habitat loss and displacement is also a potential concern for wildlife agencies. To address these concerns, field studies to document wildlife and habitat within the Study Area in accordance with the voluntary USFWS Land-Based Wind Energy Guidelines (USFWS 2012a) were completed or are underway. In addition, Glacier Ridge consulted USFWS and NDGF to discuss the project and planned wildlife survey protocols in April 2009 and in October 2011. The Applicant met with NDGF again in April 2016 (see Section 8.2). USFWS was invited to this meeting and was also provided the meeting notes.

Baseline wildlife surveys were completed in 2009-2010 and in 2012 (**Appendix B**). Avian use surveys were completed in 2009 to 2010, and bat acoustic monitoring occurred in summer and fall 2009. A ground-based raptor nest survey was conducted in 2010 and 2012. Additional eagle/avian use surveys occurred from February through May 2016. An aerial spring raptor nest inventory was conducted in April 2016 before deciduous trees leafed out. A northern long-eared bat presence/absence survey is underway and will be completed by August 2016.

Avian Species

Based on the location of the Project Area and habitat present, the majority of avian species present within the Project Area are expected to be those typically associated with agriculture and grassland habitats, but species associated with localized, scattered wooded, riparian, and wetland areas may also be present. The most common species observed during the 2009 to 2010 avian surveys were unidentified sparrow, common grackle (*Quiscalus quiscula),* red-winged blackbird (*Agelaius phoeniceus*), goose (*Branta canadensis*), and horned lark (*Eremophila alpestris*). All other species comprised less than 5 percent of the observations.

Red-tailed hawk (*Buteo jamaicensis*) and northern harrier (*Circus cyaneus*) were the most common raptor species observed (**Appendix B**).

Bats

Based on available information, moderate- or high-potential occurrences of six bat species—big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), eastern red bat (*Lasiurus borealis*), northern long-eared bat (*Myotis septentrionalis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*)—are expected within or in the vicinity of the Project Area (NatureServe 2014). Migratory tree-roosting bats, such as eastern red bats, silver-haired bats, and hoary bats, travel long distances at altitudes that may overlap the height of wind turbine blades, rendering these species of bats particularly susceptible to direct mortality from wind turbines. These have been the predominant species found during post-construction mortality studies at operational wind energy facilities in North America (Arnett and others 2013). Potential for occurrences at the site of remaining bat species found in North Dakota is believed low.

The acoustic survey in 2009 found generally low bat use (**Appendix B**). Most (74 percent) of the detected calls were low frequency species (e.g., big brown bat, hoary bat, and silver-haired bat). Suitable natural roosting habitats in the Project Area are limited to individual trees, windrows, woodlots, buildings, bridges, and riparian zones. Availability of tree-roosting habitat in the Project Area is limited due to the small size and fragmentation of wooded habitat (this habitat takes up less than 1 percent of the Project Area). Farmstead buildings (houses, barns, etc.) could also provide roosting locations within the Project Area; however, suitability of these man-made structures has not been evaluated. No known abandoned mines that bats could use for roosting are present within the Project Area (PSC 2013). Therefore, bat use of the Project Area is likely to be low given the limited availability of roosting habitat.

7.16.2 Impacts

Potential impacts from the proposed Project on avian and bat species include collisions with wind turbines and guyed MET towers, as well as loss of habitat and displacement.

Avian Collisions

Overall direct impact on birds at the proposed Project would likely be low based on records of fatalities at other wind energy facilities. Recent meta-analyses relevant to the proposed Project have estimated an average all-bird (mostly small birds) fatality rate of 1.81 birds/MW/year in the Great Plains (Loss, Would, and Marra 2013) and 2.29 small birds/MW/year in the Prairie biome (Erickson and others 2014). Discrepancies between the two rates are most likely due to differences in the way geographic areas were defined in the studies; however, both regions are represented within the Project Area, and rates of collision at the proposed Project likely would be similar to rates reported from these meta-analyses.

Bat Collisions

Overall direct impact on bats at the proposed Project would likely be low based on records of fatalities at other wind energy facilities in the Great Plains that average 3.07 bats/MW/year and range from 0.12 to 10.85 bats/MW/year (Hein, Gruver, and Arnett 2013).

Habitat Loss

As stated in the USFWS voluntary wind energy guidelines, a species of habitat fragmentation concern is a species "for which a relevant federal, state, tribal, and/or local agency has found that separation of their habitats into smaller blocks reduces connectivity such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area" (USFWS 2012a). The USFWS North Dakota field office has developed a list of species of habitat fragmentation concern for the State. The range for all 10 species of habitat fragmentation concern includes the Project Area; these species are Baird's sparrow (*Ammodramus bairdii*), bobolink (*Dolichonyx oryzvorus*), chestnut-collared longspur (*Calcarius ornatus*), grasshopper sparrow (*Ammodramus savannarum*), greater prairie chicken (*Tympanuchus cupido*), northern harrier *(Circus cyaneus*), sedge wren (*Cistothorus platensis*), sharp-tailed grouse (*Tympanuchus phasianellus*), Sprague's pipit (*Anthus spragueii*), and upland sandpiper (*Bartramia longicauda*) (USFWS 2013a). Of these species, the bobolink, grasshopper sparrow, northern harrier, sharp-tailed grouse, and upland sandpiper were observed during avian use surveys in the Project Area (**Appendix B**). Habitat fragmentation from construction of a wind energy project could reduce habitat available for these species. However, because the proposed Project would be largely within already disturbed agricultural areas (84% cultivated crops) that are generally considered suboptimal habitat for most avian species, habitat fragmentation is likely to be minimal for most species. Some short-term displacement in grassland areas is expected, but grasslands take up less than 3 percent of the Project Area according to NLCD data, and effects would be mostly limited to the construction period and the immediate area around turbines (Pearce-Higgins and others 2012, Shaffer and Buhl 2015). Regarding bats, given limited and highly fragmented forested habitat in the Project Area, development of the Project likely will not reduce or fragment bat habitat.

Potential impacts on sensitive species are discussed in more detail in **Section 7.17.2** below.

7.16.3 Mitigative Measures

Glacier Ridge is conducting environmental studies of the Project Area to aid in final placement of turbines, roads, and associated facilities in order to avoid and minimize impacts on wildlife and native habitat. The following measures will be implemented, to the extent practicable, by Glacier Ridge to help avoid potential impacts on wildlife in the Project Area during selection of turbine locations and subsequent development and operation:

- Siting access roads and turbines away from wetlands and waterbodies to the greatest extent practicable.
- Designing the layout of the proposed Project to avoid permanent impacts on wetlands where feasible. Avoiding wetland impacts would generally help reduce potential impacts on migratory birds and bats, and on sensitive habitat.
- Burying collection lines from the turbines to the collection substation to avoid collision risk following the Avian Power Line Interaction Committee (APLIC) suggested practices, if practicable.
- Reseeding temporarily disturbed areas to grassland or to crop, depending on original conditions and landowner preferences. Native prairie will be avoided to the extent practicable, and will be reseeded by use of a native prairie mix in accordance with landowner preferences.
- Conducting post-construction bird and bat mortality surveys for 1 year following construction of the proposed Project.
- Developing a voluntary Bird and Bat Conservation Strategy (BBCS), which includes an adaptive management approach, so that information gathered and experience gained from post-construction monitoring can be used to inform future management decisions at the proposed Project.
- Proposing in the lighting plan the minimum number of aviation hazard lights acceptable to FAA in order to avoid attracting migrating birds and bats to the turbines. Glacier Ridge will also install motion-activated lighting or down-shielded lighting on other proposed Project facilities that require lighting at night (i.e., the collection substation) to avoid potential to draw birds and bats toward the facility.
- During construction and operation, limiting vehicle speeds to 25 mph on proposed Project roads to minimize wildlife collisions.

7.17 RARE AND UNIQUE NATURAL RESOURCES

7.17.1 Description of Resources

The Endangered Species Act (ESA), as administered by USFWS, mandates protection of species federally listed as threatened or endangered and their associated habitats. Candidate species receive no statutory protection from USFWS under the ESA unless they are formally listed.

The following federally listed species could occur within Barnes County and potentially the Project Area: whooping crane (*Grus americana*), gray wolf (*Canis lupus*), Dakota skipper (*Hesperia dacotae)*, and northern long-eared bat (*Mytois septentrionalis*) (USFWS 2015b, **Appendix B**). Additionally, bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos,* respectively*)* could occur within the Project Area; both species are protected under the Bald and Golden Eagle Protection Act (BGEPA).

These federally protected species are described below in taxonomic order.

Northern Long-eared Bat (Federally Threatened)

The northern long-eared bat was listed as threatened on April 2, 2015, and a final 4(d) rule published in the *Federal Register* on January 14, 2016, went into effect on February 16, 2016 (USFWS 2016a). The final 4(d) rule limits prohibition of incidental take to areas affected by white-nose-syndrome (WNS) and an additional 150-foot radius buffer around these areas. Under the final 4(d) rule, incidental take is prohibited if it occurs within a hibernacula, results from tree removal within 0.25 mile of a hibernacula entrance, or results from tree removal within 150 feet of a known roost tree during the pup season (June 1 through July 31). Fatalities caused by collisions with wind turbines are explicitly excluded from the prohibition on incidental take. Incidental take is not prohibited outside of the WNS zone described above. North Dakota and specifically the Project Area fall outside of the area where take is prohibited, as currently mapped by USFWS (USFWS 2016b, map updated by USFWS on June 2, 2016).

Northern long-eared bats have been found from Maine to North Carolina on the Atlantic Coast, westward to eastern Oklahoma, and north through the Dakotas, reaching into eastern Montana and Wyoming (USFWS 2013b). The northern long-eared bat is considered common only in discrete portions of its western range, including the Black Hills of South Dakota (USFWS 2013b). This species roosts in trees during the spring, summer, and fall (USFWS 2013b). The species prefers large, contiguous tracks of upland forested habitat during the summer residency period. Natural roosting habitats in the Project Area are limited to individual trees, wind breaks, and woodlots. Northern long-eared bats do not undertake long-distance seasonal migrations between summer and winter ranges, but do undertake shorter distance movements between summer roosts and winter hibernacula. These seasonal movements are generally between 35 miles and 55 miles, but may be substantially longer in some areas, perhaps as great as 168 miles (USFWS 2013b). Information on habitat use during migration is limited, but individuals in transit are likely to use foraging habitats at least part of the time. Northern long-eared bats spend winter hibernating in caves and mines. However, no known wintering hibernacula are within North Dakota (USFWS 2013b).

Occurrence of the northern long-eared bat in the Project Area during the summer residency period (approximately May 15 to August 15) has low likelihood because of lack of large contiguous woodlots within the Project Area. The species has been detected in Barnes County (Western Area Power Administration [WAPA] and USFWS 2015), and could occur in the Project Area during seasonal movements to and from hibernacula; however, no hibernacula are known to occur in the State. Therefore, likelihood of occurrence of the northern long-eared bat within the Project Area is low. A bat acoustic study is underway in the Project Area to determine presence or absence of the northern long-eared bat (**Appendix B**).

Gray Wolf (Federally Endangered)

The gray wolf was listed as endangered in 1974 (USFWS 2014a, b). Gray wolves previously inhabited a large portion of the United States in a variety of habitats including tundra, forests, grasslands, and deserts. Although the gray wolf has been reported in Barnes County (WAPA and USFWS 2015), the Project Area lacks forested areas known to support wolf pack establishment and persistence (USFWS 2012b, NatureServe 2014). Therefore, likelihood of the species transiting the Project Area is low to moderate, but the species is unlikely to maintain a local resident population.

Whooping Crane (Federally Endangered)

The whooping crane was listed as threatened with extinction in 1967 and endangered in 1970—both listings were "grandfathered" into the ESA of 1973 (Canadian Wildlife Service [CWS] and USFWS 2007). The whooping crane population belonging to one flock that migrated between Wood Buffalo National Park in Canada and the Arkansas National Wildlife Refuge in Texas was reduced to 16 individuals during the winter of 1941-42. With conservation efforts, the Arkansas-Wood Buffalo National Park population (the single self-sustaining wild population) has been steadily rising—estimated population during the 2014-2015 winter census was 304 individuals (with 95-percent probability of actual flock size between 267 and 350 birds) (USFWS 2015c). A 200-mile-wide migration corridor has been delineated for this population; within this corridor, 95 percent of all verified sightings have occurred. Spring migration occurs primarily in April and May, whereas fall migration occurs primarily in October and November (Lewis 1995). Stopover habitat during migration includes a variety of croplands, with roosting occurring in shallow, freshwater inland wetlands (Lewis 1995). Four additional areas associated with major stopover areas are designated as critical habitat: Quivira National Wildlife Refuge and Cheyenne Bottoms State Wildlife Management Area in Kansas; a section of the Platte River in Nebraska; and the Salt Plains National Wildlife Refuge in Oklahoma (USFWS 2012a). Wind energy development has been identified as a threat to the species due to potential for displacement as a result of presence of turbines, and potential for collisions with operational wind turbines and new power lines (USFWS 2012a).

The Project is outside the defined 200-mile-wide whooping crane migration corridor, although foraging and roosting habitat is available within the Project Area. Likelihood of whooping cranes occurring within the Project Area is low based on the location of the Project Area outside of the migration corridor.

Bald Eagle (Federally Protected under BGEPA)

Bald eagles occur throughout the contiguous United States, Alaska, and Canada (Buehler 2000). Bald eagles may occur in North Dakota as breeders, winter residents, migrants, or year-round residents. The nesting period in North Dakota begins with nest building or maintenance in February and ends when the young fledge, typically in July (Johnson 2010). Although bald eagle nests have historically been found primarily along the Missouri River and Red River (Johnson 2010), the number of bald eagle nests has increased in North Dakota over the last 20 years as the species continues to recover from population declines, primarily due to environmental contaminants. Nesting bald eagles now occur in more than half of the counties in the State (Dyke, Johnson, and Isakson 2015), growing steadily to 140-150 active bald eagle nests to date (Johnson 2015). Most nests occur near streams and mid- to large-sized lakes, but bald eagles are also initiating nests in areas not considered traditional nesting habitat such as cottonwood trees surrounded by cropland or grassland (Dyke, Johnson, and Isakson 2015). The home range of bald eagles is variable. Populations in Oregon and Washington have home ranges of 2.7 to 18.1 square miles, with an average of 8.5 square miles (Watson, Garrett, and Anthony 1991). In Montana, the average home range size was 3.5 square miles (Stangl 1994). Along the Mississippi River in Minnesota, nests were separated by an average 0.94 mile (Mundahl, Bilyeul, and Maas 2013).

During the non-breeding season (September through January) (USFWS 2013c), bald eagles concentrate near large bodies of water where the water remains unfrozen, and roost up to 20 miles from foraging sites, depending on abundance of prey (Buehler 2000). Bald eagles are opportunistic foragers that prey primarily on fish but also feed on other aquatic and terrestrial vertebrates, as well as on carrion (Buehler 2000).

Although no bald eagles were observed during the 2009-2010 avian use surveys, five bald eagles were observed during the winter/spring 2016 eagle use surveys. One bald eagle nest was found approximately 1,000 feet west of the southwestern corner of the Project Area during a nest inventory in April 2016 (**Appendix B**). Glacier Ridge has implemented a 1.5 mile setback from this nest. Two additional known bald eagle nests are within 10 miles of the Project Area, according to NDGF. These nests were also located during the spring 2016 aerial raptor nest surveys.

Likelihood of occurrence of bald eagles in the Project Area during winter is low, given absence of large bodies of water that remain unfrozen within or near the Project Area. Although bald eagles are known to breed in the vicinity of the Project Area, overall likelihood of extensive breeding within the Project Area is low due to lack of suitable nesting habitat. Bald eagles nesting in the vicinity of the Project could occur in the Project Area when foraging or migrating.

Golden Eagle (Federally Protected under BGEPA)

Golden eagles are common in western North America west of the 100th meridian, with small populations also present in the eastern portions of Canada and the United States (Kochert and others 2002). Golden eagles in the western U.S. are most commonly associated with open and semi-open habitats such as shrublands, grasslands, woodland-brushlands, and coniferous forests, as well as in farmland and riparian habitats (Kochert and others 2002). Both year-round and migratory golden eagles occur in North Dakota (Dyke, Johnson, and Isakson 2015). Golden eagles nest on cliffs, utility poles, and in large trees in open areas from late January through August (Kochert and others 2002). Golden eagles in North Dakota nest mainly west of the Missouri River (Johnson 2015), and egg-laying occurs from late March to early May (Stewart 1975, DeLong 2004). The species feeds upon a wide variety of prey species but tends to hunt small to medium-sized mammals such as hares, rabbits, ground squirrels, marmots, and prairie dogs depending upon local availability (Bloom and Hawks 1982, Kochert and others 2002).

No golden eagles were observed during the 2009-2010 avian use surveys or the winter/spring 2016 eagle use surveys. No golden eagle nests were found within the Project Area or 10-mile buffer surrounding the Project Area during a nest inventory in April 2016.

Likelihood of Golden eagles breeding within the Project Area is low due to lack of suitable nesting habitat. Golden eagles could occur in the Project Area when foraging or migrating, although the prey base appears to be limited (e.g., no prairie dog towns have been observed within the Project Area during eagle surveys).

Dakota Skipper (Federally Threatened)

The Dakota skipper (*Hesperia dacotae*) is a small butterfly found in the tallgrass and mixed-grass prairies of the Northern Great Plains. On October 24, 2014, USFWS listed the Dakota skipper as a threatened species (USFWS 2014c). Although its historical range once consisted of vast, unbroken native prairie in the north-central United States and south-central Canada, its current range is now limited to scattered remnants of high-quality native prairie in Minnesota, North Dakota, South Dakota, and southern Manitoba and Saskatchewan (USFWS 2015a). Dakota skipper population has declined due to sensitivity to disturbances such as grazing and fire, and loss of native prairie habitat. USFWS designated 38 units, totaling 19,900 acres, in North Dakota, Minnesota, and South Dakota, as critical habitat (USFWS 2015d). Proposed critical habitat closest to the proposed Project Area is approximately 40 miles to the southeast in Ransom County. The Dakota skipper is known to occur in Barnes County (USFWS 2013d).

Approximately 3 percent of the Project Area is classified as herbaceous land cover according to NLCD data. Due to a shortage of grassland habitat within the Project Area, potential is low for occurrence of the Dakota skipper in the Project Area.

7.17.2 Impacts

Northern Long-eared Bat

The northern long-eared bat is considered uncommon in North Dakota although the Project Area is within the species' range (USFWS 2013b, Dyke 2014). Little suitable roosting or foraging habitat is present in the Project Area, and no known hibernacula for the northern long-eared bat are in North Dakota. The species could collide with operational turbines during the spring and fall periods when migrating between summer roosts and winter hibernaculum. Although northern long-eared bat fatalities have occurred at wind energy facilities, only 41 records of this have been confirmed—all at wind energy facilities east of the Mississippi River (USFWS 2016a). No northern long-eared bat fatalities from wind energy facilities have been documented in North Dakota (USFWS 2016a). Therefore, likelihood is low that the proposed Project would affect the northern long-eared bat. However, a bat acoustic study is underway in the Project Area to determine presence or absence of the northern long-eared bat (**Appendix B**).

Gray Wolf

As gray wolves are unlikely to establish a resident population within the Project Area, the Project is unlikely to impact the gray wolf. This conclusion is also supported by the high degree of agricultural use within the Project Area and roadways associated with this use—a combination of human and road density less than optimal for wolves (Mech and others 1988, Fuller and others 1992, Erb and Sampson 2013).

Whooping Crane

Collisions with turbines, MET towers, or transmission lines could occur as a result of the proposed Project. However, the Project Area is outside of the whooping crane migration corridor, and cranes exhibit avoidance behavior, which minimizes potential for collisions. Sandhill cranes, which often accompany whooping cranes during migration, have been documented altering flight direction in response to turbines at a wind facility in South Dakota (Nagy and others 2012), and multiple studies have documented sandhill cranes gradually climbing as they approach marked power lines (Morkill and Anderson 1991, Murphy and others 2009). Furthermore, no whooping crane fatalities have been recorded at wind facilities to date, suggesting that likelihood of collision may be low (USFWS 2009).

Potential for indirect impacts resulting from habitat loss is likely to be low, because the Project Area is outside the whooping crane migration corridor.

Given the location of the Project Area outside of the migration corridor, as well as avoidance and minimization measures discussed in **Section 7.17.3** (e.g., buried collection systems), likelihood is low that the proposed Project would impact the whooping crane.

Bald Eagle

Six bald eagle mortalities associated with wind energy facilities within the United States were reported from 1997 through June 2012 (Pagel and others 2013). To date, one bald eagle mortality has been reported at a wind energy facility in North Dakota (Public Prairie Broadcasting 2015). Bald eagles are believed to be at less risk of turbine collision than golden eagles because they tend to focus their hunting efforts for fish and waterfowl on lakes and rivers (Buehler 2000). Although the landscape within the Project Area does not support any large waterbodies or an abundance of smaller waterbodies that would attract bald eagles for nesting or foraging, one occupied bald eagle nest is approximately 1,000 feet west of the southwestern corner of the Project Area, and two occupied bald eagle nests are within the 10-mile buffer of the Project Area; however, the proposed Project turbines all would be more than 1.5 miles from the nests. Presence of occupied bald eagle nests in the vicinity of the Project Area suggests that the species could forage in or pass through the Project Area during the breeding season.

Golden Eagle

Seventy-nine golden eagle mortalities associated with wind energy facilities within the United States were reported from 1997 through June 2012, excluding the Altamont Pass Wind Resource Area in California (Pagel and others 2013); however, to date no golden eagle mortalities have been reported at wind energy facilities in North Dakota. Golden eagles are believed to be more at risk of turbine collision than bald eagles because they hunt for land-based prey along topographic contours where turbines are often located (Kochert and others 2002).

No golden eagle nests were found within the Project Area or 10-mile buffer surrounding the Project Area during a nest inventory in April 2016, and no golden eagles have been observed during avian use surveys and eagle use surveys in the Project Area. Golden eagles may forage in or pass through the Project Area; however, no known features would concentrate golden eagles within the Project Area rather than within the surrounding area.

Dakota Skipper

The Dakota skipper is known to occur in Barnes County, and the Project Area is within the extent of the species' range. However, given the low quantity of grassland habitat in the Project Area, likelihood of the Project impacting the Dakota skipper is low.

7.17.3 Mitigative Measures

General avoidance and minimization practices for vegetation and wildlife are discussed in **Sections 7.15.3** and **7.16.3**, respectively. Glacier Ridge has committed to the following additional avoidance and minimization measures specific to potential impacts on federally threatened and endangered species:

- The Project layout was designed to include a 1.5-mile setback from documented bald eagle nests.
- Glacier Ridge will provide all construction and maintenance staff with training in federally listed species identification, and will provide identification guides for whooping cranes to be kept in all vehicles.
- If an injured or dead endangered or threatened animal is found in the Project Area, Glacier Ridge employees will immediately notify USFWS.
- Glacier Ridge will prepare a BBCS that will include 1 year of post-construction mortality surveys and an adaptive management strategy.

7.18 SUMMARY OF IMPACTS

Table 7-7 summarizes resources that would be affected by the Project and appropriate mitigation.

Table 7-7. Summary of Impacts and Mitigation

Resource	Impact	Mitigation
Socioeconomics	Primarily positive due to increased expenditures during construction and long-term benefits of easement payments and an increased tax base of the County due to property taxes.	N/A
Land Use	Up to 92 acres of land would be permanently disturbed by turbines, associated access roads, junction boxes associated with collection lines, permanent MET towers, and substation/O&M facility. Temporary impacts during construction for turbine installation, road construction, cable trenching, laydown and contractor staging, and turbine storage would require an additional 920 acres.	Glacier Ridge will work with landowners and regulatory agencies to minimize impacts of the proposed Project.
Public Services	Minimal impact on existing services and infrastructure.	Construction and operation of the proposed Project will accord with all associated local, state, and federal permits and laws, as well as industry construction and operation standards. Because expected impacts will be minor, additional mitigation measures will not be required.
Human Health and Safety	No adverse 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 adverse impacts are anticipated on noise-sensitive resources (inhabited residences).	Acoustic modeling results indicated that received sound levels are all below the North Dakota sound requirement (Chapter 69-06-08-01(4)), which prescribes a limit of 50 dBA within 100 feet of an inhabited residence.
Shadow flicker	Four inhabited residences are predicted to have more than 30 hours per year of shadow flicker. One of these residences is not a Project participant, although initial conversations for a waiver were positive.	If a turbine causes more than half of the predicted shadow flicker hours to the non-participating receptor, mitigation measures will be employed to reduce shadow flicker to 30 hours per year or less at the affected residence, if necessary.
Cultural and Archaeological	The proposed Project would not directly impact any architectural resources. Avoidance buffers will be created for archaeological sites recorded during the pedestrian survey of the Survey Corridor underway. Glacier Ridge commits to	Sites within or adjacent to the construction easement will be fenced prior to construction. An unanticipated discoveries plan will be prepared prior to

	avoid any newly documented sites and previously documented cultural resources within the Survey Corridor.	construction. Consultation with SHSND will occur if eligible historic resources are visually impacted by the Project.
Recreational Resources	No direct impacts on recreational resources are anticipated.	No mitigation measures are proposed at this time.
Land-Based Economies	Up to 92 acres of land would be permanently affected. An additional 920 acres would be temporarily disturbed for turbine installation, road construction, cable trenching, and other construction activities.	Glacier Ridge has worked with landowners to minimize impacts on their land.
Soils	Impacts on soils limited to 92 acres of permanent disturbance and 920 acres of temporary disturbance.	BMPs for erosion and sediment control will be implemented to minimize wind and water erosion at the site in association with the Project SWPPP. Only land needed for the facility will be permanently affected. Temporarily disturbed areas will be restored.
Geologic and Groundwater Resources	Impacts on groundwater resources in the Project Area are anticipated to be minimal.	A discharge permit may be required if dewatering is necessary during excavation, and a well permit may be required for drilling a new well.
Surface Water and Floodplain Resources	Access roads, turbines, and other proposed Project facilities will be located and constructed in such a manner that impacts on surface waters will be avoided to the extent practicable.	Glacier Ridge will implement BMPs to minimize erosion and sedimentation at the site in association with the Project SWPPP.
Wetlands	Impacts on wetlands and WoUS will be avoided and minimized to the extent practicable.	Wetlands in close proximity to the construction easement will be delineated and flagged prior to construction. Horizontal directional drilling will be used where necessary to avoid permanent impacts on wetlands from collection line trenching during construction. All wetlands on USFWS easements will be avoided.
Vegetation	Up to 92 acres of land will be permanently affected. An additional 920 acres will be temporarily disturbed during construction. Areas of highest quality native prairie, if present, will be avoided when practical. Glacier Ridge will minimize impacts on existing trees and shrubs as practicable, and will implement BMPs during construction and operation to minimize impacts.	If impacts on trees or shrubs cannot be avoided, the individual trees or shrubs will be replaced per PSC regulations. Temporarily disturbed areas will be reseeded or restored to crop, depending on original conditions and landowner preferences. Native prairie will be reseeded by use of a native prairie mix in accordance with

		landowner preferences. No grasslands will be impacted in mapped grassland blocks within USFWS conservation easements.
Wildlife	Avian and bat collisions may occur, but are anticipated to be relatively few. Habitat fragmentation is likely to be minimal for most avian species; the Project is unlikely to fragment bat habitat.	A variety of mitigation measures will be implemented, as discussed in **Section 7.16.3**. Glacier Ridge will complete 1 year of post-construction mortality monitoring. Glacier Ridge will prepare a Project-specific BBCS that documents these measures.
Rare and Unique Natural Resources	The Project is unlikely to affect the gray wolf; likelihood is low that the Project will affect the northern long-eared bat, whooping crane, Dakota skipper, and bald and golden eagles.	Project turbines will be located at least 1.5 miles from documented bald eagle nests. O&M staff will be trained to identify federally protected species. Dead or injured federally protected species will be promptly reported to USFWS.

8.0 PUBLIC AND AGENCY COORDINATION

8.1 PUBLIC OUTREACH

Principal stakeholders in the proposed Project are the 76 Peak owners/landowners who have entered into agreements with Glacier Ridge to provide wind rights for the proposed Project. RES Americas has been in near-daily discussions with the Board members of Peak during preparation of this Application.

An informational meeting with Peak landowners will occur prior to the PSC public hearing. Adjacent landowners and interested community members will have opportunity for public comment during the Barnes County permitting process, as well as the PSC public hearing.

8.2 AGENCY COORDINATION

Per Section 69-06-01-05 of the PSC's administrative rules, Glacier Ridge and its representatives contacted key local, state, and federal agencies on May 31, 2016, to inform them of the proposed Project, and to request assistance in identifying concerns or issues within the Project Area. The Project was originally introduced to USFWS and NDGF during a meeting in April 2009 and again on October 3, 2011. The Applicant invited USFWS staff to a meeting to introduce the Project on April 28, 2016, provided notes from that meeting on May 16, 2016, and provided the proposed northern long-eared bat presence/absence survey plan for the Project on July 5, 2016. A summary of USFWS coordination appears below, although no specific response to Glacier Ridge's May 2016 letter has yet been received.

The Applicant conducted a pre-filing call with PSC staff on May 5, 2016, to introduce the Project and discuss the proposed Project schedule.

Appendix C includes agency correspondence and responses received as of July 7, 2016**; Table 8-1** summarizes responses received from agencies to date. Glacier Ridge will continue to meet with county officials as the proposed Project moves forward and Glacier Ridge seeks any necessary local permits (e.g., building permit).

Table 8-1. Summary of Agency Responses

Agency	Response Date	Response Summary
USFWS	5/3/16	USFWS reviewed the Study Area and specified locations of interest to USFWS (fee-title lands and easements) within or near the Study Area.
	5/05/16	USFWS provided documented eagle nest locations within 10 miles of the Study Area.
	6/10/16	USFWS clarified the status of conservation easements within or near the Study Area.
National Telecommunications and Information Administration (NTIA)	No response received as of July 14, 2016	
SHSND	6/8/16	The SHSND recommended Class I file search and Class III Intensive Cultural Resources Inventories for archaeological sites and historic structures.
	6/17/16	Phone conversation regarded historic structure survey to determine if any unique historic resources are in the Study Area.
NDGS	6/21/16	NDGS has no properties or projects in the Study Area. If paleontological resources are uncovered, NDGS would like to be notified.
North Dakota Department of Health	6/13/16	The agency believes that environmental impacts of the Project will be minor. Fugitive dust emissions should be minimized during construction. Aggregate for road construction should not contain erionite. Impacts on streams should be avoided, and disturbed areas should be revegetated. Projects disturbing one or more acres must have a permit to discharge stormwater runoff. Noise disturbance from construction activities can be minimized by ensuring that construction equipment is equipped with a working muffler, and by not conducting construction activities during early morning or late evening hours. The agency believes that proposed activities are consistent with the State Implementation Plan for the Control of Air Pollution for the State of North Dakota.

Agency	Response Date	Response Summary
North Dakota State Water Commission	6/24/16	No floodplains are present in the Study Area. The Commission indicated that a surface drain permit may be needed from the State Engineer if wetlands are filled or drained. The Commission maintains a network of monitoring wells and gaging stations throughout the State, many of which are close to public right of ways. Information about these locations is accessible on the Commission's website. The Commission requested that the Water Appropriations Division be informed if gaging stations or water wells may be affected or are accidently damaged. All waste materials associated with the Project must be disposed of properly and not placed in floodway areas. No sole-source aquifers have been designated in North Dakota.
NDGF	4/28/16	Glacier Ridge held a meeting with NDGF introducing the Project. Results of previous and ongoing biological studies at the Project were presented during this meeting. NDGF generally agreed that the level of these studies was appropriate for the Project. NDGF indicated that its primary concern regarding wind energy is avoidance or minimization of impacts on native grasslands.
	7/1/16	NDGF indicated that primary concern regarding wind development is disturbance of native prairie, and requested that proposed actions avoid disturbing native prairie to the extent possible. NDGF also recommended that any wetland unavoidably impacted be replaced in kind, that aboveground facilities not be placed in wetlands, and that no alterations to existing drainage patterns occur. Collection should be buried when possible, and theta overhead lines should be marked when placed over perennial streams or near wetlands to minimize avian impacts. Aerial surveys of raptor nests should occur before construction begins, and a 0.5-mile construction buffer should be implemented around active eagle nests (known occupied within the past 5 years). Routine monitoring for avian and bat mortality is recommended as part of the facility maintenance plan over the life of the Project. NDGF requested locations (in GIS format) of turbines, and updates of these locations as the Project progresses.
NDDOT	6/8/2016	NDDOT indicated that the Project would exert no adverse effects on NDDOT highways. NDDOT noted that if Project work occurs within highway right-of-ways, appropriate permits should be obtained from NDDOT, and risk management documentation should be submitted to NDDOT.

Agency	Response Date	Response Summary
USACE	7/6/16	A Section 10 permit would be required for work impacting navigable waters. A Section 404 permit would be required for discharge of dredge or fill material in WoUS.
North Dakota Parks and Recreation Department	No response received as of July 14, 2016	
North Dakota Aeronautics Commission	No response received as of July 14, 2016	
North Dakota Department of Agriculture	No response received as of July 14, 2016	
North Dakota Department of Commerce	No response received as of July 14, 2016	
North Dakota Indian Affairs Commission	No response received as of July 14, 2016	
NDDTL	No response received as of July 14, 2016	
Barnes County Soil Conservation District	No response received as of July 14, 2016	
Barnes County Municipal Airport Authority	No response received as of July 14, 2016	
Barnes County	No response received as of July 14, 2016	
Valley City	No response received as of July 14, 2016	

9.0 POTENTIAL PERMITS/APPROVALS

Table 9-1 lists federal and state permits or approvals potentially required for construction and operation of the proposed Project. Submittals of applications for permits dependent on the final site layout will occur after reception of PSC approval, but prior to construction.

Table 9-1. Potential Permits and Approvals Required for Construction and Operation of the Proposed Facility

Agency	Type of Approval	Status*	Need
Federal Approvals			
USACE	NWP 12 and 14	3	Wetland surveys are underway to ensure that the proposed Project minimizes impacts on WoUS and stays below the pre-construction notification threshold.
FAA	Form 7460-1, Notice of Proposed Construction	2	Notice and approval are required for structures over 200 feet in height. FAA approval of lighting and marking of turbines is required.
EPA	Spill Prevention Control and Countermeasures (SPCC)	2	Required if more than 1,320 gallons of oil is stored on site.
State of North Dakota			
PSC	Certificate of Site Compatibility	1	Required for construction of facility generating over 0.5 MW.
SHSND	Concurrence with effect determinations	2	Class I File Search is complete, and Class III Intensive Cultural Resources Inventories for archaeology and architecture are underway. The reports will be submitted to SHSND for review when complete.
North Dakota Department of Health	NPDES Permit: General Construction Stormwater	2	Required for disturbance of over 1 acre of land. Must prepare an SWPPP.
North Dakota Highway Patrol	Overheight/Overweight Permit	2	Permit required for hauling construction equipment and materials on State Highways.
NDDOT	Road Approach/Access Permit	2	Permit required for construction of access roads from State Highways.

	Utility Permit/Risk Management Documents	2	Permit required for utility crossings on State Highway right-of-way.
North Dakota State Water Commission	Drainage Permit	3	Required if draining a wetland with a drainage area of 80 acres or more.
Local Permits			
Barnes County	Conditional Use Permit (CUP)	1	Glacier Ridge received a CUP for the Project in March 2009. Update to this is occurring to reflect the final Project layout.
	CUP for SCADA MET towers	2	A CUP is required for each SCADA MET tower.
	Variance from public road setback for wind turbines	1	The Project was granted a variance from the 1,400-foot setback from public roads in 2009. Update to this is occurring to reflect the final Project layout.
	Building Permit	2	Permits required for wind turbines and SCADA MET towers.
	Road Crossing Agreement	3	Required for impacts on cross county right-of-ways.
	Road Haul Agreement	3	Required for impacts on county roads during construction of the proposed Project.

* Status Explanation:

1 Applied and/or Decision Pending

2 Would Apply Prior to Construction

3 Final Layout would Determine Whether Permit/Approval is Needed

10.0 FACTORS CONSIDERED

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

10.1 PUBLIC HEALTH AND WELFARE, NATURAL RESOURCES, AND THE ENVIRONMENT

Preceding sections discuss research and investigations relating to 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 7.18**.

10.2 TECHNOLOGIES TO MINIMIZE ADVERSE ENVIRONMENTAL EFFECTS

Wind energy uses no water and requires no fuel, resulting in no air emissions. Glacier Ridge will implement BMPs that minimize impacts on the environment. Current wind turbine technologies, including equipment and siting tools, optimize wind and land resources.

10.3 POTENTIAL FOR BENEFICIAL USES OF WASTE ENERGY

This factor is not applicable to the proposed Project. No waste energy is created by use of wind energy.

10.4 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse environmental effects are described for each resource area in Section 7. The proposed Project is expected to impact up to 92 acres of land during operation, which will not be available for other uses. An additional 920 acres of land would be temporarily affected due to turbine pad construction, road construction, collection line trenching, laydown and contractor staging areas, turbine storage, and temporary MET towers. Additional unavoidable effects include visual effects and increased habitat fragmentation.

10.5 ALTERNATIVES TO THE PROPOSED SITE

Glacier Ridge believes that the proposed site is the most viable alternative based on wind resource, landowner agreements, and environmental constraints.

10.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF NATURAL RESOURCES

Irreversible and irretrievable resource commitments are related to (1) use of nonrenewable resources, and (2) effects of use of these resources 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 loss in value of an affected resource that cannot be restored as a result of the action. The few commitments of resources associated with the proposed Project that are irreversible and irretrievable relate primarily to construction.

Labor and natural resources will be used in fabrication and preparation of construction materials. These materials are usually not retrievable. Construction resources to be used include aggregate resources, concrete, steel, and hydrocarbon fuel. Each steel turbine requires construction of a concrete base 40 to 60 feet across and 7 to 10 feet thick. Construction and maintenance of access roads will require aggregate resources. During construction, vehicles will be traveling to and from the site, utilizing hydrocarbon fuels. These resources are not in short supply, and use of them would not adversely affect their availability. Moreover, overall anticipated environmental and economic benefits of the proposed Project would balance the irretrievable commitment of resources resulting from construction of the proposed Project (see **Section 10.7**).

10.7 DIRECT AND INDIRECT ECONOMIC IMPACTS

Economic impacts include effects associated with temporary disturbance of up to 1,012 acres of land during construction; of this, approximately 920 acres would be reclaimed. Considerably less acreage (approximately 92 acres) would be permanently impacted. Most agricultural areas surrounding each turbine can still be farmed, and landowner compensation has been established in individual easement agreements.

Remaining direct and indirect economic impacts are primarily positive. Wind energy development removes less total land from agricultural use than do other forms of development. The rural economy and energy production in the County and State are diversified. To the extent that local contractors are used for portions of the construction, total wages and salaries paid to contractors and workers in Barnes County and surrounding areas would contribute to the total personal income of the region. Additional personal income would be generated for residents in the County by circulation and recirculation of dollars paid out by the Applicant as business expenditures, and the State and local governments would obtain additional income from higher payments of state and local taxes. Expenditures for equipment, energy, fuel, operating supplies, and other products and services would benefit businesses in the County and the State.

Long-term beneficial impacts on the county's tax base as a result of construction and operation of the wind farm would improve the local economy in this area of North Dakota. Development of wind energy in this region would be important for diversifying and strengthening the economic base of western 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 development of wind-related businesses in the area, in turn contributing to economic growth in the region.

10.8 EXISTING DEVELOPMENT PLANS OF THE STATE, LOCAL GOVERNMENTS, 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.

10.9 EFFECT OF SITE ON CULTURAL RESOURCES

As described in **Section 7.8**, a Class I Literature Review was conducted, and a Class III Cultural Resources Inventory for archaeology is underway in the proposed Project construction easement (to be completed in summer 2016). The literature review revealed no previously recorded archaeological sites within the Survey Corridor (the construction easement), and presence of five site leads within a 1-mile buffer around the Survey Corridor (i.e., the Archaeological Study Area). When complete, the report of the archaeological field survey outlining results and offering recommendations will be submitted to SHSND for review and concurrence, and will also be submitted to PSC.

Avoidance buffers will be created for archaeological sites recorded during the field survey of the Survey Corridor. Glacier Ridge commits to avoid any newly documented sites and previously documented cultural resources within the Survey Corridor.

The Class I Literature Review identified no architectural resources within the Survey Corridor and one property within the 2-mile buffer around proposed turbine locations (i.e., the Architectural Study Area). When complete, the report of the architectural field survey outlining results and offering recommendations will be submitted to SHSND for review and concurrence, and will also be submitted to PSC.

If architectural properties documented in the Architectural Study Area are recommended as potentially eligible for inclusion in the NRHP, and are found to be adversely visually impacted by the Project, Glacier Ridge will work with SHSND to develop an appropriate mitigation plan. The proposed Project will not directly impact any architectural resources.

10.10 EFFECT OF SITE ON BIOLOGICAL RESOURCES

Impacts of the proposed Project on wildlife are expected to be low. Glacier Ridge sited the proposed Project following the voluntary USFWS Wind Energy Guidelines (USFWS 2012a), and designed the proposed Project following suggested APLIC practices (APLIC 2006). Avian and bat collisions with facility turbines and MET towers could occur, as could habitat loss and fragmentation; however, Glacier Ridge will implement measures to avoid and minimize impacts on biological resources from the proposed Project. Electrocution risk is avoided by using pad-mounted transformers and burying collection system lines per APLIC 2006 recommendations. Risks of collision would be minimized by siting facilities away from wetlands and burying collection lines. A 1.5-mile setback from the documented bald eagle nest west of the Project Area has been implemented. Risk of impacts on habitat would be avoided and minimized by reseeding or planting temporarily disturbed grassland areas with native material, depending on landowner preferences.

The Project is unlikely to affect the gray wolf; likelihood is low for the Project to affect the northern long-eared bat, whooping crane, Dakota skipper, bald eagle, and golden eagle. Glacier Ridge will prepare a Project-specific BBCS documenting all avoidance, minimization, and mitigation commitments, including an adaptive management approach.

Detailed discussions of potential impacts on biological resources and proposed mitigation measures appear in **Section 7.15** (Vegetation), **Section 7.16** (Wildlife), and **Section 7.17** (Rare and Unique Natural Resources).

10.11 CUMULATIVE EFFECTS

Current activities within the Project Area and vicinity are primarily agricultural. The proposed Project is adjacent to the eastern boundaries of the Ashtabula Wind Energy Center and the Ashtabula III Wind Energy Center. Wind energy development is likely to continue in eastern North Dakota.

Wind energy development is anticipated to positively and cumulatively affect air quality, and to minimally impact geology, soils, water, noise, safety and health issues, and cultural resources. Socioeconomic impacts are anticipated to be positive, with stimulation of the rural economy and diversification of local energy production. Potential negative cumulative impacts are anticipated—primarily effects on land use, mineral resources, vegetation, and wildlife.

With increased amount of land used for wind energy generation activities, farming activities may decrease slightly. This potential shift in land use in rural communities that have historically made their livings from agricultural activities may lead to a cumulative impact; however, additional income to farmers from wind development may make it more feasible for them to retain most of their land for agricultural uses rather than allowing development for residential, commercial, or industrial uses—a net positive cumulative impact of preserving land suitable for agricultural uses.

Regarding potential cumulative impacts on wildlife resources, the proposed Project could affect local wildlife both directly (mortality) and, to a lesser extent, indirectly (through habitat loss and fragmentation). Both direct and indirect potential impacts would be avoided and minimized to the extent practicable, and therefore, are not expected to cause cumulative impacts. Although wind turbines would contribute to the utility/industrial component of the landscape, the area would remain primarily agricultural. As these agricultural lands are of minimal value to wildlife compared to native vegetation, the proposed Project is not expected to result in a cumulative loss of quality wildlife habitat. Based on existing land use, locations of existing and planned facilities, and known impacts from similar wind facilities in the area, the proposed Project is expected to result in minimal cumulative impacts on wildlife.

10.12 AGENCY COMMENTS

Agency coordination and potential permits/approvals are discussed in **Section 8** and **Section 9**, respectively. Copies of agency response letters are in **Appendix C.**

11.0 QUALIFICATIONS OF CONTRIBUTORS

Name Project Role	Education and Professional Experience
JEFF JACKSON Development Manager RES Americas	Mr. Jackson has 8 years of experience developing renewable energy projects in more than 12 states. He has managed site development for over 2,000 MW of renewable energy projects, and has developed 350 MW of in-service wind projects. Mr. Jackson holds a Bachelor of Arts in Economics from Saint John's University in Collegeville, Minnesota, and grew up in Dickinson, North Dakota.
SEAN FLANNERY Director, Permitting RES Americas	Mr. Flannery has 14 years of experience as a Project Manager and Consultant working on environmental permitting, land use permitting, environmental compliance, and energy siting projects. He received his Masters Degree in Urban and Regional Planning from the University of Minnesota, and his Bachelor of Arts Degree in Natural Science from Saint John's University. He currently supports renewable energy developers throughout the United States in efforts to coordinate project permitting strategies and implement environmental reviews. He works with local, state, and federal agencies to develop, construct, and operate wind, solar, electrical transmission, and energy storage projects in compliance with environmental laws.
ANNE-MARIE GRIGER Permitting Specialist RES Americas	Ms. Griger has 11 years of experience in environmental planning and permitting, including National Environmental Policy Act (NEPA) compliance for large-scale infrastructure projects including wind energy generating facilities. She received her Masters Degree in Urban and Regional Planning and Bachelor of Science Degree in Environmental Policy and Planning, both from Virginia Tech.
LEGAL COUNSEL **SARA BERGAN** **SARAH JOHNSON PHILLIPS** **ANDREW PIEPER** Stoel Rives LLP	Sara Bergan and Sarah Johnson Phillips both have J.D.s from the University of Minnesota. Andrew Pieper received his J.D. from the University of St. Thomas.
ADAM HOLVEN Project Manager/Archaeologist Tetra Tech, Inc.	Mr. Holven has extensive archaeological field experience, including large-scale, research-based excavations in western Nebraska and Iowa; multi-square mile cultural resource surveys of wind parks in Iowa, Indiana, Minnesota, Nebraska, North Dakota, Ohio, and South Dakota; and Phase I and II cultural resource surveys for agricultural, transportation, and telecommunication projects throughout the upper Midwest and Great Plains. The cultural resource projects that Mr. Holven manages are often critical components in development of environmental assessments and environmental impact statements for projects requiring compliance with NEPA and Section 106 of the National Historic Preservation Act.
MOLLY KUISLE Environmental Planner Tetra Tech, Inc.	Ms. Kuisle has an educational background in Environmental Studies and Business Management with applicable professional field experience. Ms. Kuisle has prepared numerous FCC categorical exclusions, and has assisted with focused environmental assessments under NEPA and Section 106 of the National Historic Preservation Act for a variety of telecommunication sites in many states in the Great Plains, Midwest, Mountain West, Southwest, Northeast, and Pacific regions.

KIM GORMAN GIS Analyst Tetra Tech, Inc.	Ms. Gorman is a Certified GIS Professional with 15 years of professional work experience in GIS/Global Positioning System (GPS) design, analysis, and application. Ms. Gorman provides GIS analysis, GPS support, data conversion, editing and management, and cartographic production for the numerous project applications including NEPA analysis, critical issues analysis, renewable energy projects, total maximum daily load (TMDL) modeling, contamination assessments, fuels reductions analysis, soils assessments, trails scoping, and cultural resource and critical ecosystem mapping. She has extensive knowledge of the Environmental Sciences Research Institute (ESRI) software line, and development and integration of sub-meter GPS technology.
KATHY BELLRICHARD Wetlands Biologist Tetra Tech, Inc.	Ms. Bellrichard has a diverse and well-rounded background in the environmental field. She is trained in wetland delineation and has completed wetland surveys and delineations in Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin. She is also experienced with wetland permitting processes including those of USACE, USFWS, and Minnesota Wetland Conservation Act. She has also prepared numerous FCC categorical exclusions and focused Environmental Assessments under NEPA for a variety of telecommunication tower sites in many states in the Upper Midwest, Mountain West, Southwest, and Northeast regions.
CLAYTON DERBY Wildlife Biologist WEST, Inc.	Clayton Derby is a Senior Manager and Wildlife Biologist for WEST, Inc. Mr. Derby received a Bachelor of Arts degree in Biology from Moorhead State University in 1992, and a Master of Science degree in Zoology from the University of Wyoming in 1995. Since graduating in 1995, he has worked for WEST, Inc. as a wildlife biologist. His work has covered numerous subject matters, including raptors, migratory birds, wetlands, fisheries, water quality, big game, and vegetation. Mr. Derby has been the Project Manager for several large natural gas pipeline development projects in the western United States, and wind energy development projects throughout the West and Midwest, including many projects within North Dakota.

12.0 REFERENCES

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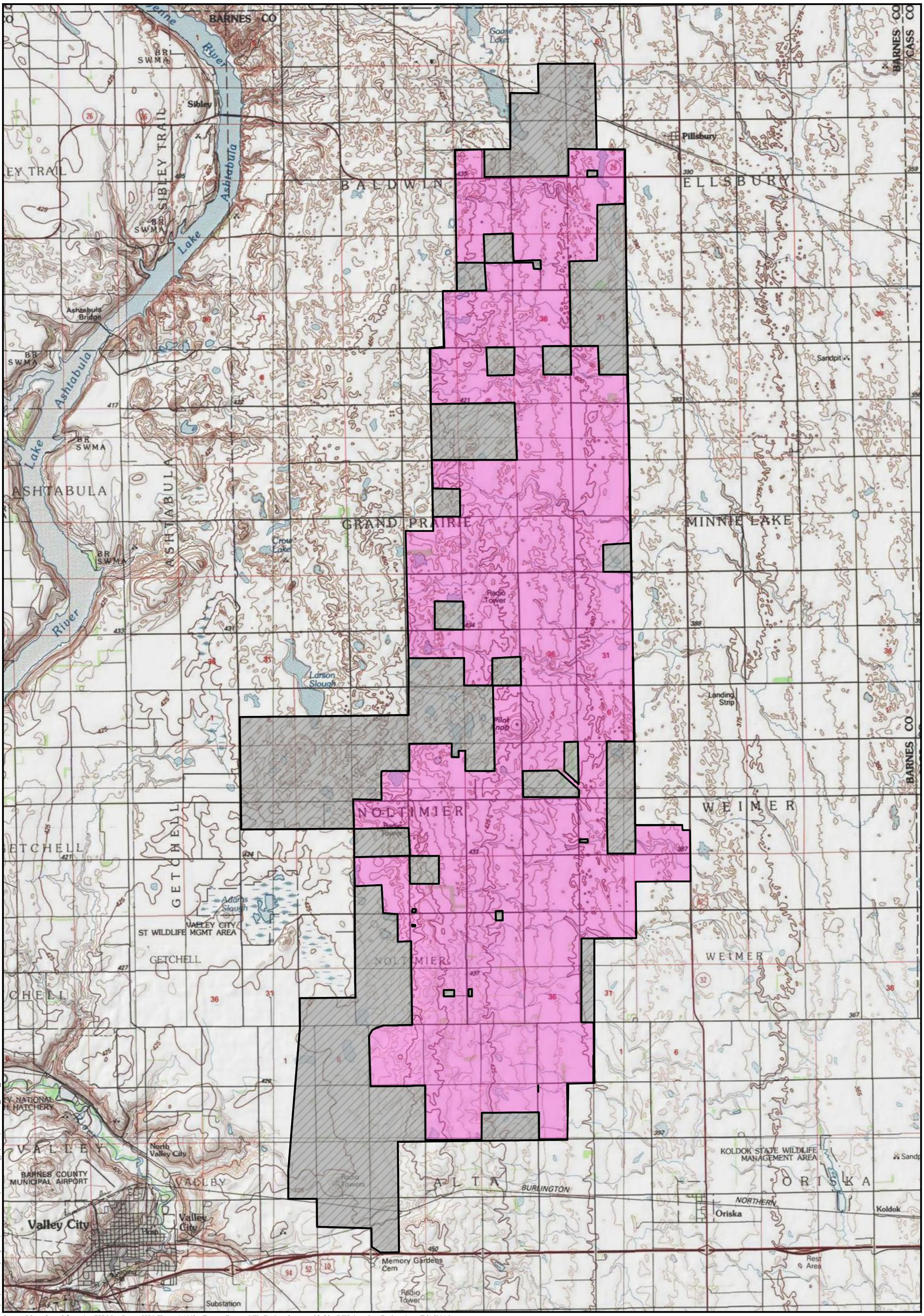
APPENDIX A - FIGURES



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Source: Map adapted from ArcGIS Map Server USA Topos 1:100k - Barnes County, ND; Project data provided by RES Americas Project Area (7/1/2016).

Project Area

Study Area

0 1 2 3 Miles

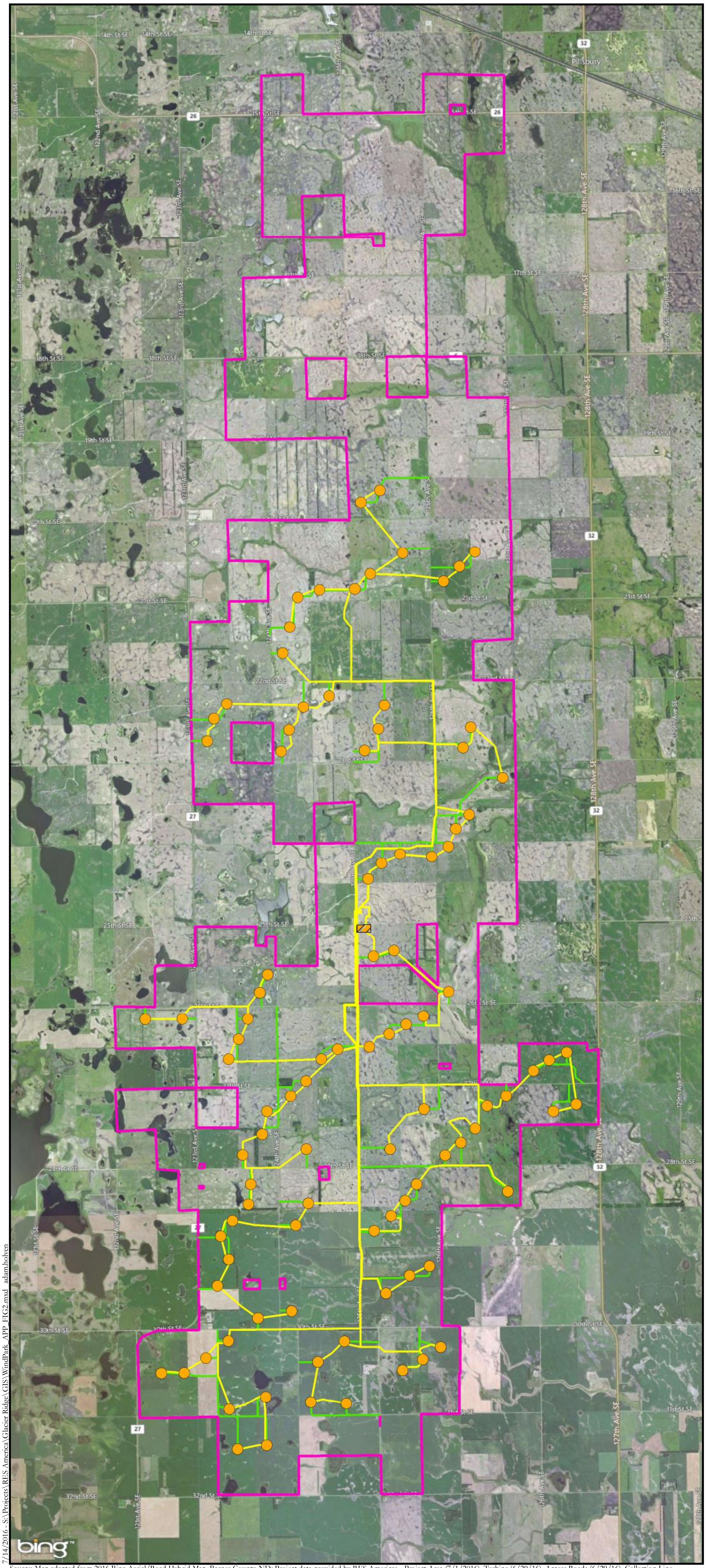
N

Figure 1. Project Location

Glacier Ridge Wind Farm
Barnes County, North Dakota

res AMERICAS powering change

TETRA TECH



Glacier Ridge Wind Farm
Barnes County, North Dakota

Project Area

Proposed Project Facility

Turbines (06/29/16)

Access Road (06/29/16)

Collection Line (06/29/16)

Substation/O&M Building (07/06/16)

0 1 2 3 Miles

Figure 2.
Project Facility Location

res AMERICAS powering change

TETRA TECH

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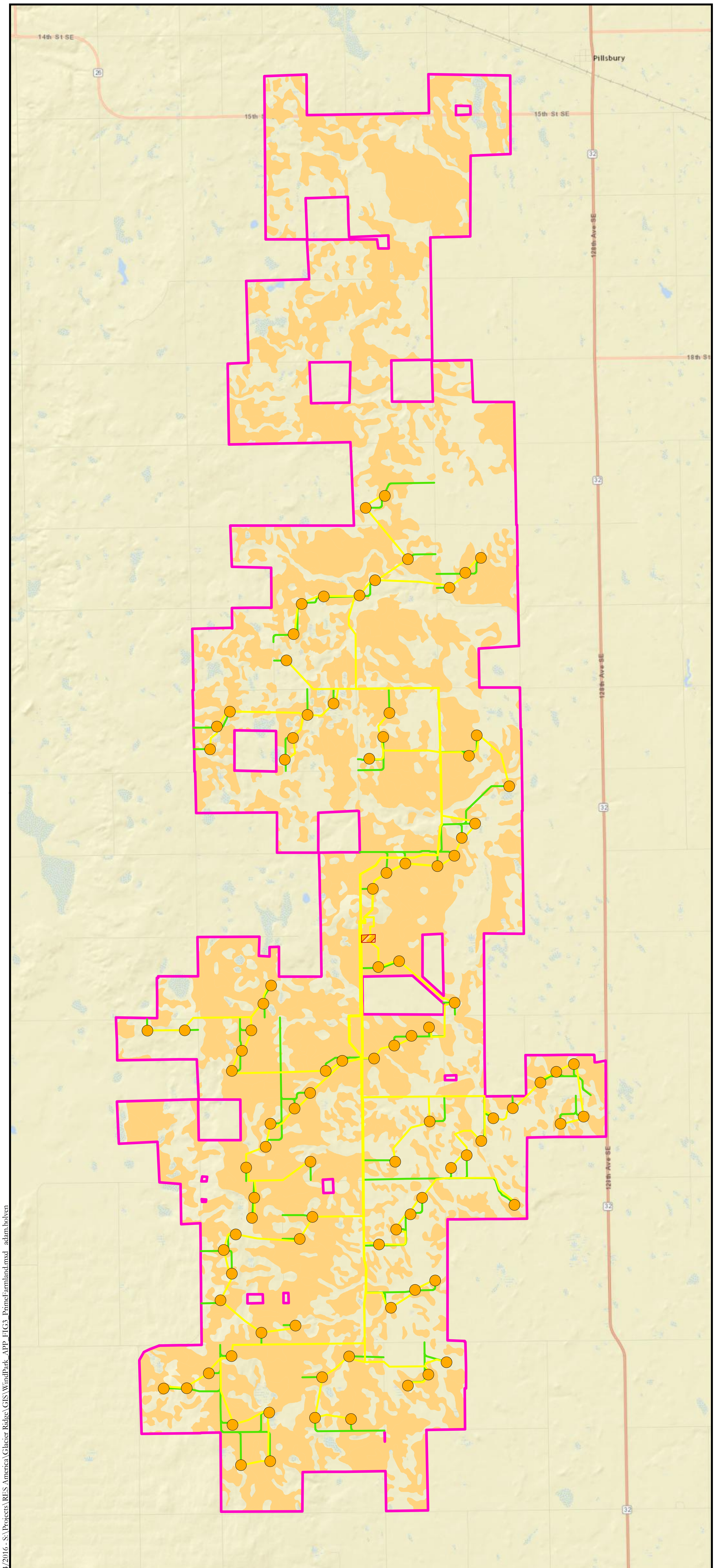
Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16).



Glacier Ridge Wind Farm
Barnes County, North Dakota

Project Area

Proposed Project Facility

- Turbines (06/29/16)
- Access Road (06/29/16)
- Collection Line (06/29/16)
- Substation/O&M Building (07/06/16)

Exclusion Area

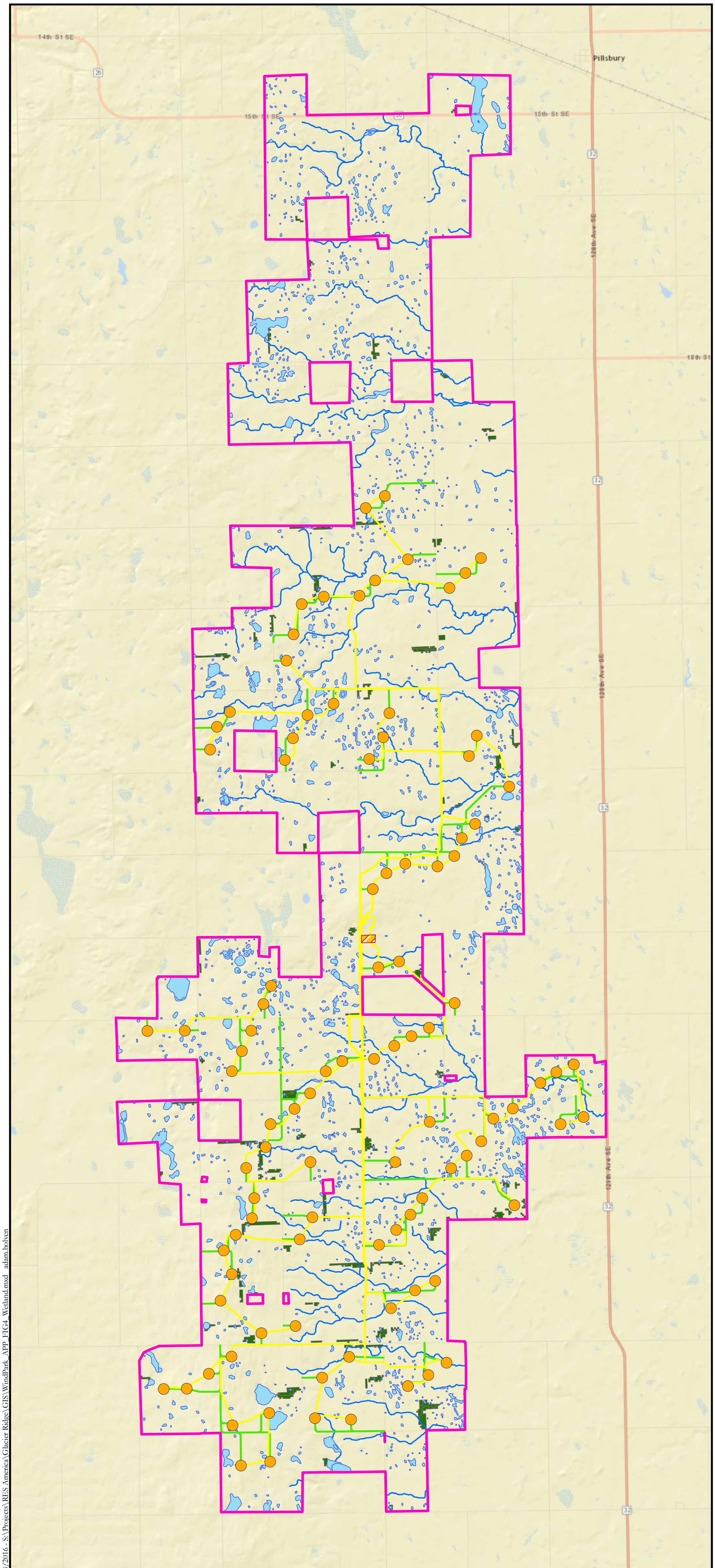
- Prime Farmland

0 1 2 3 Miles

Figure 3.
Exclusion Areas: Prime Farmland

7/14/2016 - S:\Projects\RES America\Glacier Ridge\GIS\WindPark_APP_FIG3_PrimeFarmland.mxd adam.bolven

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16). Prime Farm USDA (2016) SSURGO for Barnes County, North Dakota.



Glacier Ridge Wind Farm
Barnes County, North Dakota

Project Area

Proposed Project Facility

- Turbines (06/29/16)
- Access Road (06/29/16)
- Collection Line (06/29/16)
- Substation/O&M Building (07/06/16)

Avoidance Area

- NWI Wetland
- NHD Waterways
- NLCD Forested Area (Inlcudes Decidous, Evergreen, Mixed, and Woody Wetlands)

0 1 2 3 Miles

Figure 4.
Avoidance Areas:
Wetlands & Forested Areas

res AMERICAS powering change®   TETRA TECH

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16). NWI (USFWS 2014), NHI (USGS 2010); Forested Areas (USGS NLCD 2011).

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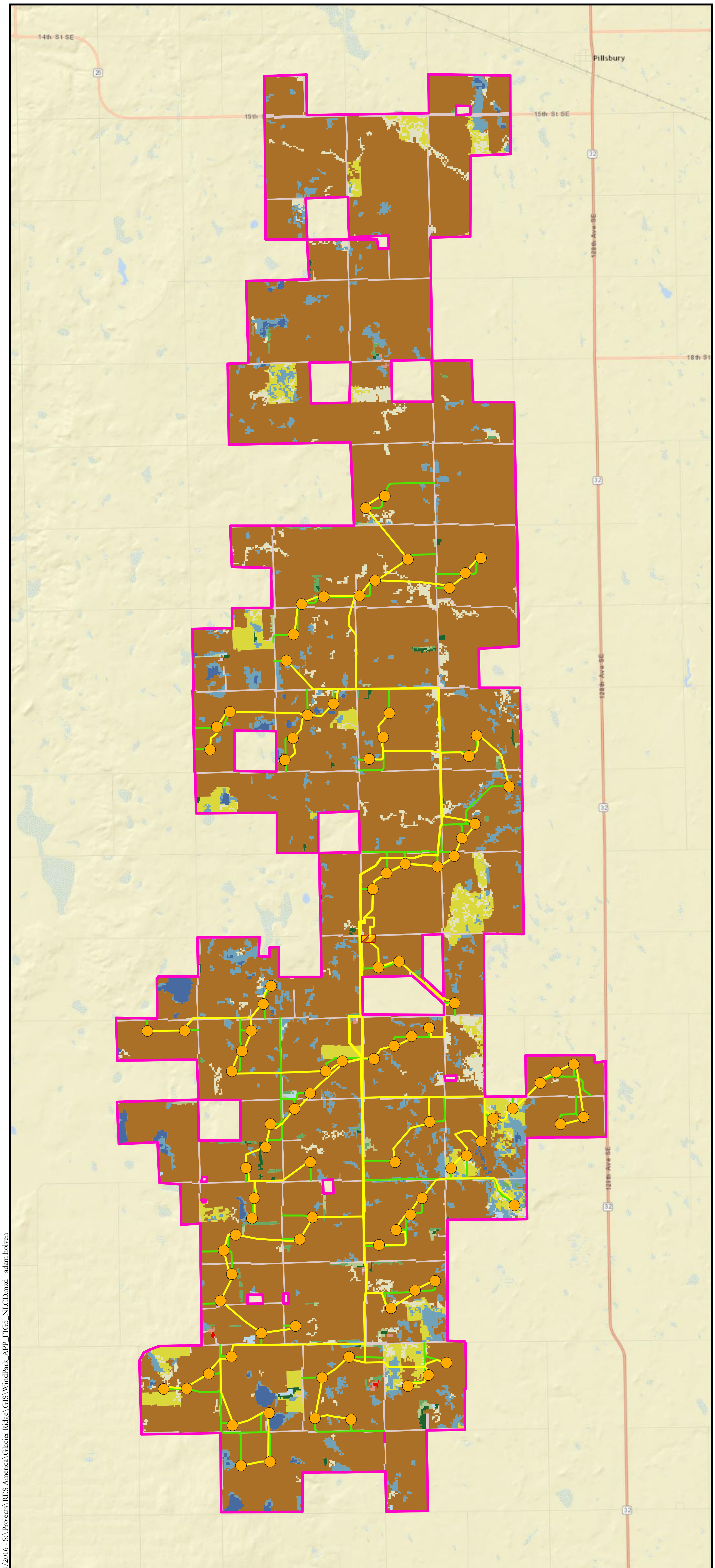

Glacier Ridge Wind Farm
Barnes County, North Dakota

Project Area

Proposed Project Facility

- Turbines (06/29/16)
- Access Road (06/29/16)
- Collection Line (06/29/16)
- Substation/O&M Building (07/06/16)

NLCD Land Cover

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Herbaceuous
- Hay/Pasture
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceuous Wetlands

0 1 2 3 Miles

Figure 5.
NLCD Land Cover within the Project Area

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TETRA TECH

7/14/2016 - S:\Projects\RES America\Glacier Ridge\GIS\WindPark_APP_FIG5_NLCD.mxd adam.holven

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16). NWI (USFWS 2014), NHI (USGS 2010); Forested Areas (USGS NLCD 2011).

Figure 6. Typical Land Use and Landforms in the Project Area

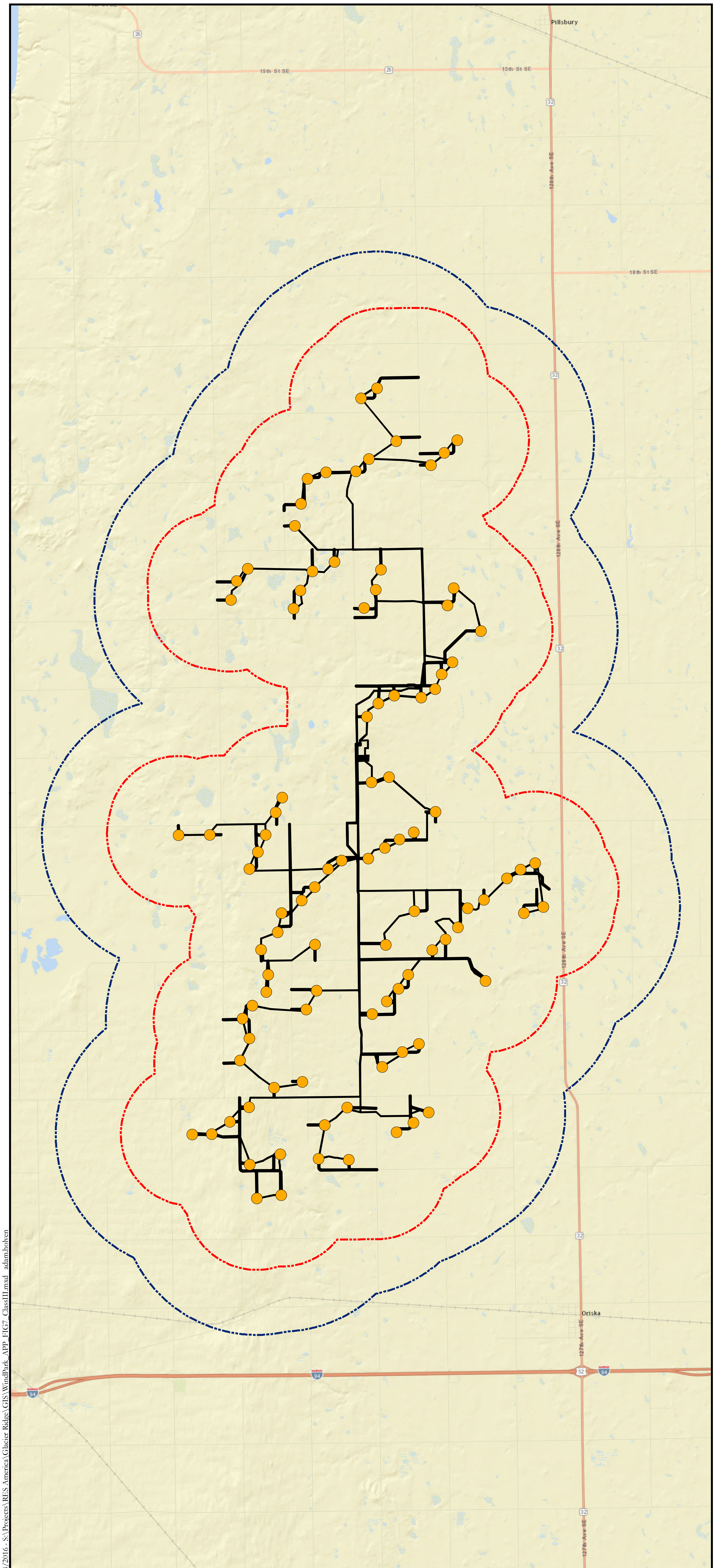
Photograph 1 (North): A typical view of land use in the southern end of the Project Area. Photograph taken on 6/21/2016.

Photograph 2 (North): A typical view of land use in the south central portion of the Project Area. Photograph taken on 6/21/2016.

Figure 6. Typical Land Use and Landforms in the Project Area

Photograph 6 (South): A typical view of land use in the east central portion of the Project Area. Photograph taken on 6/23/2016.

Photograph 4 (East): A typical view of land use in the north central portion of the Project Area. Photograph taken on 6/25/2016.



Glacier Ridge Wind Farm
Barnes County, North Dakota

Proposed Project Facility

- Turbines (06/29/16)
- Survey Corridor
- Archaeological Study Area (1-mile buffer of Survey Corridor)
- Architectural Study Area (2-mile buffer of turbines)

0 1 2 3 Miles

Figure 7.
Class III Cultural Resources Inventory Survey Corridor and Study Areas

res AMERICAS powering change

TETRA TECH

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16).

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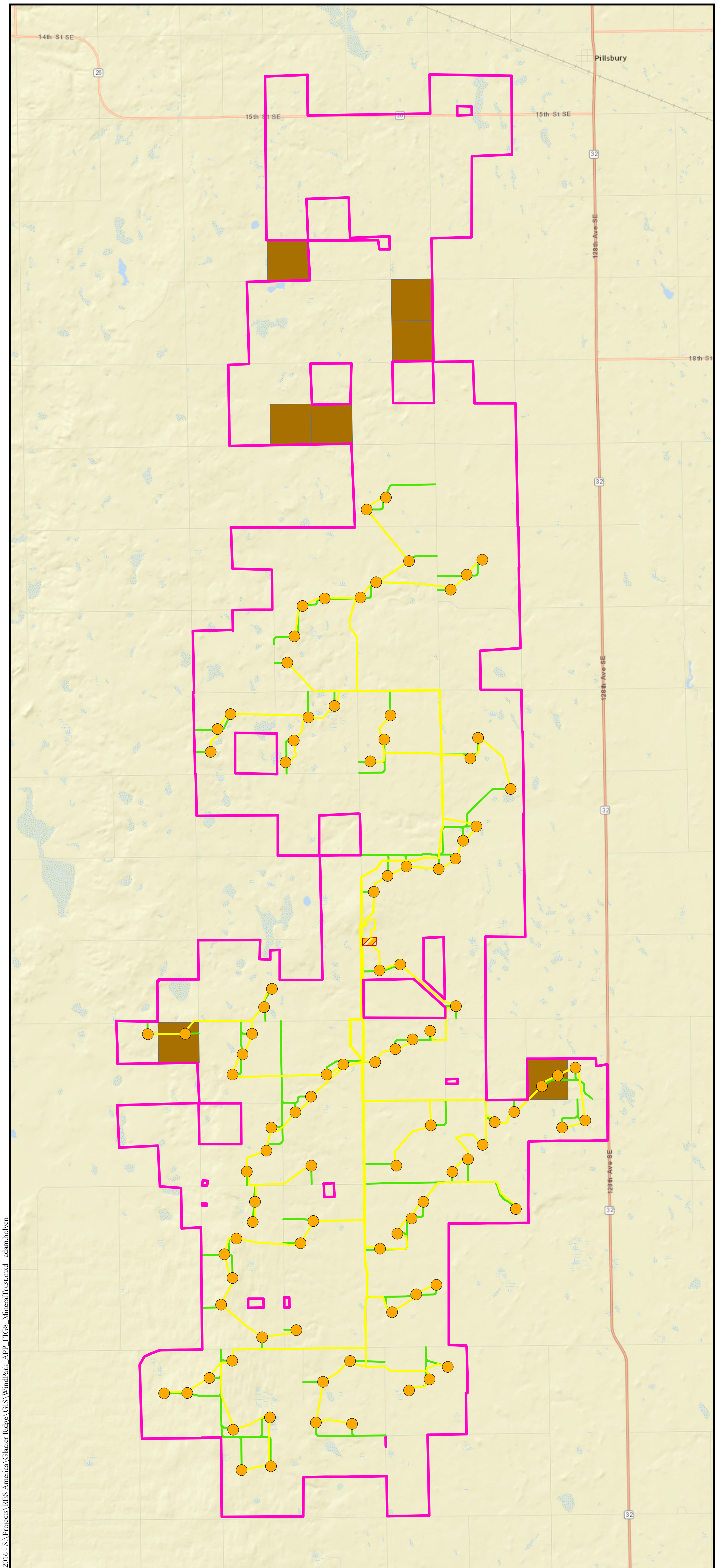


Glacier Ridge Wind Farm
Barnes County, North Dakota

Project Area

Proposed Project Facility

Turbines (06/29/16)

Access Road (06/29/16)

Collection Line (06/29/16)

Substation/O&M Building (07/06/16)

Trust Land

Mineral Tract

0 1 2 3 Miles

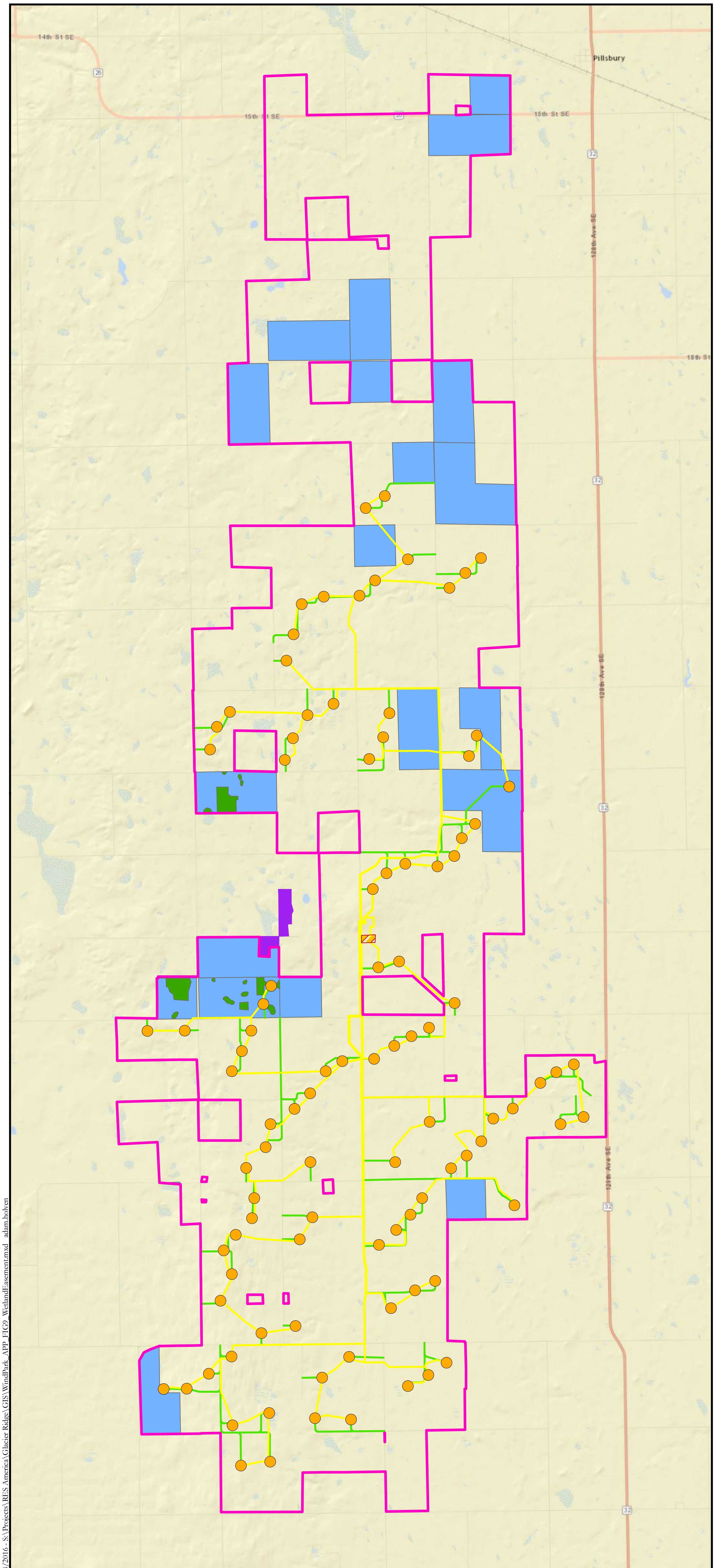
Figure 8.
Mineral Trust Lands

res AMERICAS powering change®

TETRA TECH

7/14/2016 - S:\Projects\RES America\Glacier Ridge\GIS\WindPark_APP_FIG8_MineralTrust.mxd adam.holven

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16).Trust Lands (ND Department of Trust Lands 2016).



Glacier Ridge Wind Farm
Barnes County, North Dakota

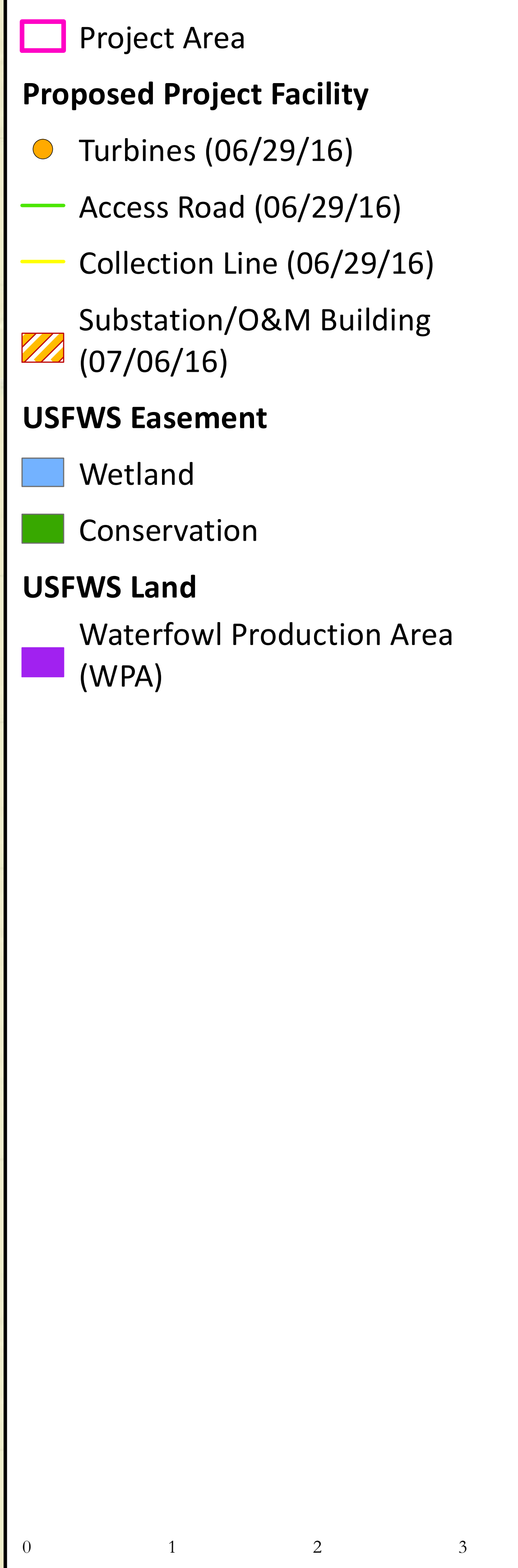


Figure 9. USFWS Easements and WPA Locations

Source: Map adapted from 2016 Bing Aerial/Road Hybrid Map, Barnes County, ND; Project data provided by RES Americas - Project Area (7/1/2016), Turbine (6/29/16), Access Roads (6/29/16), Collection Line (6/29/16), Substation (6/13/16), and O&M Building (7/6/16). Wetland and Conversation Easements (USFWS 2016).

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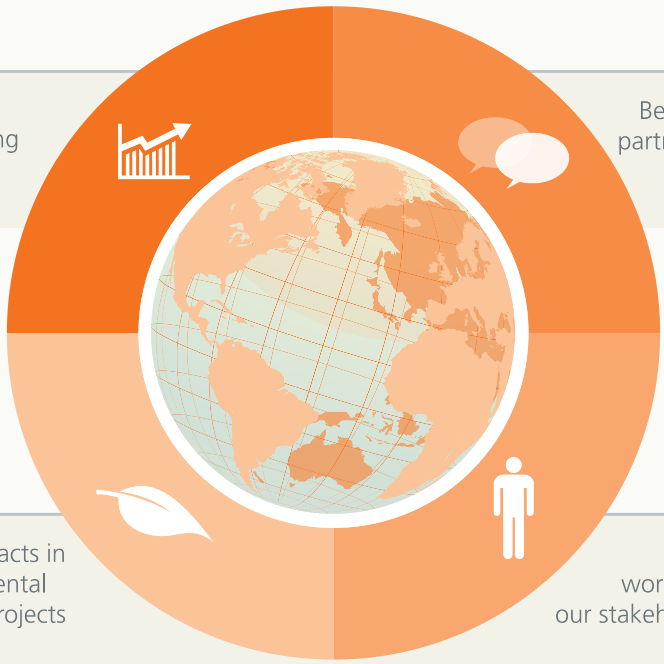
APPENDIX B - SUPPLEMENTAL DOCUMENTATION

POWER FOR GOOD

Our Sustainability Mission is to:

Power positive change by ensuring that our operations, products and services make a net positive contribution to society and the environment.

RES' SUSTAINABILITY PRINCIPLES



BUSINESS

Positioning the company for continued growth combining long term thinking with exceptional short term performance

REPUTATION

Being a thought leader and trusted partner, leaving a lasting and positive legacy for our stakeholders

ENVIRONMENT

Managing our activities and impacts in order to maximise the environmental benefit we create through our projects

SOCIAL

Providing a safe and stimulating work environment and working with our stakeholders providing mutual benefits

Federal Aviation Administration

« OE/AAA

DoD Preliminary Screening Tool

DoD Preliminary Screening Tool - Desk Reference Guide V_2014.2.0

Disclaimer:

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  -Military Operations
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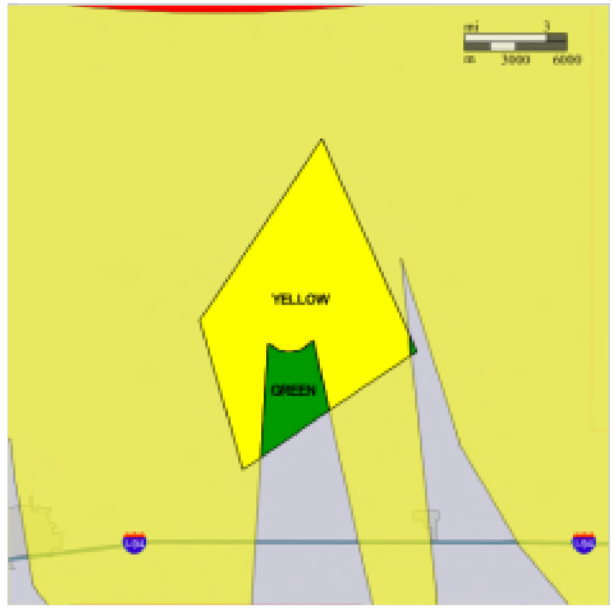
- Military Operations is only available for a single point.
- At least three points are required for a polygon, with an optional fourth point.
- The largest polygon allowed has a maximum perimeter of 100 miles.

Screening Type: Long Range Radar **Geometry Type:** Polygon

Point	Latitude Deg	Min	Sec	Dir	Longitude Deg	Min	Sec	Dir
1	47	7	44.97	N	97	50	45.49	W
2	47	1	6.97	N	97	47	48.59	W
3	46	57	27.86	N	97	53	13.83	W
4	47	2	5.95	N	97	54	34.33	W

Horizontal Datum: NAD83



Map Legend:

- **Green:** No anticipated impact to Air Defense and Homeland Security radars. Aeronautical study required.
- **Yellow:** Impact likely to Air Defense and Homeland Security radars. Aeronautical study required.
- **Red:** Impact highly likely to Air Defense and Homeland Security radars. Aeronautical study required.

Note: Map colors will show as depicted in the map legend when using the 'Polygon' Geometry Type; map colors will be subdued when using the 'Single Point' Geometry Type.

Federal Aviation Administration

« OE/AAA

DoD Preliminary Screening Tool

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Instructions:

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  -Air Defense and Homeland Security radars(Long Range Radar)
  -Weather Surveillance Radar-1988 Doppler radars(NEXRAD)
  -Military Operations
- Enter either a single point or a polygon and click submit to generate a long range radar analysis map.
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Screening Type: NEXRAD **Geometry Type:** Polygon

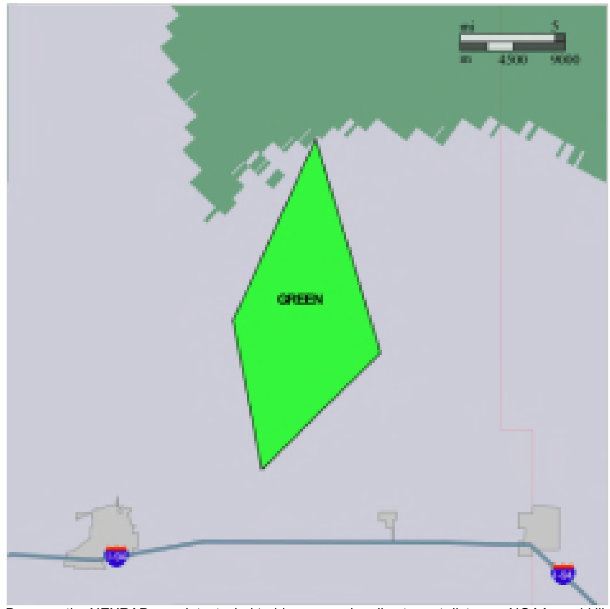
Point	Latitude Deg	Min	Sec	Dir	Longitude Deg	Min	Sec	Dir
1	47	7	44.97	N	97	50	45.49	W
2	47	1	6.97	N	97	47	48.59	W
3	46	57	27.86	N	97	53	13.83	W
4	47	2	5.95	N	97	54	34.33	W

Horizontal Datum: NAD83

Map Legend:

- **Green: No Impact Zone.** Impacts not likely. NOAA will not perform a detailed analysis, but would still like to know about the project.
- **Dk Green: Notification Zone.** Some impacts possible. Consultation with NOAA is optional, but NOAA would still like to know about the project.
- **Yellow: Consultation Zone.** Significant impacts possible. NOAA requests consultation to discuss project details and to perform a detailed impact analysis. NOAA may request mitigation of significant impacts.
- **Orange: Mitigation Zone.** Significant impacts likely. NOAA will likely request mitigation if a detailed analysis indicates that the project will cause significant impacts.
- **Red: No-Build Zone.** Severe impacts likely. NOAA requests developers not build wind turbines within 3 km of the NEXRAD. Detailed impact analysis required.

Note: Map colors will show as depicted in the map legend when using the 'Polygon' Geometry Type; map colors will be subdued when using the 'Single Point' Geometry Type.



Because the NEXRAD can detect wind turbines occasionally at great distance, NOAA would like to know the location of all wind farm projects so that corrupted radar data can be flagged. Send project information directly to NOAA at wind.energy.matters@noaa.gov or through the National Telecommunications & Information Administration (NTIA) in the Dept. of Commerce. NOAA protects all wind project information as proprietary and sensitive.

Federal Aviation Administration

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DoD Preliminary Screening Tool

DoD Preliminary Screening Tool - Desk Reference Guide V_2014.2.0

Disclaimer:

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Instructions:

- Select a screening type for your initial evaluation. Currently the system supports pre-screening on:
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- At least three points are required for a polygon, with an optional fourth point.
- The largest polygon allowed has a maximum perimeter of 100 miles.

Screening Type: Military Operations **Geometry Type:** Single Point

Point	Latitude Deg	Min	Sec	Dir	Longitude Deg	Min	Sec	Dir
1	47	1	46.06	N	97	51	3.24	W

Horizontal Datum: NAD83

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact Dr. Thomas (Thom) H. Rennie at the USAF Regional Enviromental Coordinator at (214)767-4678 for confirmation and documentation.

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact the US Navy Representative, FAA Central Service Area at the USN Regional Enviromental Coordinator at (817) 222-5930 for confirmation and documentation.

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact LTC Owen B. Castlemain at the USA Regional Enviromental Coordinator at (817) 222-5921 for confirmation and documentation.

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact the US Navy Representative, FAA Central Service Area at the USMC Regional Enviromental Coordinator at (817) 222-5930 for confirmation and documentation.

This is a preliminary review of your proposal and does not preclude official FAA processes.
Your search data is not retained and the privacy of all your searches is assured.

Any questions interpreting the map, please email Steve Sample with your question/s and phone number at steven.sample@pentagon.af.mil

GLACIER RIDGE WIND FARM

Sound Modeling Assessment for the Glacier Ridge Wind Farm

Glacier Ridge Wind Farm, LLC

Document No.: 10026534-HOU-R-01
Issue: A**, Status:** Final
Date: 13 July 2016

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Project name:	Glacier Ridge Wind Farm	
Report title:	Sound Modeling Assessment for the Glacier Ridge Wind Farm	
Customer:	Glacier Ridge Wind Farm, LLC 330 2nd Avenue South, Suite 820, Minneapolis, MN 55401 USA	
Contact person:	A. Griger	
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Task and objective: Sound Assessment of the Glacier Ridge Wind Farm located in Barnes County, North Dakota

Prepared by:	Verified by:	Approved by:
Anna Danaitis Analyst, Environmental Permitting Services	Aren Nercessian Analyst, Project Development and Engineering	Bruce Moreira Project Manager, Environmental Permitting Services Michael Cookson, Team Leader/Project Development and Engineering

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Keywords:
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Issue	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	13 July 2016	Final	A. Danaitis	A. Nercessian	B. Moreira, M. Cookson

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EXECUTIVE SUMMARY

Glacier Ridge Wind Farm, LLC., is developing the Glacier Ridge Wind Farm in North Dakota. Glacier Ridge Wind Farm, LLC., has instructed DNV KEMA Renewables, Inc. (DNV GL) to carry out a sound modeling assessment of the proposed wind project. The results of the work are reported here.

The site is located in Barnes County, North Dakota, approximately 10 km northeast of Valley City, North Dakota. The Project layout currently consists of 99 Vestas V126 wind turbine generators operating in Noise Mode 0, and one transformer. According to the Customer, only 87 of the 99 turbines modeled in this report will be built. In order to provide additional flexibility in future siting of wind turbines, all 99 turbines and the transformer have been included in the sound modeling assessment. The sound contribution of the neighboring Ashtabula I and III projects is also considered.

The sound pressure level (SPL) at each receptor for the aggregate of all wind turbine generators and transformers associated with the Project was calculated based on the ISO 9613-2 method. The results indicate that the calculated sound levels are within the allowable limits under North Dakota noise regulations at each of the 49 receptors located within 1 mile (approximately 1,600 m) of a project turbine or transformer.

1 INTRODUCTION

This report is issued to Glacier Ridge Wind Farm, LLC ("Customer") pursuant to a written agreement arising from the *Proposal for Siting Study Support for the Glacier Ridge Wind Project* dated 31 May 2016, DNV GL Document No. 130652-USPO-P-01-A. The Customer has requested that DNV KEMA Renewables, Inc. (DNV GL) perform Project Development services, including a sound modeling assessment for the Glacier Ridge Wind Farm (the "Project") located in Barnes County, North Dakota.

The Project layout currently consists of 99 Vestas V126 STE wind turbine generators operating in Noise Mode 0 at a hub height of 87 m. Only 87 of the 99 proposed turbine locations will be built. These turbines can have an effect on the sound levels experienced at receptors in the vicinity of the site. The neighboring Ashtabula I and III projects are also considered in the assessment.

The objective of this assessment is to predict the sound levels generated by the Project's wind turbine generators at all receptors within a mile of the Project, using the ISO 9613-2 method [1] and in accordance with the North Dakota Administrative Code Energy Conversion Facility Siting Criteria, Chapter 69-06-08-01(4) [2] and Barnes County Development Code, Section 6.10 [3].

2 ENVIRONMENTAL SOUND BACKGROUND

Sound levels are expressed in the decibel unit and are quantified on a logarithmic scale to account for the large range of acoustic pressures to which the human ear is exposed. A decibel (dB) is used to quantify sound levels relative to a 0 dB reference. The reference level of 0 dB is defined as a sound pressure level of 20 micropascals (µpa), which is the typical lower threshold of hearing for humans.

Sound levels can be presented both in broadband (sound energy summed across the entire audible frequency spectrum) and in octave band spectra (audible frequency spectrum divided into bands). Frequency is expressed in the Hertz unit (Hz), measuring the cycles per second of the sound pressure waves. The audible range of humans spans from 20 to 20,000 Hz. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighting filter is applied to closely approximate the human ear's response to sound. This scale is commonly used in environmental and industrial sound. Sound expressed in the A-weighted scale is denoted dBA.

A sound source has a certain sound power level (PWL) rating which describes the amount of sound energy per unit of time. This is a basic measure of how much acoustical energy it can produce and is independent of its surroundings. Sound pressure is created as sound energy flows away from the source. The measured sound pressure level (SPL) at a given point depends not only on the power rating of the source and the distance between the source and the measurement point (geometric divergence), but also on the amount of sound energy absorbed by environmental elements between the source and the measurement point (attenuation). Sound attenuation factors include meteorological conditions such as wind direction, temperature, and humidity; sound interaction with the ground; atmospheric absorption; terrain effects; diffraction of sound around objects and topographical features; and foliage.

3 APPLICABLE REGULATIONS

The Glacier Ridge Wind Farm is regulated by the North Dakota Public Service Commission (PSC) which has specific noise ordinances under the North Dakota Administrative Code Energy Conversion Facility Siting Criteria Chapter 69-06-08-01(4) [2]. The intent of this report is to verify the Project is in compliance with the North Dakota PSC and Barnes County zoning regulations.

The North Dakota Administrative Code Energy Conversion Facility Siting Criteria, Chapter 69-06-08-01(4) states:

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

The zoning regulations for Barnes County, North Dakota do not contain any provisions specific to noise from wind energy facilities or wind turbines. General noise regulations state (Section 6.10) [3]:

> *6.10 Sustained noise of over seventy-five (75) decibels during the day and sixty-five (65) decibels at night is not allowed*.

For the purposes of this assessment, the more conservative limit of 50 dBA was applied.

4 DESCRIPTION OF THE WIND PROJECT SITE

4.1 Site description

The site is located in Barnes County, North Dakota approximately 45 miles (72 km) west of Fargo, North Dakota.

The proposed wind project is situated in relatively simple terrain, consisting of flat farm land, with wind turbine base elevations ranging from 410 m to 460 m. The ground cover on and near the site is primarily comprised of farm land and open fields. Dwellings are interspersed throughout the Project site.

4.2 Wind project layout

The proposed turbine layout, which consists of 99 Vestas V126 3.45 MW STE wind turbine generators at a hub height of 87 m operating in Noise Mode 0 and one transformer, has been provided by the Customer [4]. Only 87 of the 99 proposed turbine locations will be built. The coordinates of each turbine and one transformer are presented in Appendix A.

4.3 Adjacent wind projects

NExtEra Energy Resources owns the operational wind projects Ashtabula I and Ashtabula III, located immediately to the northwest of the Glacier Ridge project. Ashtabula I and III respectively consist of 131 GE sle 1.5 MW and 39 GE xle 1.6 MW wind turbine generators at a hub height of 80 m. In the assessment, these wind projects were considered as external sources of noise. The wind turbine locations for these projects were obtained from the Customer and confirmed with Google Earth imagery.

The closest Ashtabula I turbine is located approximately 506 m from T60 of the Glacier Ridge project and approximately 454 m from the nearest receptor in this report.

The closest Ashtabula III turbine is located approximately 5,971 m from T77 of the Glacier Ridge project and approximately 5,432 m from the nearest receptor in this report.

Sound power level information for the GE sle 1.5 MW and GE xle 1.6 MW wind turbines, as well as the respective transformer locations and sound power levels, were retrieved from the Ashtabula III Wind Energy Center Acoustic Assessment [5].

The coordinates for Ashtabula I and III turbines and transformers are shown in Appendix A.

4.4 Receptor locations

A list of 128 receptors to be considered as sound receptors was identified on site by RES and validated by DNV GL using available aerial imagery. Of the 128 total identified receptors provided by the Customer [6], results for 49 receptors located within 1 mile (approximately 1,600 m) of the project turbines are reported here. Coordinates of each receptor are presented in Appendix B.

5 SOUND ASSESSMENT

5.1 Description of the sound source

The sources of sound considered in this analysis are the Project wind turbine generators and transformer. Sound associated with other sources in the vicinity of the Project, such as construction activities, have not been considered.

Broadband sound power levels and octave band distributions for the Vestas V126 3.45 MW MW STE wind turbine generators, at a hub height of 87 m, were provided by the Customer [7]. This acoustic emissions data was determined in accordance with the IEC 61400-11 standard [8]. At the request of the Customer, an uncertainty level of 2 dBA was added to the maximum wind turbine acoustic emission. The maximum wind turbine acoustic emission plus the 2 dB uncertainty level (total of 109.3 dBA) is considered in this assessment and is presented in Table 5-1.

Table 5-1 Vestas V126 3.45 MW STE Mode 0 acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	80.7	89.2	94.8	100.6	104.5	105.0	99.6	91.3	69.6	109.3

For the transformer, a broadband sound power level of 116.6 dBA was estimated based on standard NEMA TR.1 Table 0-1 [9] and IEEE standard C57.12.90-2006 [10] for one 330 MVA, 345 kV utility scale transformer, as specified by RES. A typical transformer octave band distribution was estimated, as shown in Table 5-2. The sound power level of the transformer includes a 5 dB penalty for tonality.

Table 5-2 Transformer acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	73.8	93.0	105.1	107.6	113.0	110.2	106.4	101.2	92.1	116.6

5.2 Ashtabula I and III wind projects

The octave band sound power levels used to model the GE sle 1.5 MW wind turbines belonging to Ashtabula I Wind Energy Center are shown in Table 5-3. These were taken from the Ashtabula III Wind Energy Center Acoustic Assessment [5].

Table 5-3 Ashtabula I Wind Energy Center – GE sle 1.5 MW acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	N/A	87.1	96.0	99.2	100.6	99.9	96.5	89.3	80.1	106.0

The octave band sound power levels used to model the GE xle 1.6 MW wind turbines belonging to Ashtabula III Wind Energy Center are shown in. These were taken from the project acoustic assessment [5].

Table 5-4 Ashtabula III Wind Energy Center – GE xle 1.6 MW acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	N/A	86.8	95.6	101.2	102.8	102.1	99.3	91.1	88.2	108.0

For the Ashtabula III transformer, a broadband sound power level of 108.4 dBA was used, using the octave band sound power levels in the acoustic assessment [5]. This includes a 5 dB tonal penalty as per industry best practice. A typical transformer octave distribution was used in the acoustic assessment, as shown in Table 5-5.

Table 5-5 Ashtabula III Wind Energy Center – Transformer acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband (dBA)
Sound Power Level [dB]	105	111	113	108	108	102	97	92	85	108.4

For the Ashtabula I transformer, details were not provided in the acoustic assessment report. Therefore, a broadband sound power level of 111.4 dBA was estimated using the Ashtabula III transformer sound power levels [5] and adding 3 dBA due to the total capacity of the Ashtabula I project being 196.5 MW - much larger than Ashtabula III. This includes a 5 dB tonal penalty as per industry best practice. The modeled octave band sound power levels, scaled up from Table 5-5, are shown in Table 5-6.

Table 5-6 Ashtabula I Wind Energy Center – Transformer acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband (dBA)
Sound Power Level [dB]	108	114	116	111	111	105	100	95	88	111.4

5.3 Assessment methodology

The sound pressure level (SPL) at each receptor for the aggregate of all wind turbine generators and transformers associated with the Glacier Ridge Wind Farm were calculated using CadnaA 4.2 acoustic modeling software based on the ISO 9613-2 method [1]. The simulation was run for the wind speed corresponding with the maximum sound power level (PWL) of the turbines and the maximum sound power level of the transformer. The hub height of the turbines is 87 m. The Glacier Ridge transformer was modeled as a point source at a height of 4.9 m above ground level, assuming the transformer is raised 0.3 m above the ground. The transformers for Ashtabula I and III was modeled as point sources at a height of 4.5 m above ground level. All receptors were modeled at a height of 1.5 m.

The ISO 9613 standard provides a prediction of the equivalent continuous sound pressure level at a distance from one or more point sources. The method consists of octave-band algorithms (i.e., with nominal mid-band frequencies from 31.5 Hz to 8 kHz) for calculating the attenuation of the emitted sound. The algorithm takes into account the following physical effects:

- Geometrical divergence – attenuation due to spherical spreading from the sound source

- Atmospheric absorption – attenuation due to absorption by the atmosphere
- Ground absorption – attenuation due to the acoustical properties of the ground

The ISO 9613 standard calculates attenuation under meteorological conditions favorable to propagation from sources of sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as it commonly occurs at night. In other words, though a physical impracticality, the ISO 9613-2 standard treats every receptor as being downwind from every source of sound emission (in this case, turbines and transformers).

The ISO 9613-2 standard accounts for ground effect by assigning a numerical coefficient (G) with a value ranging from 0 to 1. A G = 0 equates to hard ground (paving, water, ice, concrete, tamped ground, and other ground surfaces with a low porosity), while a G = 1 equates to porous ground (ground covered by grass, trees, or other vegetation, and other ground surfaces suitable for the growth of vegetation such as farming land). Though the ground use on and around the site is farming, a mixed (semi-reflective) overall ground factor of G = 0.5 was used in this assessment.

Additionally, temperature, barometric pressure, and humidity parameters were selected to represent conditions favorable to sound propagation, and topographical information to accurately represent terrain in three-dimensions was included in this assessment.

Specifically, the ISO 9613-2 parameters were set as follows:

- Ambient air temperature: 10ºC
- Ambient barometric pressure: 101.32 kPa
- Humidity: 70%
- Overall ground factor: 0.5
- Topography included

Additional attenuation from foliage was not considered in this assessment, implying that the lower sound levels are expected in areas where there is foliage present in the line of sight between any turbine and a sound receptor. Similarly, because the model assumes every receptor is downwind of every sound source at all times, lower sound levels are expected at times when a receptor is upwind of any sound source [1].

The wind turbine and transformer sound emission ratings used for each octave band were those specified in Table 5-1 to Table 5-6. The sound impact was calculated for each receptor and the calculated sound level was then compared with the applicable sound limit.

No distinction was made between daytime or night time sound emissions in the simulation because the project is assumed to be operating at maximum capacity at all times.

6 RESULTS

Detailed maps illustrating predicted sound pressure levels at receptors located in the vicinity of the Project is presented in Figure 6-1 to Figure 6-8.

The results of the sound study are presented for all sound receptors in tabular format in Appendix B. For each receptor, the following information is provided:

- ID;
- Coordinates in UTM projection and NAD83 Datum;
- Sound levels in dBA at the receptor location at 1.5 m above ground level;
- Closest wind turbine; and
- Distance to the closest wind turbine.

The sound pressure levels at each of the 49 receptors located within 1 mile (approximately 1,600 m) of a project turbine are within the allowable limits under the applicable regulations.

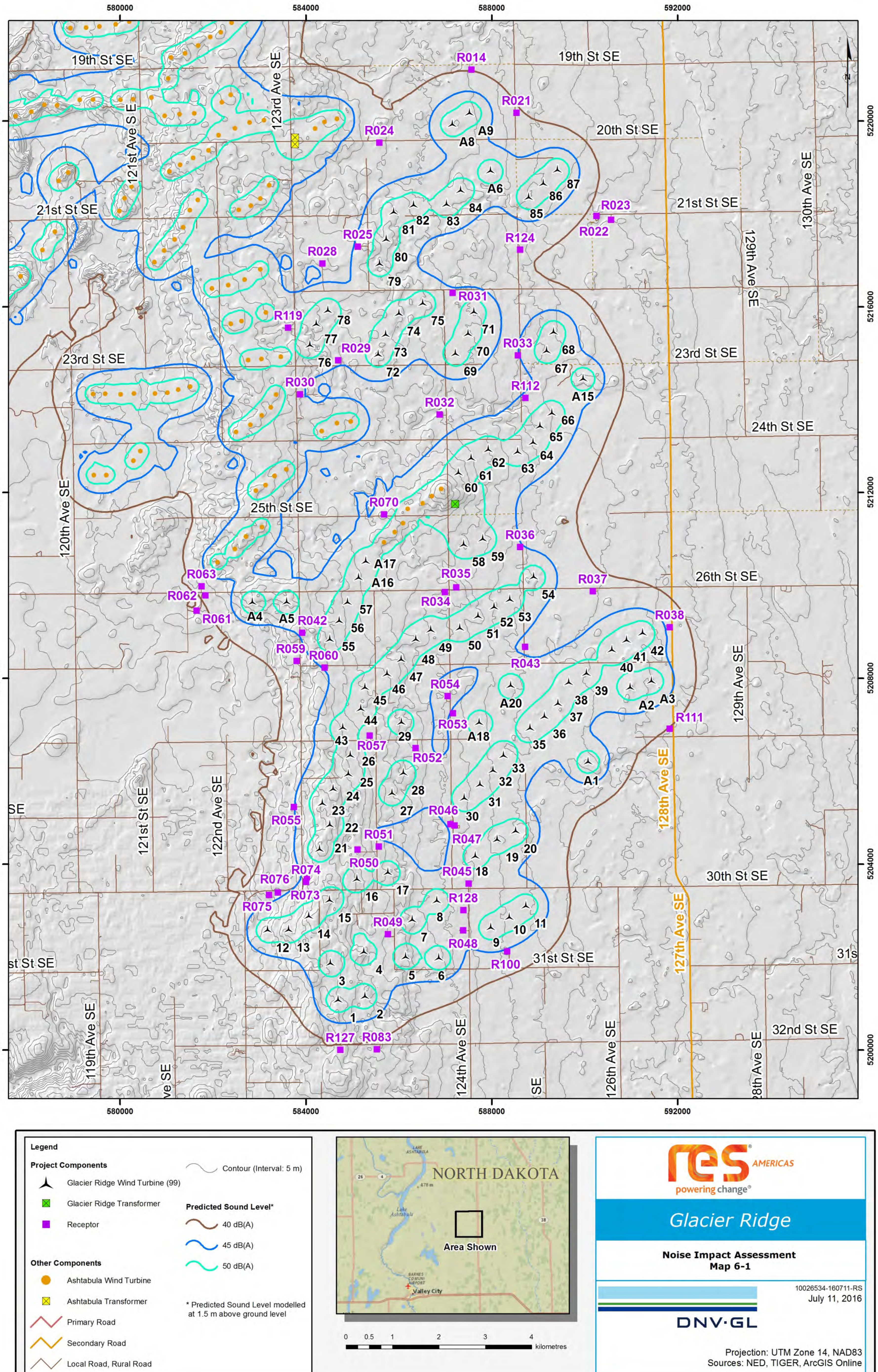


Figure 6-1 Modeled sound levels at Glacier Ridge Wind Project

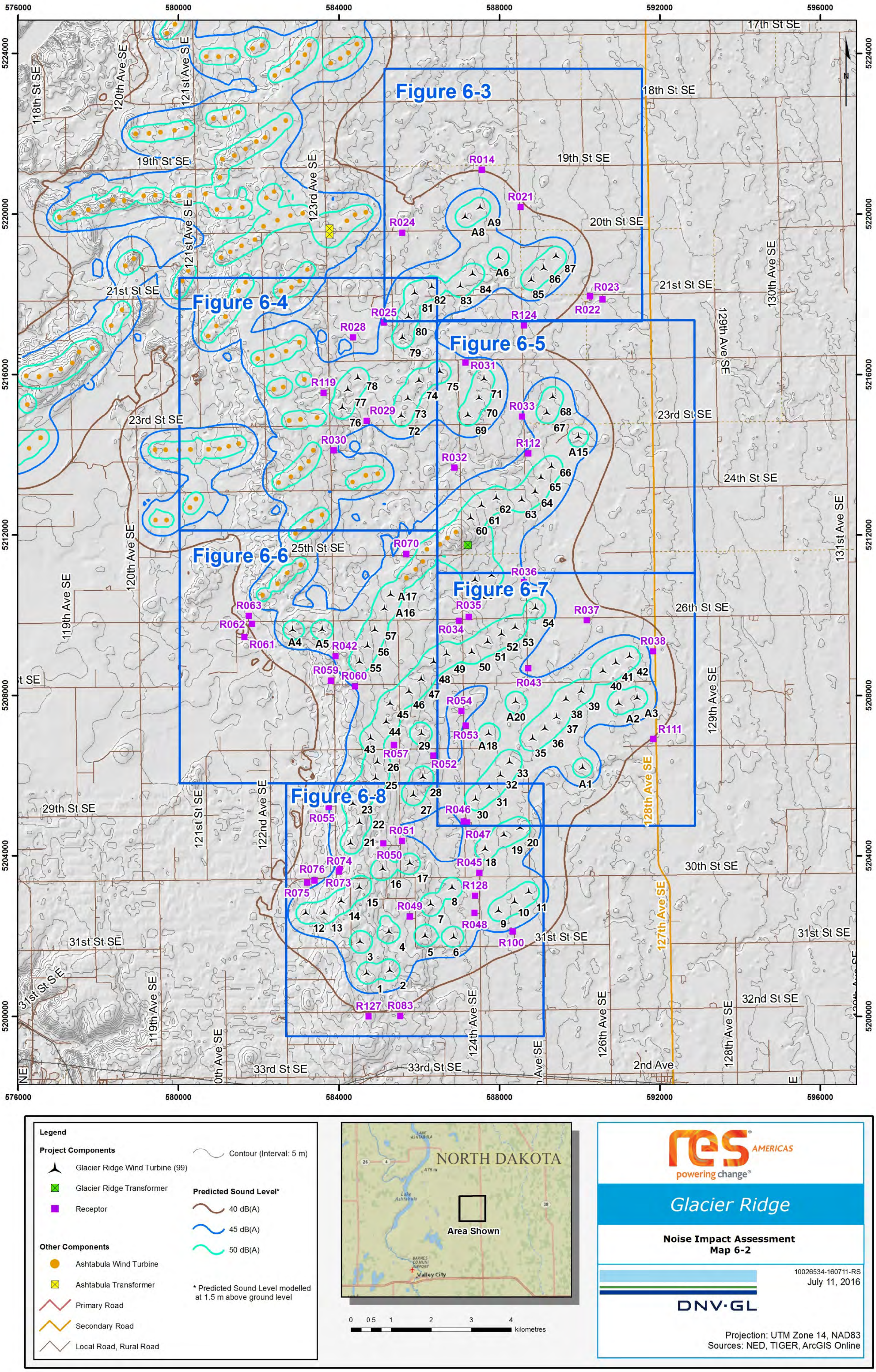


Figure 6-2 Key Map for Detailed Figures

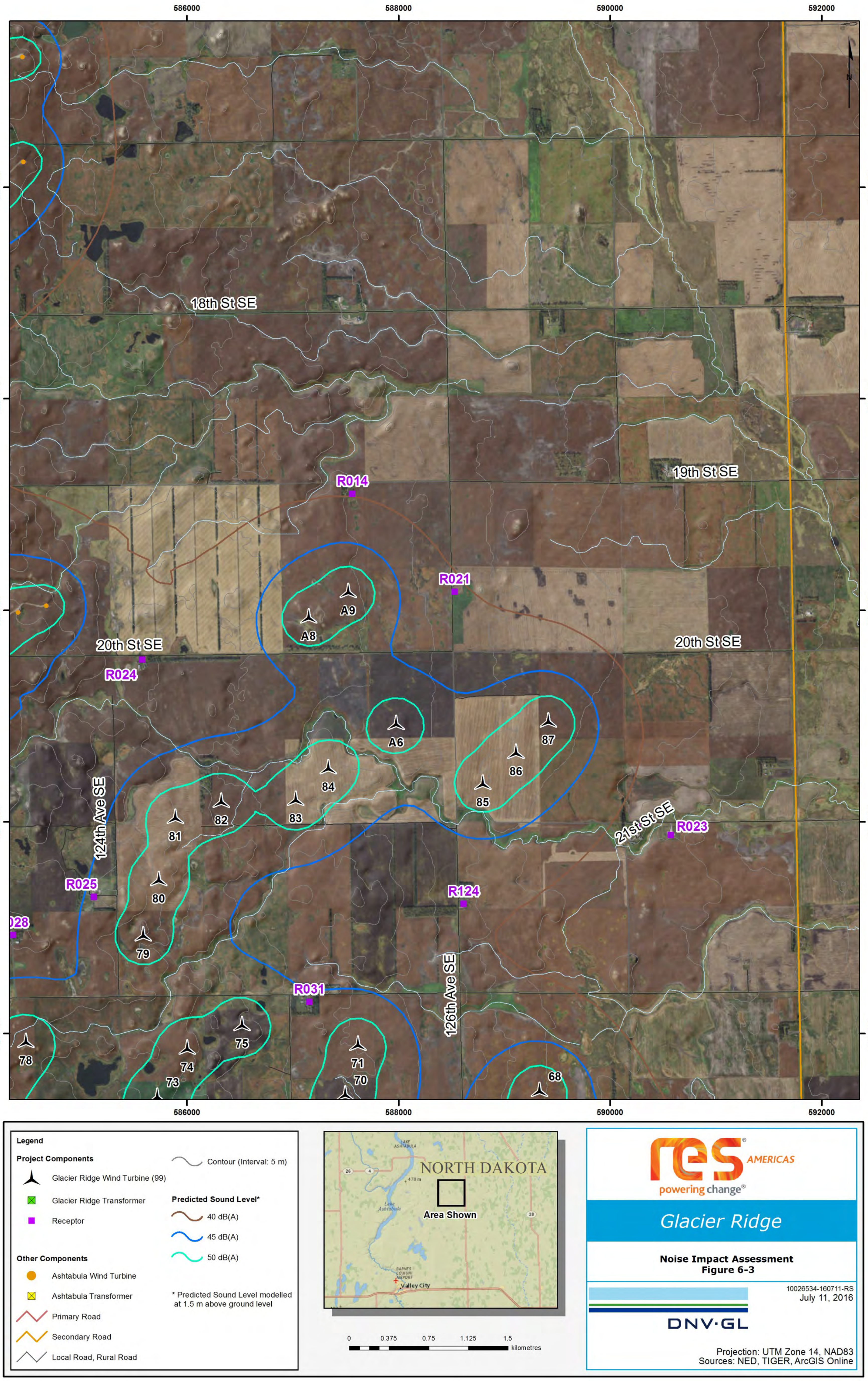


Figure 6-3 Detailed Isocontour Map 1

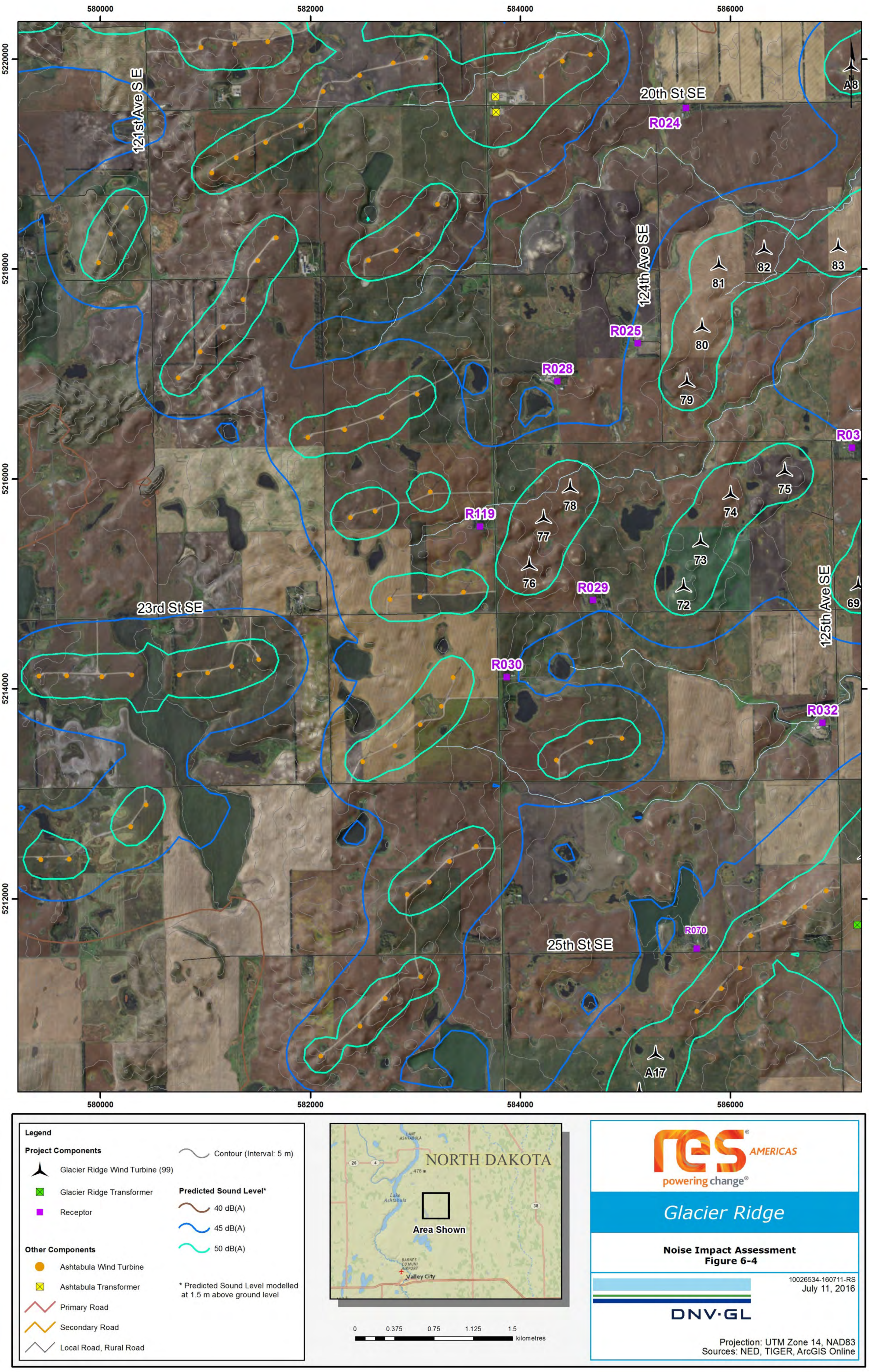


Figure 6-4 Detailed Isocontour Map 2

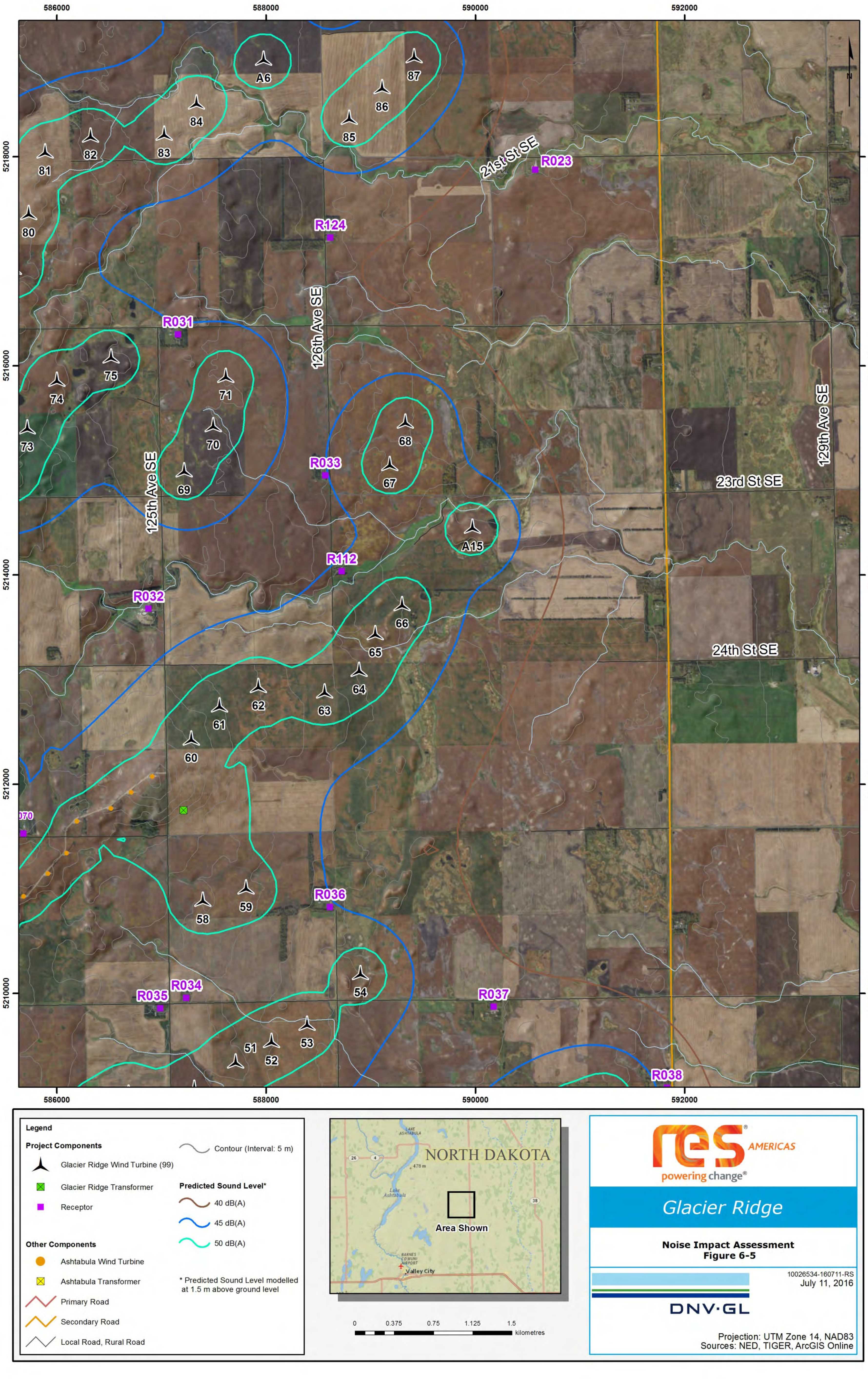
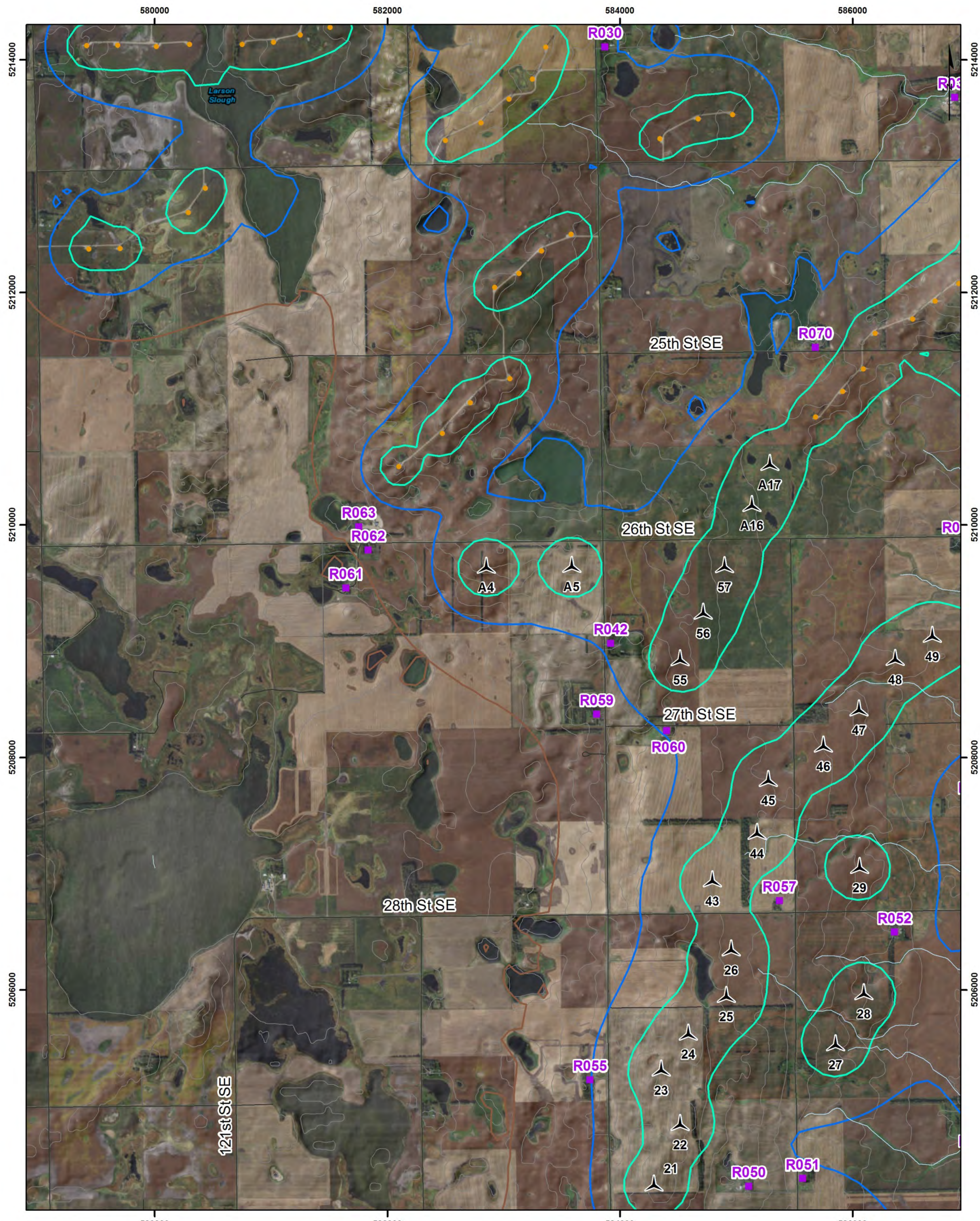


Figure 6-5 Detailed Isocontour Map 3



Legend

Project Components

Glacier Ridge Wind Turbine (99)

Glacier Ridge Transformer

Receptor

Other Components

Ashtabula Wind Turbine

Ashtabula Transformer

Primary Road

Secondary Road

Local Road, Rural Road

Contour (Interval: 5 m)

Predicted Sound Level*

40 dB(A)

45 dB(A)

50 dB(A)

* Predicted Sound Level modelled at 1.5 m above ground level

0 0.375 0.75 1.125 1.5 kilometres

res AMERICAS powering change

Glacier Ridge

Noise Impact Assessment
Figure 6-6

10026534-160711-RS
July 11, 2016

DNV·GL

Projection: UTM Zone 14, NAD83
Sources: NED, TIGER, ArcGIS Online

Figure 6-6 Detailed Isocontour Map 4

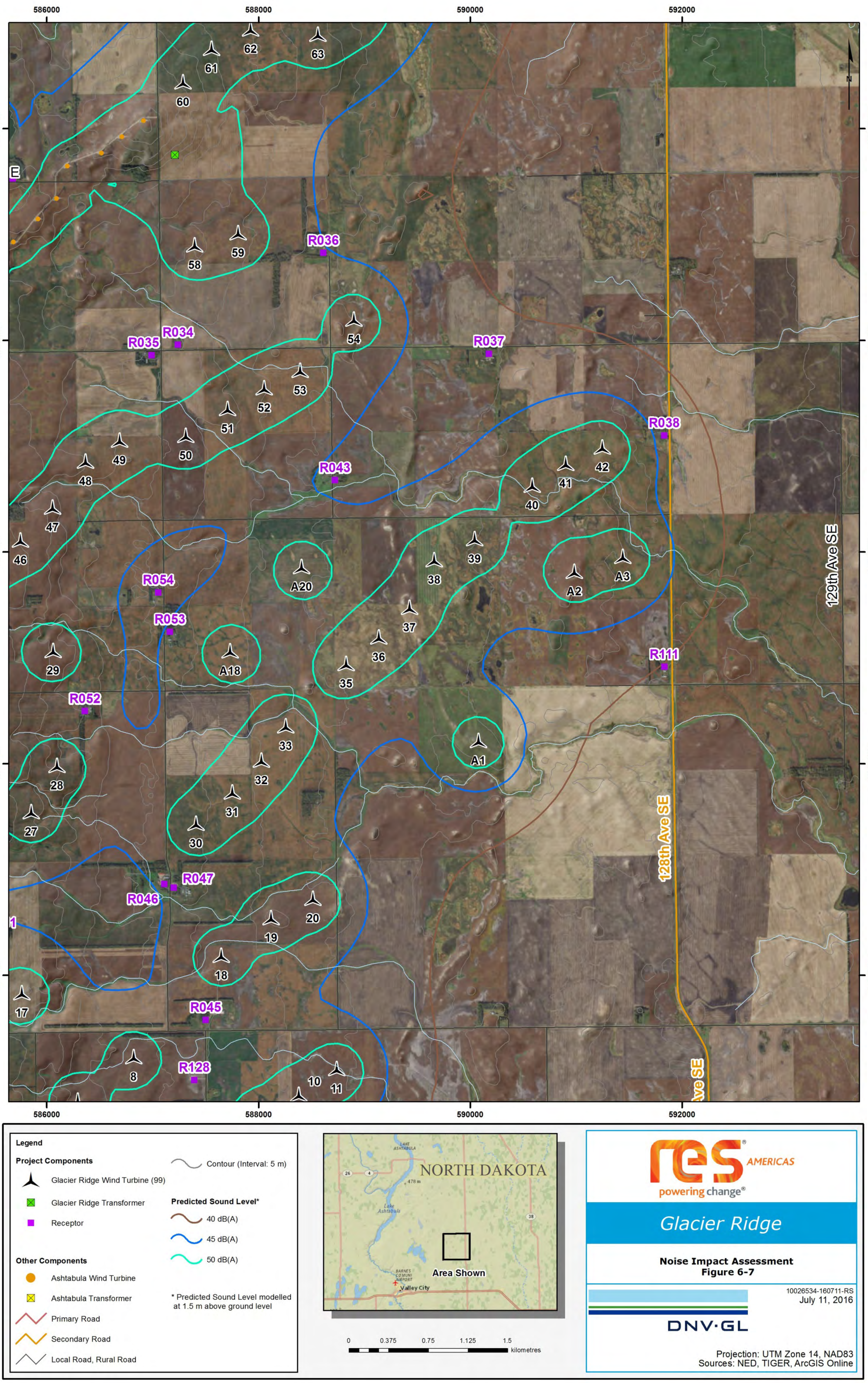


Figure 6-7 Detailed Isocontour Map 5

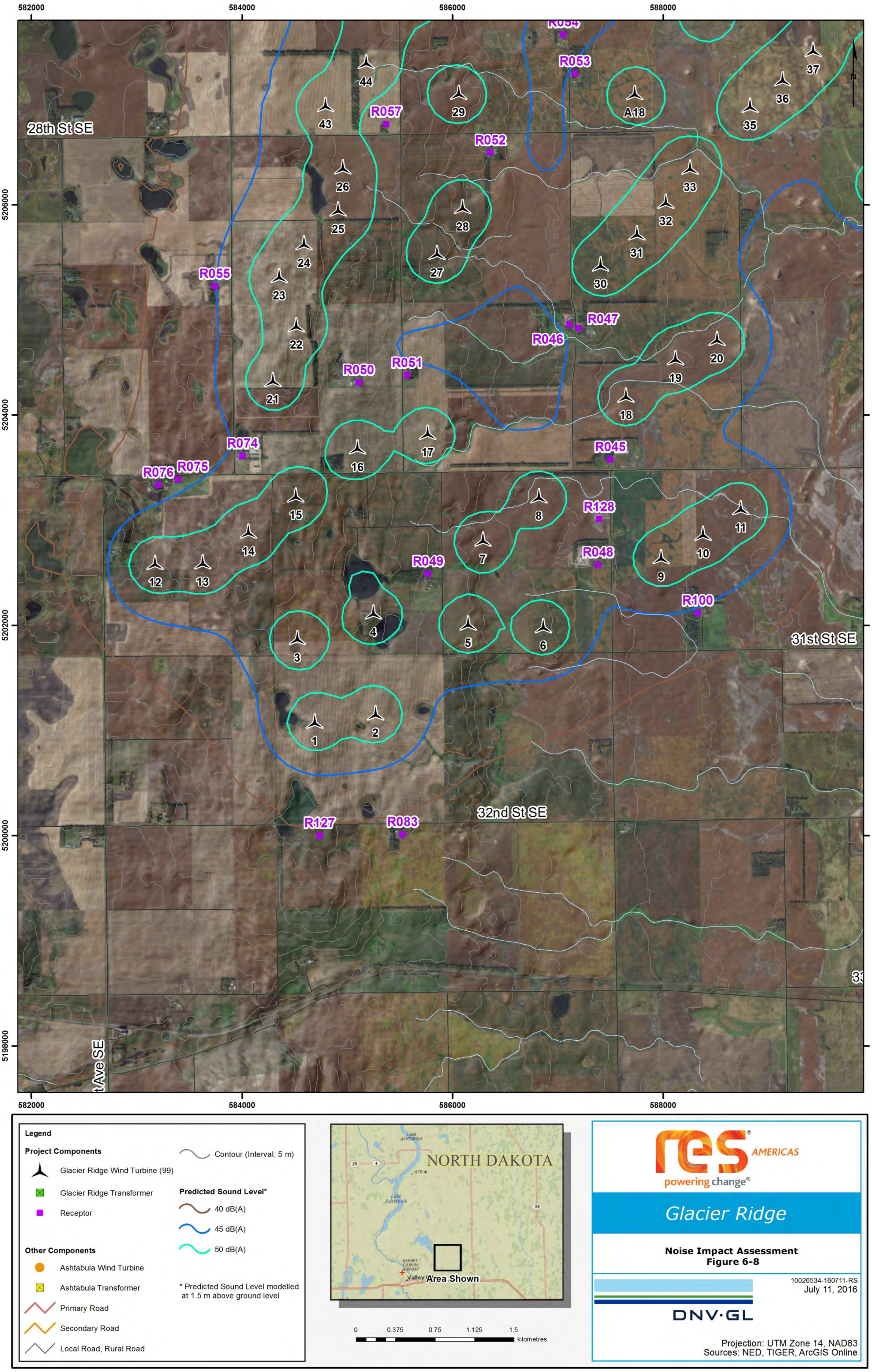


Figure 6-8 Detailed Isocontour Map 6

7 CONCLUSION

An analysis has been conducted to determine the maximum sound levels predicted to be experienced at sound receptors in the vicinity of the Glacier Ridge Wind Farm in Barnes County, North Dakota. This analysis was undertaken specifically for the Vestas V126 3.45 MW STE Mode 0 wind turbine generator at a hub height of 87 m. One transformer, 99 turbines, and the adjacent Ashtabula I and III wind projects were included in the model. Only 87 of the 99 proposed turbine locations will be built.

The results indicate that the calculated sound levels are within the allowable limits under the North Dakota Administrative Code Energy Conversion Facility Siting Criteria regulations and the Barnes County regulations at each of the 49 receptors located within a mile (approximately 1,600 m) of the project turbines.

8 REFERENCES

[1] International Organization for Standardization. ISO 9613-2: Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation. 15 December 1996.

[2] North Dakota Administrative Code. Chapter 69-06-08-01. Energy conversion facility siting criteria.

[3] Barnes County Development Code. Section 6.10. Noise. Barnes County, North Dakota. 2016.

[4] Turbine layout locations sent by email, by RES, to B. Moreira, DNV GL, 13 June 2016, “PUSAevg140_ND_StatePlane_NAD83_USft.csv”.

[5] Tetratech EC, INC. Ashtabula III Wind Energy Center Acoustic Assessment Barnes County, North Dakota, NextEra Energy Resources, July 2010.

[6] Receptor locations sent by email, by RES, to B. Moreira, DNV GL, 20 June 2016, “houses 5_31_16”.

[7] Turbine acoustic specifications sent by email, by RES, to B. Moreira, DNV GL, 13 June 2016, “Vestas_-_3MW_Platform_General_Description_r2.pdf” and “0055-1400_V00 - V126-3_45MW Low Torque Third Octaves.pdf”.

[8] International Electrotechnical Commission. IEC 61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Measurement Techniques. 07 November 2012.

[9] National Electrical Manufacturers Association. NEMA Standards Publication No TR 1-1993 (R2000): Transformers, Regulators, and Reactors. 2000.

[10] C57.12.90-2006 IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

APPENDIX A – WIND TURBINE GENERATOR AND TRANSFORMER COORDINATES

Glacier Ridge Wind Project wind turbine and transformer coordinates given in UTM Zone 14, NAD 83 Datum.

Customer ID	Easting [m]	Northing [m]
A1	590076	5206196
A2	590981	5207795
A3	591439	5207934
A4	582849	5209629
A5	583584	5209635
A6	587977	5218917
A8	587150	5219922
A9	587524	5220163
A15	589971	5214442
A16	585134	5210160
A17	585288	5210512
A18	587730	5207044
A20	588406	5207838
T1	584691	5201066
T2	585268	5201144
T3	584526	5201860
T4	585247	5202104
T5	586148	5202000
T6	586861	5201974
T7	586290	5202798
T8	586821	5203209
T9	587980	5202631
T10	588380	5202851
T11	588737	5203096
T12	583173	5202575
T13	583626	5202581
T14	584061	5202873
T15	584510	5203216
T16	585095	5203673
T17	585763	5203813
T18	587646	5204166
T19	588117	5204521
T20	588513	5204705
T21	584292	5204315
T22	584515	5204835
T23	584354	5205304
T24	584587	5205613
T25	584913	5205936
T26	584956	5206337
T27	585852	5205522
T28	586096	5205960
T29	586058	5207046

Customer ID	Easting [m]	Northing [m]
T30	587407	5205414
T31	587750	5205710
T32	588027	5206010
T33	588256	5206335
T35	588827	5206922
T36	589136	5207175
T37	589425	5207453
T38	589657	5207903
T39	590041	5208102
T40	590586	5208607
T41	590902	5208814
T42	591247	5208969
T43	584793	5206931
T44	585178	5207338
T45	585273	5207795
T46	585749	5208090
T47	586053	5208401
T48	586364	5208835
T49	586685	5209034
T50	587313	5209079
T51	587708	5209332
T52	588051	5209527
T53	588391	5209693
T54	588900	5210177
T55	584516	5208832
T56	584714	5209233
T57	584898	5209633
T58	587395	5210877
T59	587807	5210994
T60	587285	5212419
T61	587554	5212735
T62	587925	5212919
T63	588559	5212869
T64	588889	5213074
T65	589041	5213426
T66	589298	5213703
T67	589180	5215042
T68	589331	5215446
T69	587217	5214981
T70	587494	5215412
T71	587614	5215885
T72	585554	5214964
T73	585717	5215393
T74	586001	5215847
T75	586517	5216070
T76	584083	5215171

Customer ID	Easting [m]	Northing [m]
T77	584221	5215618
T78	584475	5215910
T79	585585	5216917
T80	585730	5217440
T81	585888	5218030
T82	586321	5218182
T83	587027	5218200
T84	587333	5218498
T85	588794	5218350
T86	589109	5218643
T87	589415	5218939
Transformer	587210	5211751

Ashtabula I Wind Project wind turbine and transformer coordinates given in UTM Zone 14, NAD 83 Datum.

ID	Easting [m]	Northing [m]
Ash-N1	580537	5226982
Ash-N2	580888	5227010
Ash-N3	581367	5227242
Ash-N4	581624	5227421
Ash-N5	583912	5226912
Ash-N6	584200	5227141
Ash-N7	584487	5227433
Ash-N8	579706	5224510
Ash-N9	579914	5224736
Ash-N10	580007	5225014
Ash-N11	579929	5225549
Ash-N12	579983	5225833
Ash-N13	580147	5226374
Ash-N14	583881	5225080
Ash-N15	584164	5225180
Ash-N16	584445	5225233
Ash-N17	580696	5223928
Ash-N18	581004	5223927
Ash-N19	581323	5223937
Ash-N20	581854	5224128
Ash-N21	582085	5224209
Ash-N22	582406	5223456
Ash-N23	582726	5223588
Ash-N24	582984	5223776
Ash-N25	583153	5223970
Ash-N26	583269	5224217
Ash-N27	583802	5223762
Ash-N28	584041	5223879
Ash-N29	584233	5224021
Ash-N30	584452	5224241
Ash-N31	580874	5222381
Ash-N32	581159	5222395
Ash-N33	581488	5222534
Ash-N34	579983	5218061
Ash-N35	580096	5218334
Ash-N36	580247	5218585
Ash-N37	581060	5218914
Ash-N38	581292	5219058
Ash-N39	581574	5219205
Ash-N40	581907	5219363
Ash-N41	582123	5219693
Ash-N42	582470	5219845
Ash-N43	582789	5219965
Ash-N44	583100	5220014
Ash-N45	580742	5216963
Ash-N46	580950	5217211
Ash-N47	581173	5217446
Ash-N48	581357	5217709
Ash-N49	581499	5218081

ID	Easting [m]	Northing [m]
Ash-N50	581675	5218299
Ash-N51	582553	5218083
Ash-N52	582819	5218175
Ash-N53	583022	5218332
Ash-N54	583211	5218617
Ash-N55	581976	5216395
Ash-N56	582327	5216468
Ash-N57	582680	5216587
Ash-N58	583018	5216808
Ash-N59	582380	5215632
Ash-N60	582618	5215692
Ash-N61	583142	5215877
Ash-N62	579415	5214123
Ash-N63	579680	5214126
Ash-N64	580013	5214115
Ash-N65	580299	5214132
Ash-N66	580751	5214134
Ash-N67	581022	5214151
Ash-N68	581252	5214214
Ash-N69	581507	5214280
Ash-N70	582758	5214852
Ash-N71	583044	5214877
Ash-N72	583459	5214924
Ash-N73	579433	5212373
Ash-N74	579702	5212377
Ash-N75	580289	5212686
Ash-N76	580436	5212895
Ash-N77	582499	5213306
Ash-N78	582804	5213457
Ash-N79	583047	5213661
Ash-N80	583246	5213835
Ash-N81	583361	5214109
Ash-N82	582098	5210503
Ash-N83	582472	5210787
Ash-N84	582713	5211052
Ash-N85	583054	5211258
Ash-N86	582923	5212043
Ash-N87	583132	5212162
Ash-N88	583326	5212357
Ash-N89	583579	5212501
Ash-N90	584344	5213323
Ash-N91	584672	5213493
Ash-N92	584968	5213529
Ash-N93	585684	5210929
Ash-N94	585917	5211147
Ash-N95	586094	5211342
Ash-N96	586195	5211647
Ash-N97	586518	5211770
Ash-N98	586711	5211924
Ash-N99	586914	5212076
Ash-O1	578930	5221996

ID	Easting [m]	Northing [m]
Ash-O2	579266	5222012
Ash-O3	579553	5222037
Ash-O4	579906	5222084
Ash-O5	580200	5222143
Ash-O6	577033	5219922
Ash-O7	577389	5220017
Ash-O8	577753	5220106
Ash-O9	578091	5220200
Ash-O10	578369	5220348
Ash-O11	578646	5220335
Ash-O12	579134	5220454
Ash-O13	579420	5220464
Ash-O14	580006	5220454
Ash-O15	580278	5220467
Ash-O16	580674	5220501
Ash-O17	581039	5220915
Ash-O18	581095	5221368
Ash-O19	581398	5221458
Ash-O20	581678	5221621
Ash-O21	581942	5221805
Ash-O22	582167	5221907
Ash-O23	582403	5222119
Ash-O24	582678	5222333
Ash-O25	580959	5220110
Ash-O26	581279	5220146
Ash-O27	581595	5220166
Ash-O28	582192	5220403
Ash-O29	582384	5220560
Ash-O30	584199	5219835
Ash-O31	584402	5219980
Ash-O32	584668	5220042
AshI-Tranformer	583763	5219639

Ashtabula III Wind Project wind turbine and transformer coordinates given in UTM Zone 14, NAD 83 Datum.

ID	Easting [m]	Northing [m]
AshIII-T1	581721	5229602
AshIII-T2	582016	5229633
AshIII-T3	582186	5229853
AshIII-T4	582168	5230781
AshIII-T5	582340	5231145
AshIII-T6	582519	5231456
AshIII-T7	582928	5230353
AshIII-T8	583123	5230550
AshIII-T9	583307	5230758
AshIII-T10	583770	5230782
AshIII-T11	584067	5230996
AshIII-T12	584319	5231298
AshIII-T13	581041	5227910
AshIII-T14	581212	5228164
AshIII-T15	582159	5228049
AshIII-T16	582521	5228018
AshIII-T17	582918	5228061
AshIII-T18	583316	5228276
AshIII-T19	583679	5228371
AshIII-T20	583931	5228483
AshIII-T21	584656	5227984
AshIII-T22	584973	5228196
AshIII-T23	586052	5228815
AshIII-T24	586340	5228838
AshIII-T25	575909	5213922
AshIII-T26	576276	5214162
AshIII-T27	576564	5214424
AshIII-T28	576228	5215256
AshIII-T29	576203	5215966
AshIII-T30	576526	5215948
AshIII-T31	576825	5215990
AshIII-T32	577065	5216137
AshIII-T33	577355	5216291
AshIII-T34	577522	5216565
AshIII-T35	577858	5216655
AshIII-T36	578330	5217223
AshIII-T37	578594	5217617
AshIII-T38	578679	5218712
AshIII-T39	578882	5218888
AshIII-Tranformer	583767	5219495

APPENDIX B – RECEPTOR LOCATIONS AND ASSOCIATED SOUND LEVELS

Receptor ID	UTM Coordinates		Calculated SPL at Receptor [dBA]	Nearest Turbine [ID]	Distance to Nearest Turbine [m]
	Easting [m]	Northing [m]			
R014	587562	5221104	40.0	A9	941
R021	588531	5220177	40.8	A9	1007
R022	590255	5217954	38.7	T87	1295
R023	590572	5217874	37.1	T87	1573
R024	585578	5219533	41.2	T81	1534
R025	585118	5217293	46.1	T79	600
R028	584354	5216931	43.1	T78	1028
R029	584690	5214845	45.6	T76	689
R030	583869	5214113	45.7	T76	1080
R031	587158	5216301	45.9	T71	617
R032	586878	5213678	42.9	T61	1161
R033	588565	5214953	45.0	T67	621
R034	587238	5209958	46.4	T51	783
R035	586989	5209860	46.1	T50	846
R036	588612	5210827	45.4	T54	711
R037	590176	5209874	41.5	T41	1285
R038	591832	5209102	44.1	T42	600
R042	583918	5208982	45.9	T55	617
R043	588721	5208679	44.7	A20	898
R045	587501	5203580	45.8	T18	604
R046	587109	5204862	45.7	T30	627
R047	587199	5204831	46.0	T30	619
R048	587383	5202578	45.8	T9	600
R049	585767	5202491	47.1	T7	606
R050	585108	5204313	46.5	T16	640
R051	585569	5204380	45.8	T17	599
R052	586360	5206498	46.6	T28	600
R053	587162	5207247	45.5	A18	604
R054	587053	5207619	44.4	A18	888
R055	583742	5205228	45.2	T23	616
R057	585372	5206769	48.3	T26	600
R059	583799	5208374	42.8	T55	851
R060	584400	5208230	45.5	T55	613
R061	581643	5209458	38.9	A4	1218
R062	581835	5209785	41.0	A4	1026
R063	581753	5209984	41.5	A4	1152
R070	585680	5211529	47.7	A17	1089
R073	584021	5203718	45.9	T21	656
R074	584004	5203615	46.1	T15	644
R075	583392	5203391	44.2	T13	843
R076	583205	5203338	43.8	T12	764
R083	585526	5200014	38.6	T2	1159
R100	588329	5202120	44.7	T9	619

Receptor ID	UTM Coordinates		Calculated SPL at Receptor [dBA]	Nearest Turbine [ID]	Distance to Nearest Turbine [m]
	Easting [m]	Northing [m]			
R111	591834	5206916	40.0	A3	1091
R112	588722	5214037	46.0	T66	666
R119	583617	5215549	47.6	T76	600
R124	588614	5217226	40.9	T85	1138
R127	584738	5200004	39.2	T1	1063
R128	587393	5203011	46.0	T8	605

Coordinates given in UTM Zone 14, NAD83 Datum

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GLACIER RIDGE WIND FARM

Shadow Flicker Report

Glacier Ridge Wind Farm, LLC

Document No.: 10026534-HOU-R-02
Issue: A, **Status**: FINAL
Date: 13 July 2016

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Task and objective:
Shadow flicker analysis of the Glacier Ridge wind project.

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A	13 July 2016	FINAL	A. Shomer	A. Nercessian	M. Cookson B. Moreira

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EXECUTIVE SUMMARY

An analysis has been conducted to predict the duration of shadow flicker to be experienced at receptors in the vicinity of the Glacier Ridge Wind Farm (the "Project") in North Dakota. This analysis was undertaken for a total of 99 Vestas V126-3.45MW wind turbines (87 proposed and 12 alternate), at a hub height of 87 m and rotor diameter of 126 m. The impact of the adjacent operational Ashtabula I and III wind projects has also been taken into consideration when applicable.

128 receptors have been identified by DNV GL in the vicinity of the Project using aerial imagery. Of these 128 receptors, 47 potentially affected receptors within 1500 m of a turbine have been included in this report.

The receptor that is predicted to experience the most hours of shadow flicker in one year as well as the highest predicted minutes of shadow flicker in a single day is receptor 57. The predicted duration of shadow flicker at this receptor is 44 hours per year when taking into account average monthly cloud cover and annual wind rose as well as 89 minutes in a single day on May 16 without consideration of cloud cover or wind rose statistics.

There are certain simplifications and conservative assumptions inherent within the model that may result in an overestimation of shadow flicker duration.

1 INTRODUCTION

DNV KEMA Renewables, Inc. ("DNV GL") has been commissioned by Glacier Ridge Wind Farm, LLC (the "Customer" or "Glacier Ridge") to independently assess the impact of the shadow flicker effects in the vicinity of the proposed Glacier Ridge Wind Farm (the "Project"). The proposed Glacier Ridge wind project is located in Barnes County, North Dakota, approximately 45 miles (72 km) west of Fargo. The current layout consists of 99 Vestas V126-3.45MW wind turbines (including 87 proposed and 12 alternate locations) with a maximum blade tip height of 150 m, a hub height of 87 m and a rotor diameter of 126 m.

The purpose of this shadow flicker analysis is to calculate the predicted shadow flicker duration from the proposed Project at nearby receptor locations. This report includes a brief presentation of the Project site, a description of the shadow flicker assessment methodology, results of the analysis including a map illustrating areas prone to shadow flicker, and concluding comments.

1.1 Shadow flicker definition

Shadow flicker is defined as the modulation of light levels resulting from the periodic passage of a rotating wind turbine blade between the sun and a viewer. The duration of shadow flicker experienced at a specific location can be determined using a purely geometric analysis which takes into account the relative positions of the sun throughout the year, the wind turbines at the site, and the viewer. This method has been used to determine the shadow flicker duration at sensitive locations in vicinity of the Project.

It should be noted, as described in Section 3, that there are certain simplifications and conservative assumptions inherent within the model that may result in an overestimation of shadow flicker duration.

2 DESCRIPTION OF THE WIND PROJECT SITE

2.1 Site description

The proposed Project is located in northern Barnes County, North Dakota, approximately 45 miles west of West Fargo, ND.

The proposed wind project is situated in relatively simple terrain, consisting of flat farm land, with wind turbine base elevations ranging from 410 m to 460 m. The ground cover on and near the site is primarily comprised of farm land and open fields with some forested areas. Dwellings are interspersed throughout the Project site.

2.2 Wind project layout

The proposed turbine layout supplied by the Glacier Ridge [1] considered 99 Vestas V126-3.45MW wind turbines of which 87 are to be built and 12 are alternates. The precise coordinates of each turbine are presented in Appendix A.

NExtEra Energy Resources owns the operational wind projects, Ashtabula I and Ashtabula III, located immediately to the north west of the Glacier Ridge project. Ashtabula I and III respectively consist of 131 GE sle 1.5 MW and 39 GE xle 1.6 MW wind turbine generators at a hub height of 80 m. The locations were obtained from Glacier Ridge and confirmed with Google Earth imagery.

These turbines were considered in a cumulative simulation and only in cases where receptors experience flicker from both Glacier Ridge and Ashtabula wind turbines during the year.

2.3 Receptors locations

A list of 128 receptors to be considered as shadow flicker receptors was identified on site by Glacier Ridge [4] and validated by DNV GL using available aerial imagery. Of the 128 total identified receptors, shadow flicker duration was calculated for 47 receptors located within 1500 m (10 times the tip height, as explained in Section 3.2) of a turbine.

Maps of turbine locations and receptor locations are included in Figure 4-1 to Figure 4-8. The IDs and coordinates of these receptors are listed in Appendix B.

2.4 Applicable regulations

There are no applicable local or state requirements with regard to exceedance limits of shadow flicker in the jurisdictions associated with this Project. However, other jurisdictions have recommended maximum levels of 30 hours/year. DNV GL considers these levels as best practices that should ideally be applied to wind projects.

DNV GL can recommend shadow flicker mitigation measures to the Glacier Ridge upon request.

3 SHADOW FLICKER ASSESSMENT

3.1 Overview

Shadow flicker may occur under certain combinations of circumstances with regards to the sun's position and wind direction; when the sun passes behind the rotating blades of a wind turbine, a moving shadow is cast in front of or behind the turbine. When viewed from a stationary position, the moving shadows cause periodic flickering of the sunlight, otherwise known as the "shadow flicker" phenomenon.

The effect is most noticeable inside buildings, where the flicker appears through a window opening. The likelihood and duration of the effect depends on a number of variables, namely:

- Orientation of the building relative to the turbine;
- Wind direction: the shape and intensity of the shadow are determined by the position of the sun relative to the blades (the turbine rotor continuously yaws to face the wind so the rotor plane will always be perpendicular to the wind direction;
- Distance from turbine: the farther the observer from the turbine, the less pronounced the effect;
- Turbine height and rotor diameter: a larger turbine rotor diameter will cast a larger shadow, meaning a larger area will be prone to incidences of shadow flicker;
- Time of year and day: position of sun relative to the horizon;
- Weather conditions: cloud cover reduces the occurrence of shadow flicker;
- Vegetation and other obstacles that help to mask shadows;
- Operational status of turbines.

3.2 Assessment methodology

The number of hours of shadow flicker experienced annually at a given location can be calculated using a geometrical model which takes into account the sun's position, topography of the wind project site and wind turbine specifications such as rotor diameter and hub height.

Shadow flicker has been calculated at the subject receptors (i.e. residences) at a height of 2 m to represent ground floor windows. Rather than facing a particular direction, shadow flicker receptors (windows) are simulated as horizontal planes, meaning they experience shadow flicker over 360°; this assumption therefore represents a worst case scenario. Simulations with WindFarmer Analyst have been carried out with a resolution of 1 minute; if shadow flicker occurs in any 1-minute period, the model registers this as 1 minute of shadow flicker.

It is generally accepted that shadow flicker from wind turbines does not occur beyond a distance, D, from a given wind turbine. The UK wind industry considers this distance to be equivalent to 10 rotor diameters [2], while the Danish wind industry suggests a value of between 500 and 1000 m [3]. DNV GL has adopted a conservative approach and has assumed the length, D, that a shadow can be cast to be defined as follows:

D = 10 x (hub height + rotor radius)

Beyond this distance, a viewer does not perceive the turbine blade to be chopping the light, but rather as an object passing in front of the sun.

The annual hours of shadow flicker at receptors has been calculated in two steps:

1) A “Worst Case” or astronomical worst-case, which represents the number of hours of annual shadow flicker that does not take into account attenuating factors, such as cloud cover or the site specific wind rose.

2) An “Expected case” that does consider cloud cover and the site specific wind rose in order to get a more realistic estimate, as described below. It shall be noted that additional attenuation factors are still present but were not considered.

Shadow flicker calculations can be adjusted using average monthly cloud coverage, which is based on historical meteorological data and statistics. According to data gathered from the Bismarck, Fargo, and Williston National Oceanic and Atmospheric Administration (NOAA) stations, monthly cloud cover can be estimated and applied as a percentage decrease in flicker duration. These cloud cover percentages are shown in Table 3-1.

Table 3-1 Monthly cloud cover percentage (%) reduction (Bismarck, Fargo, and Williston)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentage	33.5	34.3	32.8	35	37.9	41.6	55.9	54.3	47.2	41.9	30.7	32.8

Further, the annual site-specific wind rose was used in order to consider the probability of the turbines being oriented in a given direction. This produces a more accurate estimate of shadow flicker duration at residences. The frequency by sector distribution was provided by Glacier Ridge [4] and is shown in Table 3-2.

Table 3-2 Site specific directional frequencies (%) at mast M1

Sector (°)	0	30	60	90	120	150	180	210	240	270	300	330
Percentage	9.6	8.0	4.6	3.6	5.8	10.3	8.7	6.1	7.0	8.8	14.8	12.8

Note: The sectors are defined as 30° sectors centered at the given value

No attempt has been made to account for vegetation or other shielding effects around each shadow receptor in the calculations of shadow flicker duration. Similarly, turbine operational shut-down has not been considered in this analysis. Consideration of these factors could lead to a reduction of the levels of shadow flicker predicted.

3.3 Simplifications and conservative assumptions

Shadow flicker duration calculated in the manner described above has several limitations and may over-estimate the annual number of hours of shadow flicker experienced at a specified location for several reasons, namely:

- The modeling of the wind turbine blades as discs rather than individual blades results in an overestimate of shadow flicker duration.

  Turbine blades are of non-uniform thickness with the thickest part of the blade (maximum chord) close to the hub and the thinnest part (minimum chord) at the tip. Diffusion of sunlight, as discussed above, results in a limit to the maximum distance that a shadow can be perceived. This maximum distance will also be dependent on the thickness of the turbine blade and the human threshold for perception of light intensity variation. As such, a shadow cast by the blade tip will be shorter than the shadow cast by the thickest part of the blade [5].
- Additionally, the orientation of windows on a given house has not been taken into account, i.e. the model assumes that a window is always facing the turbine(s).
- Aerosols (moisture, dust, smoke, etc.) in the atmosphere have the ability to influence shadows cast by a wind turbine. The length of the shadow cast by a wind turbine is dependent on the degree that direct sunlight is diffused, which in turn is dependent on the amount of dispersants (humidity, smoke and other aerosols) in the path between the light source (sun) and the receiver [5].
- The presence of vegetation or other physical barriers around a shadow receptor location may shield the view of the wind turbine, and therefore reduce the incidence of shadow flicker.
- Periods where the wind turbine is not in operation due to low winds, high winds, or for operational and maintenance reasons will also reduce shadow flicker occurrence.

In light of the reasons listed above, it is likely that the shadow flicker durations presented in Section 4, Appendix B and Appendix C can be regarded as conservative.

4 RESULTS AND CONCLUSION

An analysis has been conducted to determine the duration of shadow flicker predicted for receptors in the vicinity of the Glacier Ridge Wind Farm in North Dakota. This analysis was undertaken specifically for the Vestas V126-3.45MW wind turbine with a blade tip height of 150 m.

Detailed maps illustrating predicted shadow flicker duration at receptors lying within 1500 m of the Glacier Ridge Wind Farm is presented in Figure 4-1 through Figure 4-8. These maps take into account average monthly cloud cover and annual site wind rose. For illustrative purposes shadow flicker is shown when occurring 30 hours or more per year.

The receptor that is predicted to experience the most hours of shadow flicker in one year as well as the highest predicted minutes of shadow flicker in a single day is receptor 57. The predicted duration of shadow flicker at this receptor is 44 hours per year when taking into account average monthly cloud cover and annual wind rose as well as 89 minutes in a single day on May 16 without consideration of cloud cover or wind rose statistics.

Of the 128 dwelling locations provided by the Glacier Ridge, 47 are within a distance of 1500 m. The results of the shadow flicker assessment are presented for all receptor locations in the Project area (in terms of minutes on worst day and total hours per year) in tabular format in Appendix B.

Results for the Expected Case in hours per year take into account the average monthly cloud cover from the NOAA meteorological stations at Bismarck, Fargo, and Williston and the annual site specific wind rose. It should be noted that the predicted level of exposure for minutes on worst day assumes no cloud cover or wind rose statistics.

There are four (4) receptors with a predicted annual shadow flicker level that exceeds 30 hours per year.

Three (3) of the receptors are predicted to incur additional cumulative shadow flicker impact from the neighboring Ashtabula I and III projects. Two (2) of these receptors are below 30 hours per year predicted annual shadow flicker. One (1) receptor (R119) exceeds 30 hours per year predicted annual shadow flicker and is included in the four (4) receptors mentioned above. The cumulative shadow flicker for these receptors was calculated in a cumulative simulation and is shown in Appendix C.

As described in Section 3, certain conservative assumptions have been made in this analysis, which likely results in an overestimation of the shadow flicker impacts that may be experienced at each receptor.

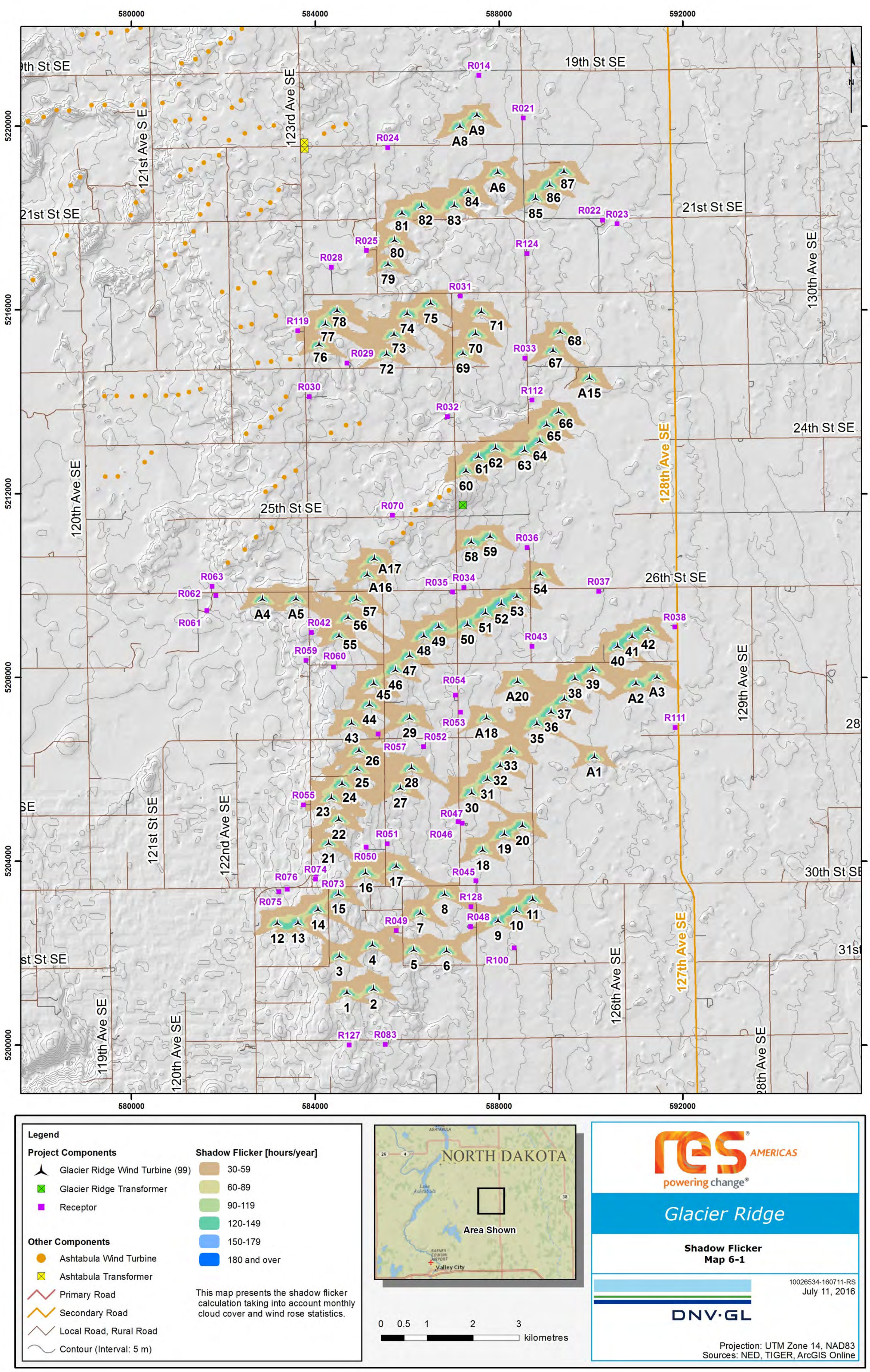


Figure 4-1 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

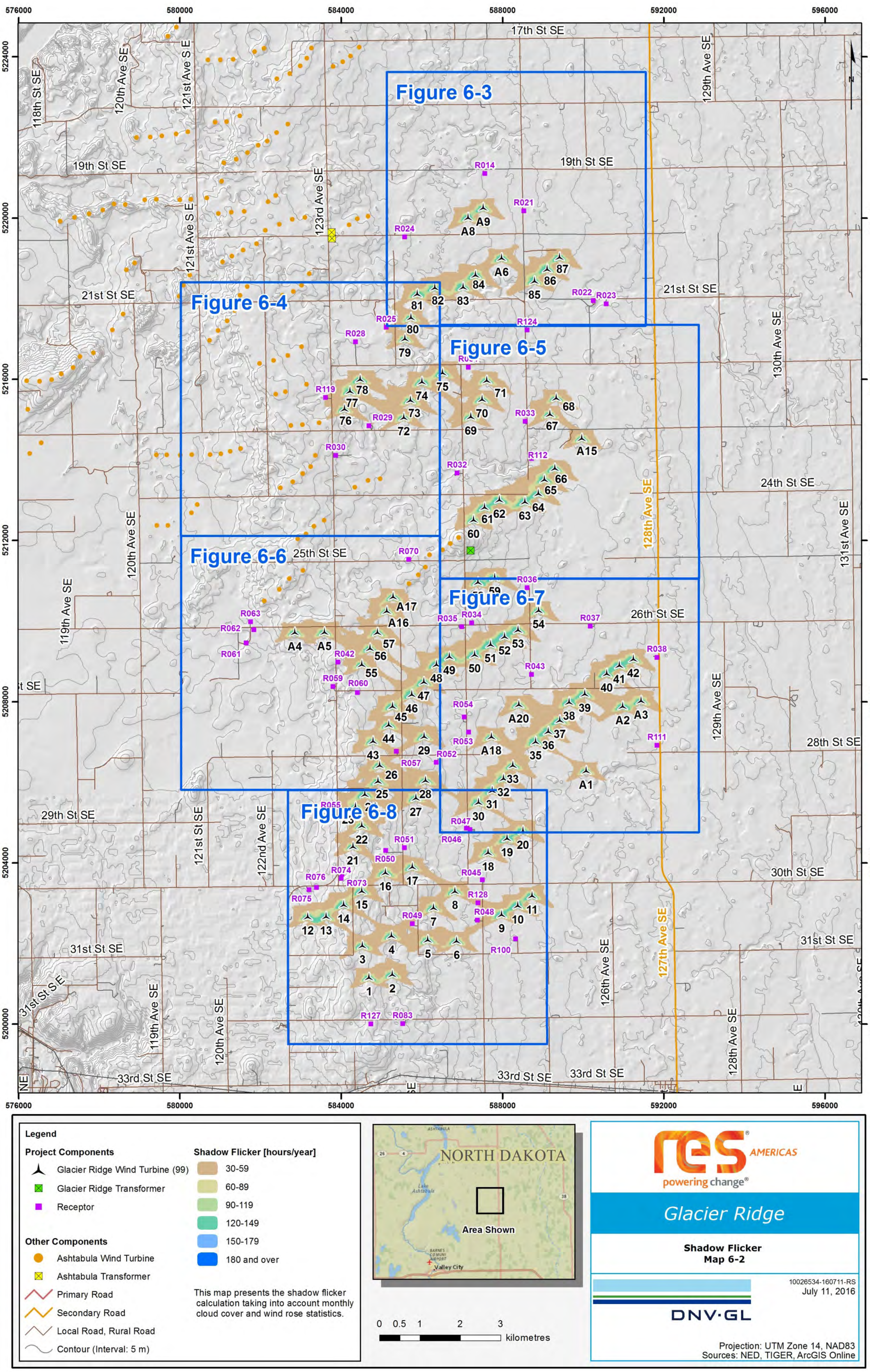


Figure 4-2 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

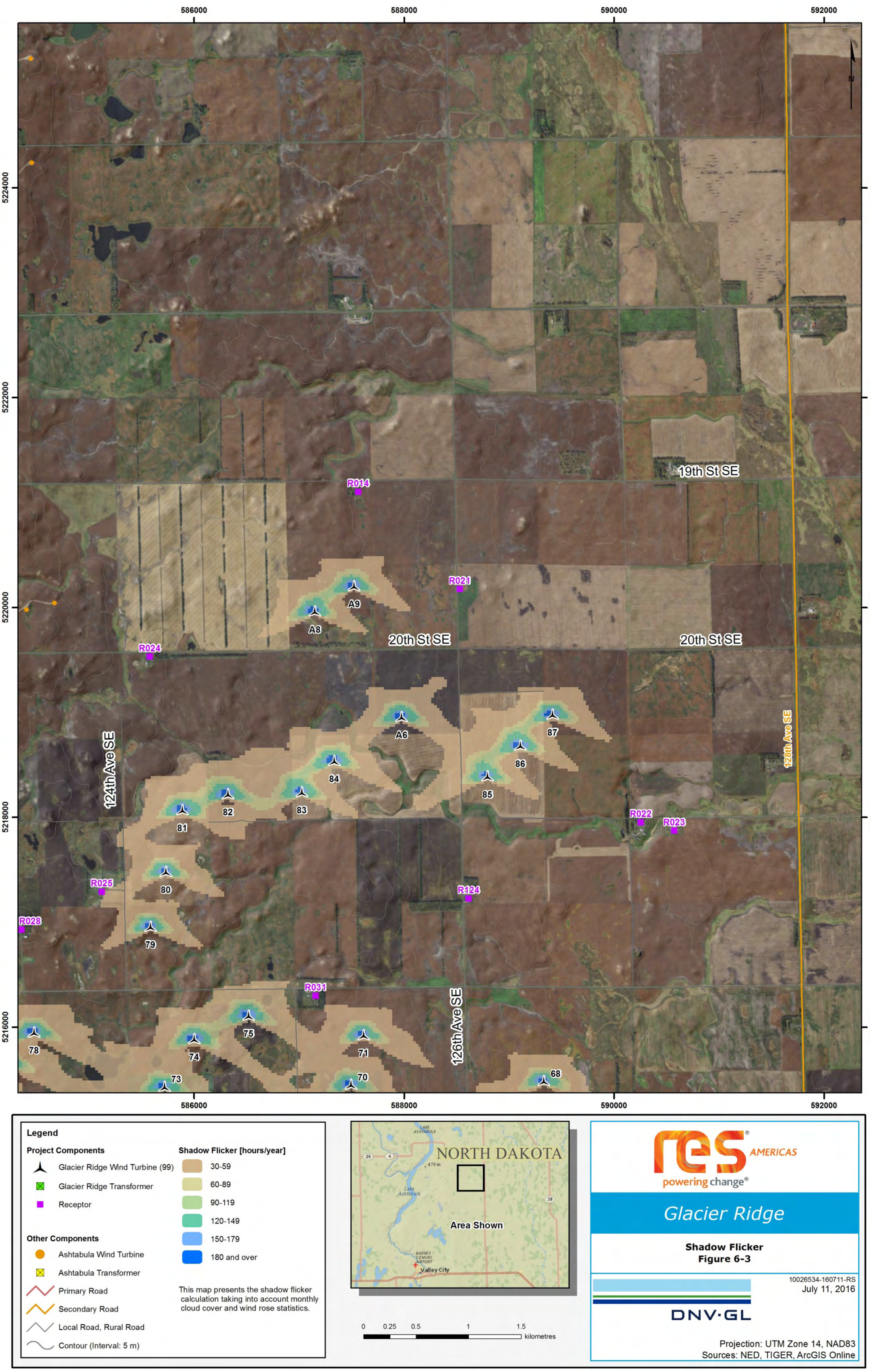


Figure 4-3 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

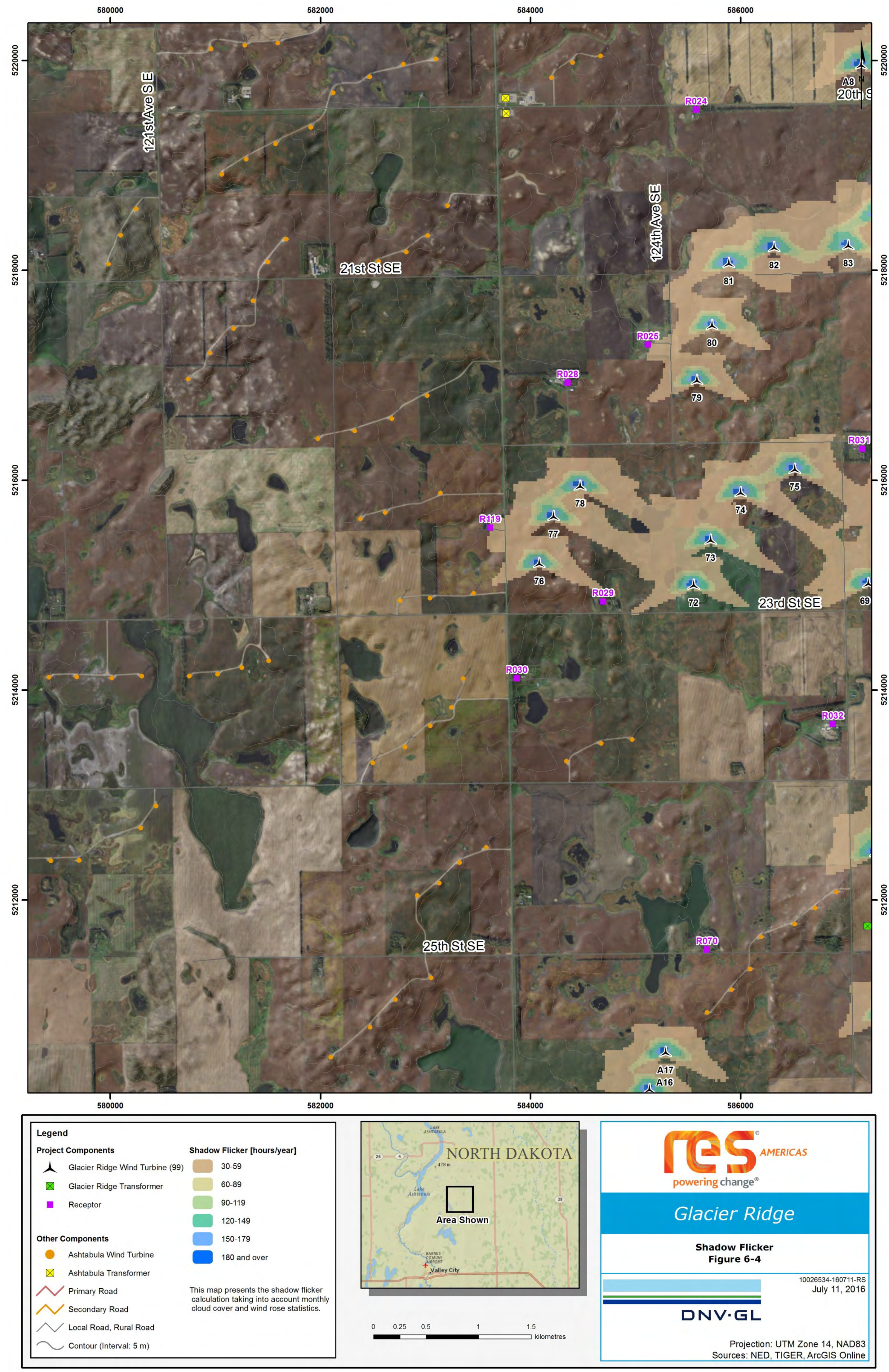


Figure 4-4 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

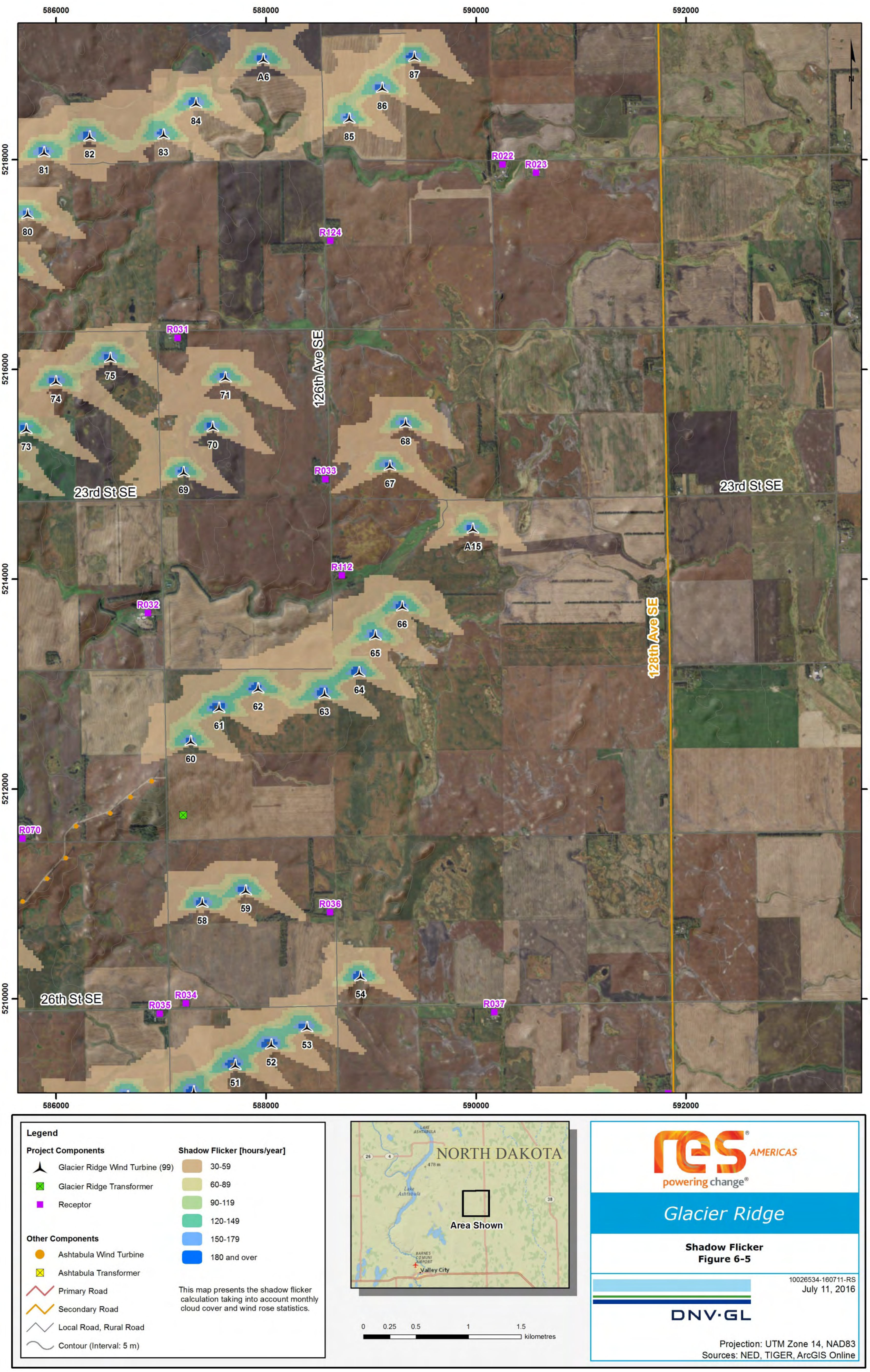


Figure 4-5 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

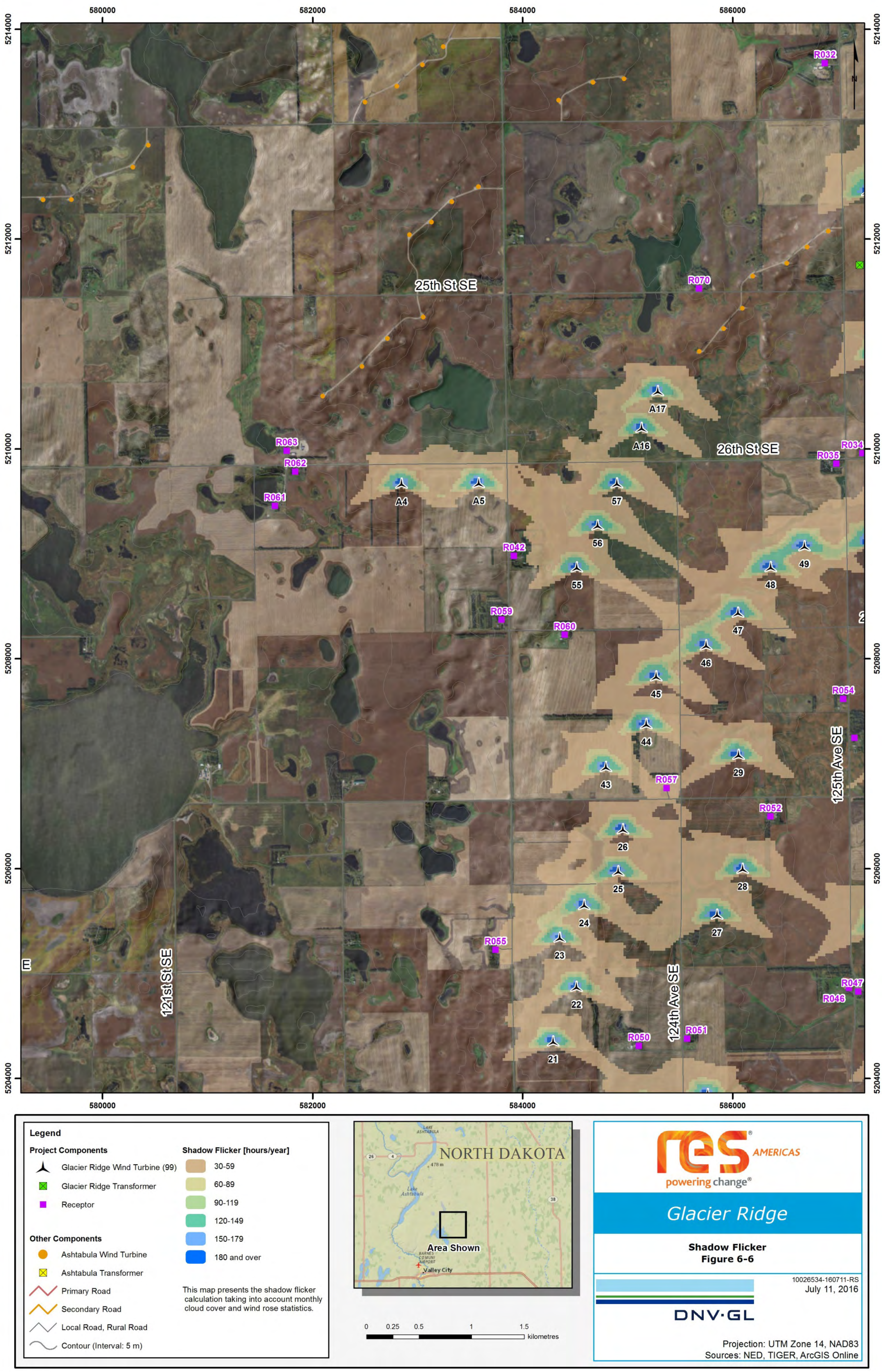


Figure 4-6 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

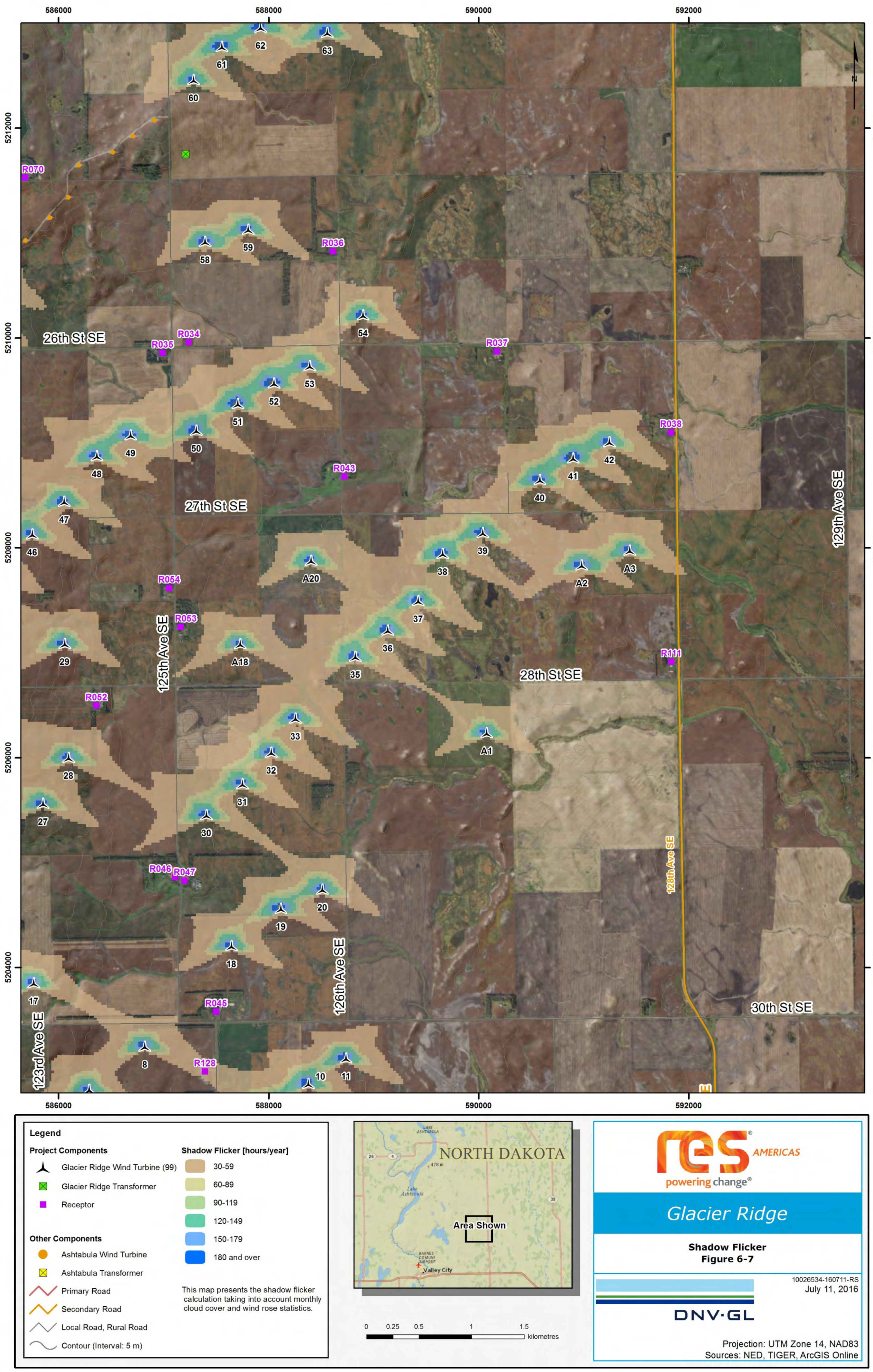


Figure 4-7 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

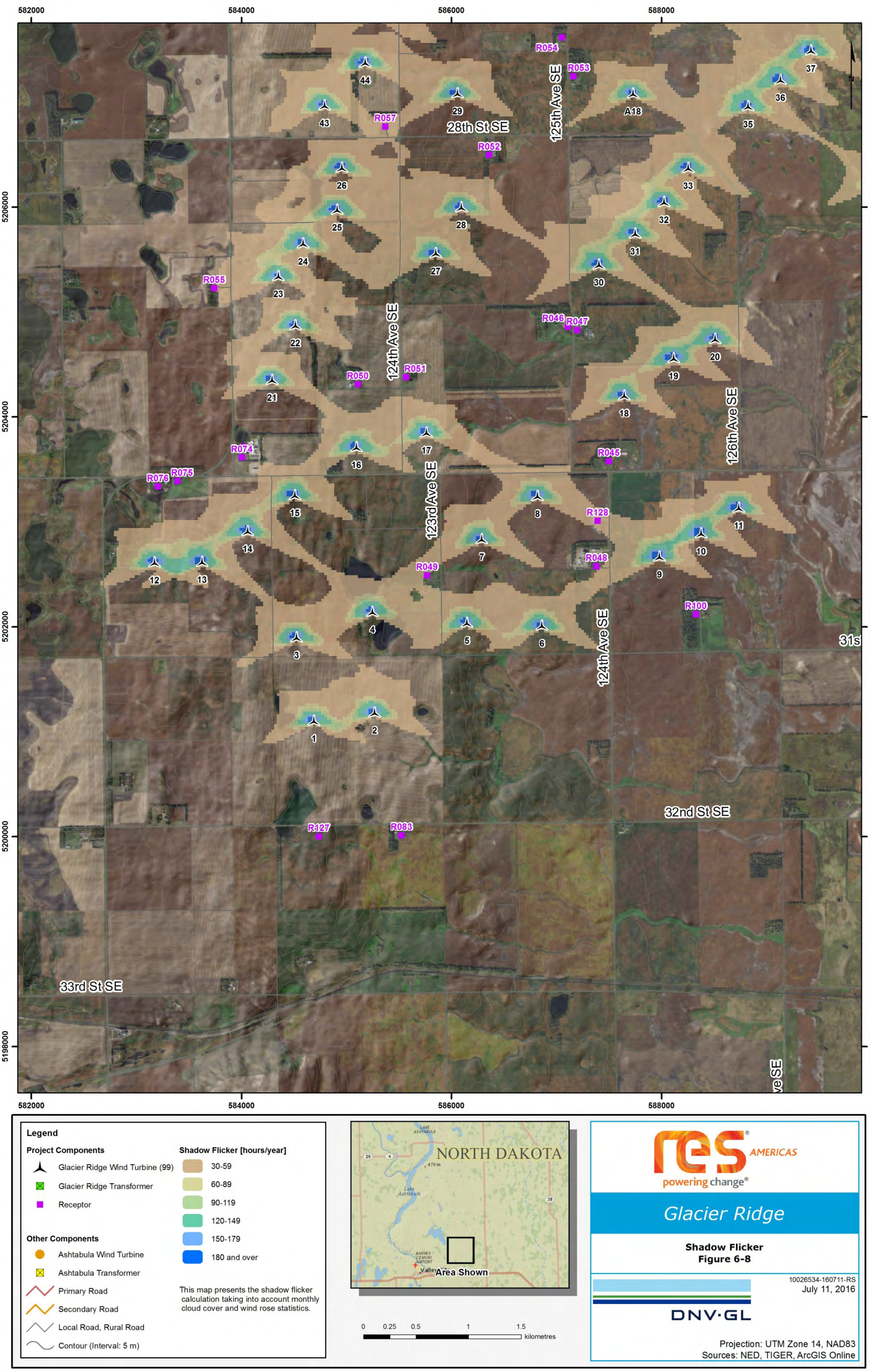


Figure 4-8 Modeled hours of shadow flicker at Glacier Ridge Wind Farm

5 REFERENCES

[1] Turbine layout locations sent by email, by Glacier Ridge, to B. Moreira, DNV GL, 13 June 2016, “PUSAevg140_ND_StatePlane_NAD83_USft.csv”.

[2] Department for Business Enterprise & Regulatory Reform, UK, “Onshore Wind: Shadow Flicker”, http://webarchive.nationalarchives.gov.uk/20090609003228/http:/www.berr.gov.uk/whatwedo/energy/sources/renewables/planning/onshore-wind/shadow-flicker/page18736.html

[3] Danish Wind Industry Association, "Shadow variations from Wind turbines", http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/env/shadow/shadow2.htm

[4] Receptor locations sent by email, by Glacier Ridge, to B. Moreira, DNV GL, 20 June 2016, “houses 5_31_16

[5] Freud H-D, Kiel F.H., "Influences of the opaqueness of the atmosphere, the extension of the sun and rotor blade profile on the shadow impact of wind turbine", DEWI Magazine No. 20 pp 43-51, Feb 2002.

APPENDIX A – TURBINE LAYOUT

Turbine ID	Easting [m][1]	Northing [m][1]
A1	590076	5206196
A2	590981	5207795
A3	591439	5207934
A4	582849	5209629
A5	583584	5209635
A6	587977	5218917
A8	587150	5219922
A9	587524	5220163
A15	589971	5214442
A16	585134	5210160
A17	585288	5210512
A18	587730	5207044
A20	588406	5207838
T1	584691	5201066
T2	585268	5201144
T3	584526	5201860
T4	585247	5202104
T5	586148	5202000
T6	586861	5201974
T7	586290	5202798
T8	586821	5203209
T9	587980	5202631
T10	588380	5202851
T11	588737	5203096
T12	583173	5202575
T13	583626	5202581
T14	584061	5202873
T15	584510	5203216
T16	585095	5203673
T17	585763	5203813
T18	587646	5204166
T19	588117	5204521
T20	588513	5204705
T21	584292	5204315
T22	584515	5204835
T23	584354	5205304
T24	584587	5205613
T25	584913	5205936

Turbine ID	Easting [m][1]	Northing [m][1]
T26	584956	5206337
T27	585852	5205522
T28	586096	5205960
T29	586058	5207046
T30	587407	5205414
T31	587750	5205710
T32	588027	5206010
T33	588256	5206335
T35	588827	5206922
T36	589136	5207175
T37	589425	5207453
T38	589657	5207903
T39	590041	5208102
T40	590586	5208607
T41	590902	5208814
T42	591247	5208969
T43	584793	5206931
T44	585178	5207338
T45	585273	5207795
T46	585749	5208090
T47	586053	5208401
T48	586364	5208835
T49	586685	5209034
T50	587313	5209079
T51	587708	5209332
T52	588051	5209527
T53	588391	5209693
T54	588900	5210177
T55	584516	5208832
T56	584714	5209233
T57	584898	5209633
T58	587395	5210877
T59	587807	5210994
T60	587285	5212419
T61	587554	5212735
T62	587925	5212919
T63	588559	5212869
T64	588889	5213074
T65	589041	5213426
T66	589298	5213703

Turbine ID	Easting [m][1]	Northing [m][1]
T67	589180	5215042
T68	589331	5215446
T69	587217	5214981
T70	587494	5215412
T71	587614	5215885
T72	585554	5214964
T73	585717	5215393
T74	586001	5215847
T75	586517	5216070
T76	584083	5215171
T77	584221	5215618
T78	584475	5215910
T79	585585	5216917
T80	585730	5217440
T81	585888	5218030
T82	586321	5218182
T83	587027	5218200
T84	587333	5218498
T85	588794	5218350
T86	589109	5218643
T87	589415	5218939

1 Coordinate system is UTM Zone 14N, NAD83 datum.

APPENDIX B – RECEPTOR LOCATIONS AND ASSOCIATED SHADOW FLICKER

Receptor ID	UTM Easting[1] [m]	UTM Northing[1] [m]	Layout pUSAevg142 results					Turbine IDs contributing to the events	Closest turbine	
			Days per year	Worst day	Minutes on Worst day	Total Hours in Year [hrs/yr]			Distance [m]	Turbine ID
						Worst case	Considering annual cloud cover and wind rose			
57	585372	5206769	219	16-May	89	185	44	T26 T29 T43	600	T26
128	587393	5203011	249	13-Mar	52	141	39	T7 T8 T9 T10 T11	605	T8
49	585767	5202491	192	29-Oct	78	146	32	T4 T5 T3 T6 T7 T8 T15	606	T7
119	583617	5215549	236	18-Jan	51	130	31	T76 T77 T78	600	T76
55	583742	5205228	210	16-Apr	47	117	30	T22 T24 T23 T25	616	T23
25	585118	5217293	181	20-Jan	51	114	27	T79 T80	600	T79
48	587383	5202578	181	19-Aug	83	104	25	T5 T6 T7 T9 T10 T11	600	T9
31	587158	5216301	154	5-Jan	50	99	23	T71 T74 T75	617	T71
29	584690	5214845	122	4-Jun	63	77	21	T72 T73 T76	689	T76
33	588565	5214953	193	15-Apr	47	79	20	A15 T67 T68 T69 T70	621	T67
42	583918	5208982	163	7-Mar	47	68	17	A4 T55 T56 T57	617	T55
74	584004	5203615	142	22-Jan	47	75	17	T15 T16	644	T15
53	587162	5207247	165	8-Mar	54	66	16	A18 A20 T29 T33	604	A18
54	587053	5207619	176	8-Jan	35	60	14	A18 A20 T29 T46	888	A18
73	584021	5203718	110	2-Jan	45	59	14	T15 T16	656	T21
50	585108	5204313	136	19-Jan	36	57	13	T21 T17	640	T16
45	587501	5203580	135	21-Oct	52	57	13	T7 T8 T10 T11	604	T18
38	591832	5209102	91	14-Mar	48	47	12	T40 T41 T42	600	T42
75	583392	5203391	130	21-Jan	36	51	11	T14 T15	843	T13
112	588722	5214037	104	6-Feb	45	44	10	A15 T66	666	T66
51	585569	5204380	111	18-May	27	32	9	T21 T22	599	T17
36	588612	5210827	84	23-Apr	36	33	9	T58 T59	711	T54
46	587109	5204862	121	15-Oct	26	31	9	T19 T20 T27	627	T30
35	586989	5209860	143	22-Jan	34	40	9	T51 T52 T53	846	T50

Receptor ID	UTM Easting[1] [m]	UTM Northing[1] [m]	Layout pUSAevg142 results					Turbine IDs contributing to the events	Closest turbine	
			Days per year	Worst day	Minutes on Worst day	Total Hours in Year [hrs/yr]				
						Worst case	Considering annual cloud cover and wind rose		Distance [m]	Turbine ID
43	588746	5208670	139	6-Jan	25	33	8	T38 T39 T50 T51	899	A20
76	583205	5203338	75	30-Oct	31	25	6	T14 T15	764	T12
37	590176	5209874	79	15-Aug	21	20	5	T42 T54	1285	T41
34	587238	5209958	74	9-Feb	30	21	5	T52 T53	783	T51
47	587199	5204831	63	26-Feb	29	17	4	T19 T20	619	T30
60	584400	5208230	65	29-Oct	30	17	4	T45 T46	613	T55
21	588531	5220177	60	30-Mar	28	17	4	A8 A9	1007	A9
62	581853	5209784	36	14-Mar	29	13	3	A4	1008	A4
59	583799	5208374	48	17-Jun	25	15	3	T55	851	T55
28	584354	5216931	53	14-Sep	21	10	3	T79 T80	1028	T78
63	581753	5209984	34	26-Feb	26	10	3	A4	1152	A4
32	586878	5213678	59	21-Nov	22	11	3	T62	1161	T61
61	581643	5209458	33	12-Apr	24	9	2	A4	1218	A4
52	586360	5206498	51	19-Mar	20	10	2	A18 T26	600	T28
22	590255	5217954	42	20-Jun	15	7	2	T86	1295	T87
100	588329	5202120	24	20-Mar	18	5	1	T6	619	T9
14	587562	5221104	0	-	0	0	0		941	A9
30	583920	5214126	0	-	0	0	0		1058	T76
70	585680	5211529	0	-	0	0	0		1089	A17
83	585526	5200014	0	-	0	0	0		1159	T2
111	591834	5206916	0	-	0	0	0		1091	A3
124	588614	5217226	0	-	0	0	0		1138	T85
127	584738	5200004	0	-	0	0	0		1063	T1

APPENDIX C – CUMULATIVE SHADOW FLICKER RESULTS OF RECEPTORS AFFECTED BY NEIGHBORING LAYOUT

Receptor ID	UTM Easting[1] [m]	UTM Northing[1] [m]	Including Ashtabula turbines					Turbine IDs contributing to the events	Closest turbine	
			Days per year	Worst day	Minutes on Worst day	Total Hours in Year [hrs/yr]				
						Worst case	Considering annual cloud cover and wind rose		Distance [m]	Turbine ID
119	583617	5215549	236	17-Jan	67	149	36	T76 T77 T78 Ash-N59 Ash-N60 Ash-N70	578	Ash-N61
29	584690	5214845	123	4-Jun	63	80	22	T72 T73 T76 Ash-N72	689	T76
28	584354	5216931	58	20-Sep	24	13	3	T79 T80 Ash-N58	1028	T78

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter, and greener.

Wind Power GeoPlanner™

Microwave Study

Glacier Ridge

Prepared on Behalf of
Glacier Ridge Wind
Farm, LLC

May 6, 2016

COMSEARCH
A CommScope Company

Table of Contents

1. Introduction

Microwave bands that may be affected by the installation of wind turbine facilities operate over a wide frequency range (900 MHz – 23 GHz). Comsearch has developed and maintains comprehensive technical databases containing information on licensed microwave networks throughout the United States. These systems are the telecommunication backbone of the country, providing long-distance and local telephone service, backhaul for cellular and personal communication service, data interconnects for mainframe computers and the Internet, network controls for utilities and railroads, and various video services. This report focuses on the potential impact of wind turbines on licensed, proposed and applied non-federal government microwave systems.

2. Project Overview

Project Information

Name: Glacier Ridge

County: Barnes

State: North Dakota

Number of Turbines: TBD

Blade Diameter: 126 meters

Hub Height: 87 meters

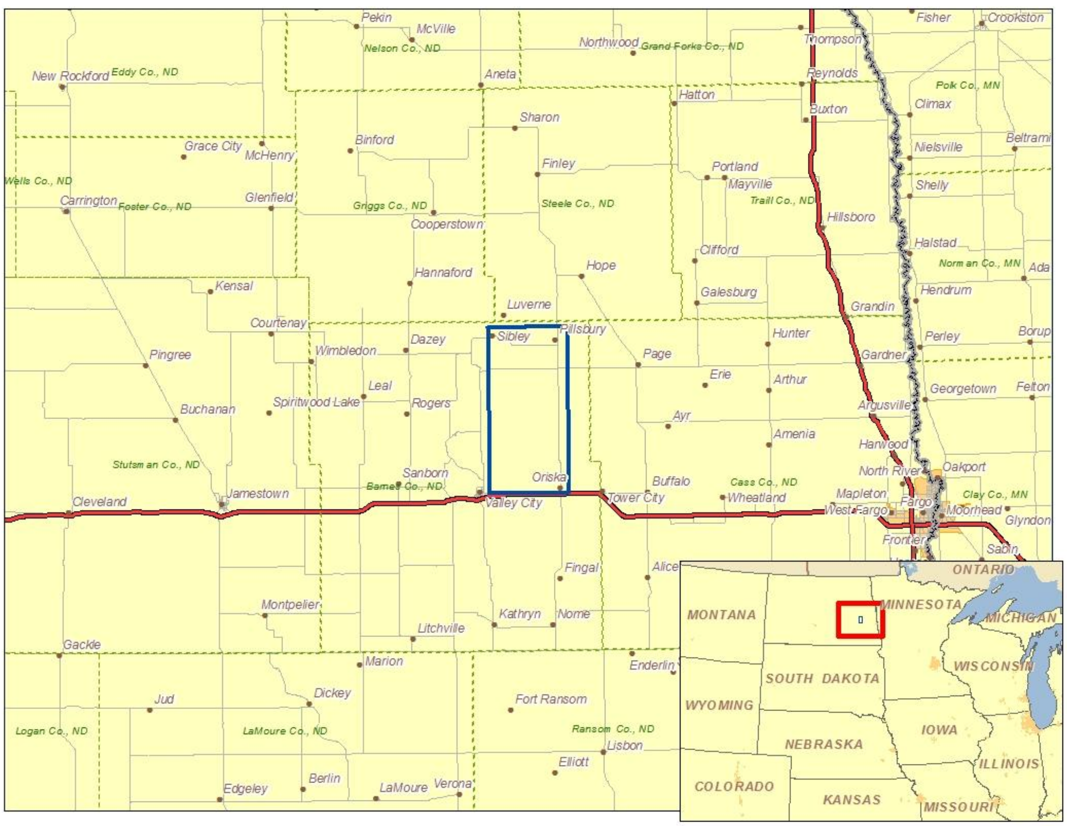


Figure 1: Area of Interest

3. Fresnel Zone Analysis

Methodology

Our obstruction analysis was performed using Comsearch's proprietary microwave database, which contains all non-government licensed, proposed and applied paths from 0.9 - 23 GHz[1]. First, we determined all microwave paths that intersect the area of interest[2] and listed them in Table 1. These paths and the area of interest that encompasses the planned turbine locations are shown in Figure 2.

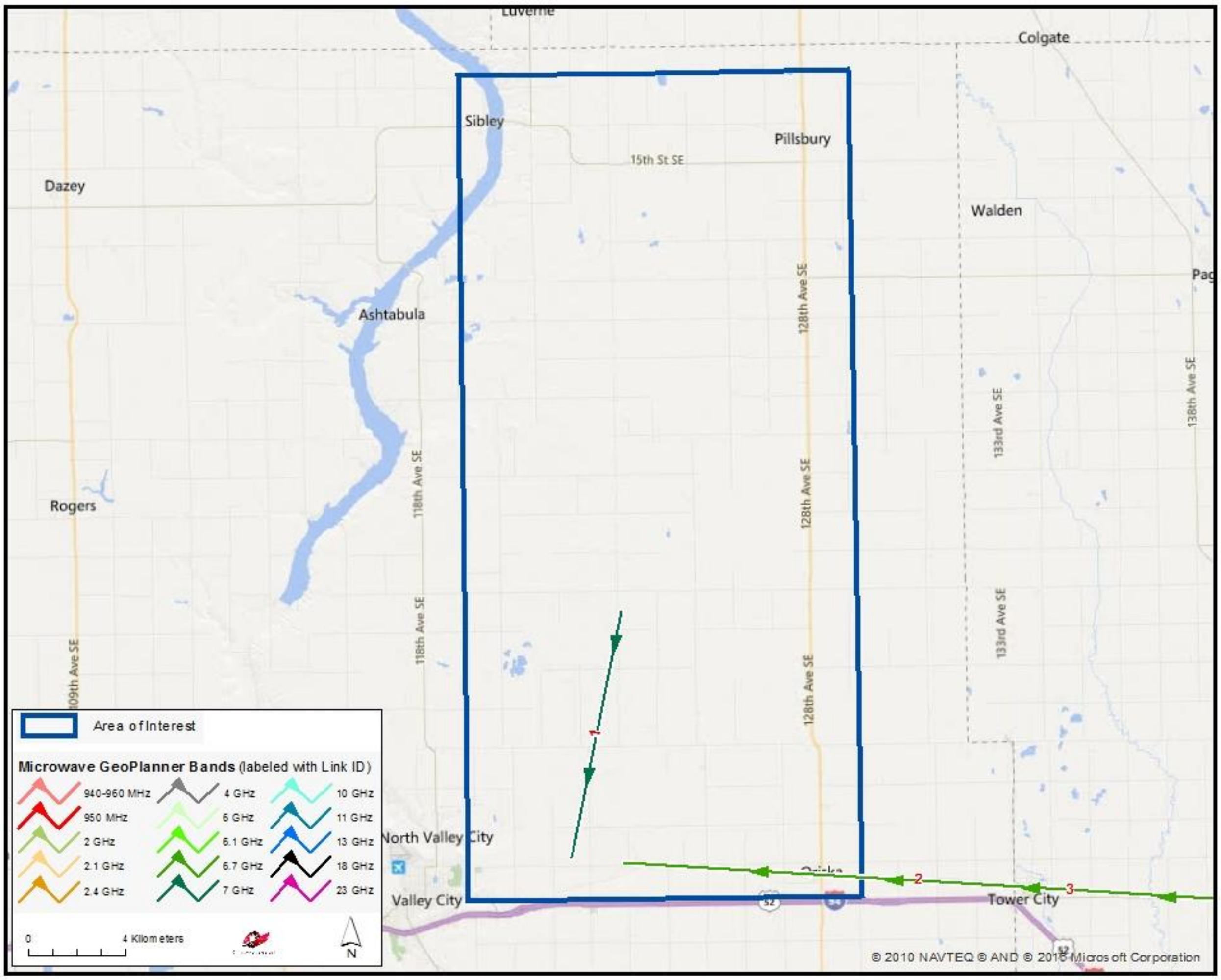


Figure 2: Microwave Paths that Intersect the Area of Interest

1 Please note that this analysis does not include unlicensed microwave paths or federal government paths that are not registered with the FCC.

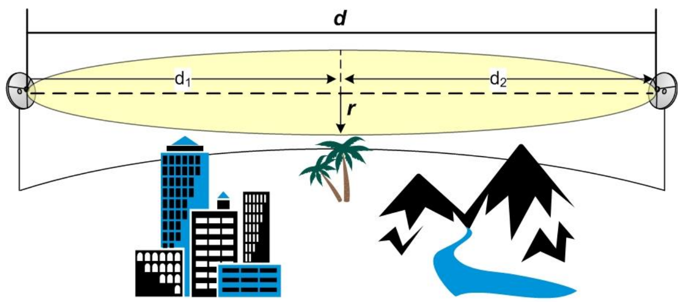
2 We use FCC-licensed coordinates to determine which paths intersect the area of interest. It is possible that as-built coordinates may differ slightly from those on the FCC license.

ID	Status	Callsign 1	Callsign 2	Band	Path Length (km)	Licensee
1	Licensed	KAZ80	RXONLY	7 GHz	10.43	South Dakota Television, Inc
2	Licensed	WPON209	WPYS527	6.1 GHz	46.52	New Cingular Wireless PCS-ND,SD,NE,IA,MT
3	Licensed	WPON209	WPYS527	6.7 GHz	46.52	New Cingular Wireless PCS-ND,SD,NE,IA,MT

Table 1: Summary of Microwave Paths that Intersect the Area of Interest
(See enclosed mw_geopl.xlsx for more information and GP_dict_matrix_description.xls for detailed field descriptions)

Next, we calculated a Fresnel Zone for each path based on the following formula:

$$r \cong 17.3\sqrt{\frac{n}{F_{GHz}}\left(\frac{d_1 d_2}{d_1 + d_2}\right)}$$



Where,

- r = Fresnel Zone radius at a specific point in the microwave path, meters
- n = Fresnel Zone number, 1
- F_{GHz} = Frequency of microwave system, GHz
- d_1 = Distance from antenna 1 to a specific point in the microwave path, kilometers
- d_2 = Distance from antenna 2 to a specific point in the microwave path, kilometers

The calculated Fresnel Zone shows the narrow area of signal swath and is calculated for each microwave path in the project area. In general, this is the area where the planned wind turbines should be avoided, if possible. A depiction of the individual Fresnel Zones is shown in Figure 3, and is also included in the shapefiles[3,4].

[3] The ESRI® shapefiles enclosed are in NAD 83 UTM Zone 14 projected coordinate system.

[4] Comsearch makes no warranty as to the accuracy of the data included in this report beyond the date of the report. The data provided in this report is governed by Comsearch's data license notification and agreement located at http://www.comsearch.com/files/data_license.pdf.

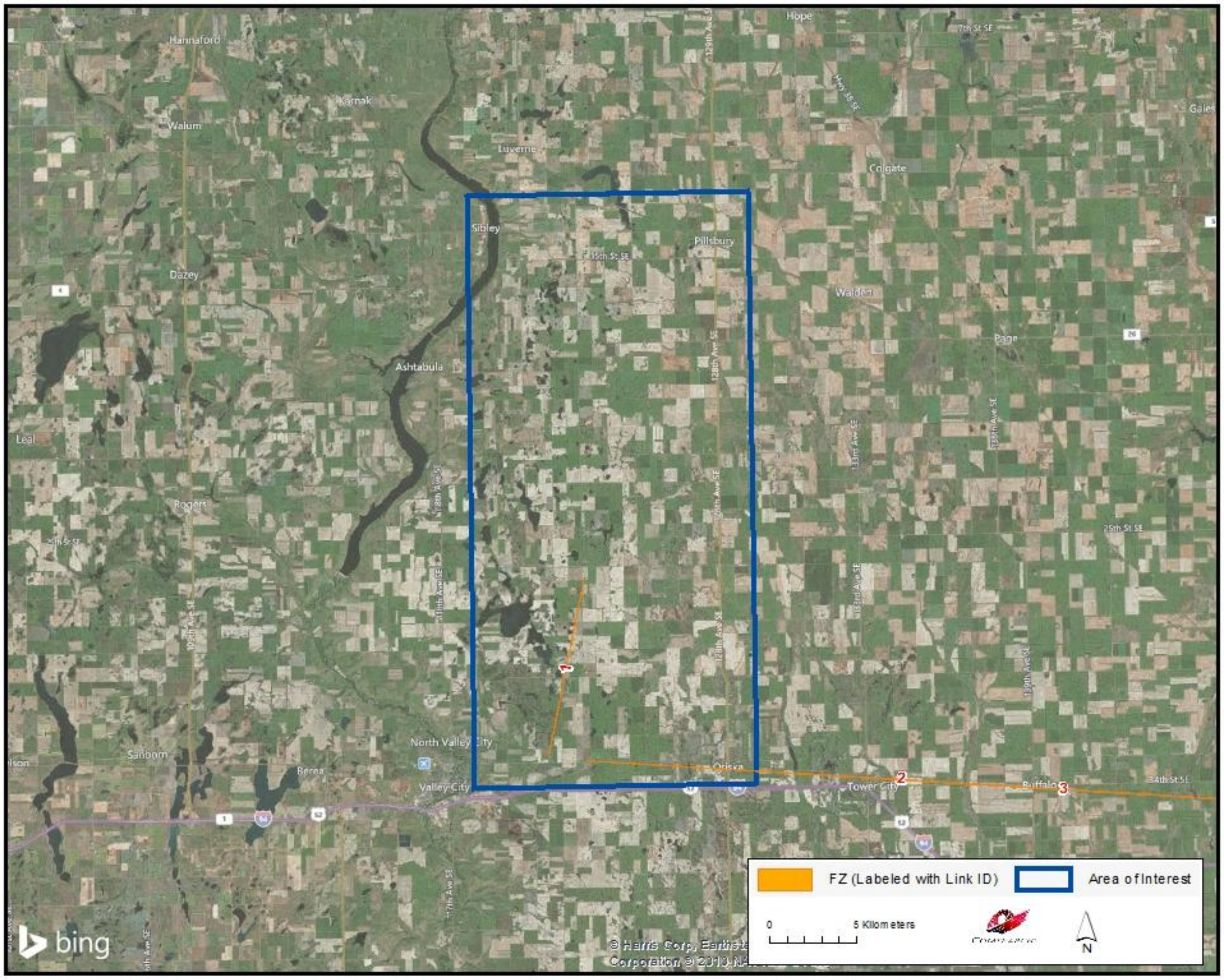


Figure 3: Fresnel Zones in the Area of Interest

Discussion of Potential Obstructions

Total Microwave Paths	Paths with Affected Fresnel Zones	Total Turbines	Turbines intersecting Fresnel Zones
3	N/A	N/A	N/A

For this project, turbine locations were not provided; thus we could not determine if any potential obstructions exist between the planned wind turbines and the incumbent microwave paths. If the latitude and longitude values for turbine locations are provided, Comsearch can identify where a potential conflict might exist.

4. Conclusion

Our study identified three microwave paths intersecting the Glacier Ridge project area. The Fresnel Zones for these microwave paths were calculated and mapped. We recommend that all turbines be sited in locations that will not obstruct the Fresnel Zones.

5. Contact

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Wildlife Baseline Studies for the Glacier Ridge Wind Project Barnes County, North Dakota

Final Report
July 2009 – June 2010

Prepared for:

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WEST Inc.
Environmental & Statistical Consultants

November 18, 2010

EXECUTIVE SUMMARY

Glacier Ridge Wind, LLC (Glacier Ridge) has proposed a wind energy facility in Barnes County, North Dakota. Glacier Ridge contracted Western EcoSystems Technology, Inc. to conduct surveys and monitor wildlife resources in the Glacier Ridge Wind Project to estimate the impacts of project construction and operations on wildlife. The following document contains results for fixed-point bird use surveys, roadside raptor nest searches, and incidental wildlife observations. The principal objectives of the study were to provide site specific bird use data that would be useful in evaluating potential impacts from the proposed wind energy facility and provide information that could be used in project planning and design of the facility to minimize impacts to birds.

The proposed wind energy facility contains, mostly cropland, but also has areas of pastures, planted grasslands, and deciduous forests. 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 consistent within regions or topographic features to suggest that any portions of the Glacier Ridge Wind Project should be avoided when siting turbines.

Fixed-point surveys were conducted from July 16, 2009, through June 25, 2010, at 10 points established throughout the Glacier Ridge Wind Project. A total of 156 20-minute fixed-point surveys were completed and 69 bird species were identified. Overall, a total of 2,597 individual bird observations within 453 separate groups were recorded during the fixed-point surveys. Waterfowl use was highest during the fall (7.45 birds/plot/20-minute survey), primarily due to large groups of Canada geese. Raptor use was highest during the spring (0.49 birds/plot/20-minute survey) and lowest during the summer (0.21). The most common raptors observed in the study area were red-tailed hawk and northern harrier. Seasonal use by passerines ranged from 6.76 birds/plot/20-minute survey in summer to 22.00 in fall; however, the focus for small birds was within a 100-meter viewshed, so use by small bird types is not directly comparable to the large bird types.

During the study, 147 individual large birds or groups of large birds totaling 578 individuals were observed flying during fixed-point bird use surveys. For all large bird species combined, 70.6% of birds were observed flying below the likely rotor swept heights, 29.1% were within the rotor swept heights, and 0.3% were observed flying above the rotor swept heights for typical turbines that could be used in the Glacier Ridge Wind Project. Bird types most often observed flying within the turbine rotor swept heights were waterfowl (39.1%) and raptors (17.4%). A total of 1,086 passerines and other small birds in 105 groups were recorded flying within 100 meters of the survey plots in the proposed wind resource area, with 100% below the rotor swept heights.

For large bird species with at least 20 separate groups of flying birds, mallards (27.5%) were observed most often within the rotor swept heights. Based on the use (measure of abundance) of the study area by each species and the flight characteristics observed for that species, the Canada goose had the highest probability of turbine exposure, with an exposure index of 0.80. Red-tailed hawk had the highest exposure index for raptors, ranking fifth of all species; although its

exposure index was only 0.05. All passerines and other small birds had an exposure index of zero, due to 100% of observations occurring below the estimated rotor-swept height.

Levels of bird use varied within the study area by point. For all large bird species combined, use was highest at points 10 and four, with 14.9 and 10.9 birds/20-minute survey, respectively. The higher mean use at points 10 and four was due mostly to high use by waterfowl (8.00 and 10.6 birds/20-minute survey, respectively). Raptor use was highest at points eight and A (0.54 and 0.53 birds/20-minute survey, respectively). Passerine use, within 100 meters, was highest at points four and 10, with 42.4 and 38.5 birds/20-minute survey, respectively, and ranged from 1.31 to 10.7 at the other points.

Based on fixed-point bird use data collected for the Glacier Ridge Wind Project, mean annual raptor use was 0.33 raptors/plot/20-minute survey. The annual rate was low relative to raptor use at other wind energy facilities that implemented similar protocols to this study and had data for three or four different seasons. Similar studies with publicly available data were conducted at 39 other wind energy facilities. Mean raptor use in the study area was low compared to the other wind resource areas, ranking thirtieth.

A regression analysis of raptor use and raptor collision mortality for 13 new-generation wind energy facilities where similar methods were used to obtain raptor use estimates showed a significant (R^2 = 69.9%) correlation between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality the Glacier Ridge Wind Project yields an estimated fatality rate of <0.01 fatalities/megawatt/year, or less than one raptor per year for each 100-megawatt of wind energy development. Based on species composition of the most common raptor fatalities at other western wind energy facilities and species composition of raptors observed at the Glacier Ridge Wind Project during the surveys, the majority of the fatalities of diurnal raptors will likely consist of red-tailed hawk and Swainson’s hawk. Based on the seasonal use estimates, it is expected that risk to raptors would be highest during the spring and fall.

Some species considered to be sensitive or of conservation concern were observed within the Glacier Ridge Wind Project. During all surveys and incidental observations, 13 sensitive species were observed including eight North Dakota critically imperiled species: Swainson’s hawk, black tern, upland sandpiper, American white pelican, black-billed cuckoo, ferruginous hawk, grasshopper sparrow, and willet. Additionally, five North Dakota imperiled species, northern harrier, northern pintail, bobolink, redhead, and sharp-tailed grouse, were all recorded during surveys at the Glacier Ridge Wind Project. This is a tally that in some cases represents repeated observations of the same individual. Research concerning displacement impacts of wind energy facilities are limited, but some show the potential for small scale displacement of 180 meters (591 feet) or less, while impacts to densities of birds at larger scales has not been shown.

Only one potential raptor nest was located during roadside raptor nest surveys. The nest was located in a live cottonwood approximately a half mile from the project boundary.

The most abundant large bird species recorded incidentally was snow goose (1,400 observations in two groups). A total of three mammal species were also recorded incidentally, with white-tailed deer being the most commonly observed species (four observations).

STUDY PARTICIPANTS

Western EcoSystems Technology

Kristen Chodachek	Project Manager, Title of Project Manager
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REPORT REFERENCE

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INTRODUCTION

Glacier Ridge Wind, LLC (Glacier Ridge) has proposed to develop a wind energy facility in Barnes County, North Dakota (Figure 1). Glacier Ridge requested Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline studies of bird and bat use in the Glacier Ridge Wind Project (GRWP) for the purpose of estimating the impacts of the wind project on birds and bats and to assist with siting turbines to minimize impacts to birds and bats.

The principal objectives of the study were to: (1) provide site specific bird and bat resource and use data that would be useful in evaluating potential impacts from the proposed wind energy facility and (2) provide information that could be used in project planning and design of the facility to minimize impacts to birds and bats. The protocols for the baseline studies are similar to those used at other wind energy facilities across the nation, and follow the guidance of the National Wind Coordinating Collaborative (Anderson et al. 1999). The protocols have been developed based on WEST's experience studying wildlife at proposed wind energy facilities throughout the US; and were designed to help predict potential impacts to bird (particularly raptors) and bat species.

Baseline surveys were conducted from July 16, 2009 through June 25, 2010 and included fixed-point bird use surveys, roadside raptor nest 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 mortality at the proposed GRWP is greatly enhanced by operational monitoring data collected at existing facilities. For several wind energy facilities, standardized data on fixed-point surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird use with bird mortality. Where possible, comparisons with regional and local studies were made.

The results of the acoustic bat surveys were presented in a separate final report (Chodachek et al. 2010).

STUDY AREA

The proposed GRWP, currently about 35,000 acres (14,164 hectares) in size, is located in southeast Barnes County, approximately three miles (4.8 kilometers [km]) northeast of Valley City, North Dakota (Figure 1). The GRWP falls within the Northern Glaciated Plains Ecoregion, which covers much of eastern North Dakota and portions of eastern South Dakota (Bryce et al. 1996ftp://ftp.epa.gov/wed/ecoregions/nd_sd/ndsd_front.pdf). Historically covered by a grassland transitional between the tall- and shortgrass prairie, the Northern Glaciated Plains Ecoregion has largely been converted to tilled agriculture, predominantly spring wheat (*Triticum* spp.), barley (*Hordeum vulgare*), sunflowers (*Helianthus annuus*), corn (*Zea maize*) and alfalfa (*Medicago sativa*). Topography in the region is nearly flat to gently rolling hills with elevations in the GRWP ranging from 1,270 to 1,522 feet (ft; 387 to 464 meters [m]).

The number and size of wind turbines that will be installed within the GRWP is currently unknown. A rotor swept height (RSH) for potential collision with a turbine blade of 35 to 130 m (114 to 427 ft) above ground level (AGL) was used for the purposes of the analysis.

METHODS

The study at the GRWP reported here consisted of the following research components: 1) fixed-point bird use surveys and 2) incidental wildlife observations.

Fixed-Point Bird Use Surveys

The objective of the fixed-point bird use surveys was to estimate the seasonal and spatial use of the GRWP by birds, particularly raptors, defined here as kites, accipiters, buteos, harriers, eagles, falcons, and osprey. 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, while also providing relatively even coverage. All birds seen during each 20-minute (min) fixed-point survey were recorded.

Bird Use Survey Plots

Ten points were selected to achieve relatively even coverage and survey representative habitats and topography within the GRWP (Figure 1). Points were labeled 1 through 10 with the exception of 7. Point 7 ended up being in the middle of a field and was replaced by an alternative point, point A. Each survey plot was an 800-m (2,625-ft) radius circle centered on the point.

Bird Survey Methods

All species of birds observed during fixed-point surveys were recorded. 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. 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 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.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Fixed-point surveys were conducted from July 16 through November 5, 2009 and March 15 through June 25, 2010. Surveys were conducted every other week during each of the seasons during daylight hours; with survey periods varying to approximately cover all daylight hours during a season. To the extent practical, each point was surveyed about the same number of times.

Raptor Nest Surveys

The objective of raptor nest surveys was to locate all potential raptor nest structures that raptors may use. A raptor nest structure survey was conducted prior to leaf out conditions on April 26, 2010 from public roads and/or private areas where access was obtained. In addition to this survey, the field biologist also surveyed for raptor nest structures during each avian use survey. While the survey timing may not allow for species determination or occupancy, an early survey was needed to view nests.

Incidental Wildlife Observations

The objective of incidental wildlife observations was to provide record of wildlife seen outside of the standardized surveys. All raptors, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded in a similar fashion to 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 the case of sensitive species, the location was recorded by Universal Transverse Mercator (UTM) or Global Positioning System (GPS) coordinates.

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 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

<u>Bird Diversity and Species Richness</u>
Bird diversity was illustrated by the total number of unique species observed. 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. 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 diversity and richness were compared between seasons for fixed-point bird use surveys.

Bird Use, Composition, and Frequency of Occurrence

For the standardized fixed-point bird use estimates, only observations of large birds detected within the 800-m (2,625-ft) radius plot were used; small bird observations were limited to 100 m (328 ft). Estimates of mean 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 was calculated as the percent of surveys in which a particular bird type or species was observed. Percent composition was calculated as the proportion of the overall mean use for a particular species/bird type. Frequency of occurrence and percent composition provide relative estimates of species exposure to the proposed wind energy facility. For example, a particular species might have high use estimates for the study area based on just a few observations of large groups; however, the frequency of occurrence would indicate that the species only occurred during a few of the surveys, therefore making it less likely to be affected by the wind energy facility or the transmission corridor.

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 RSH for collision with turbine blades of 35 to 130 m (114 to 427 ft) AGL, which is the blade height of typical turbines that could be used at the GRWP.

Bird Exposure Index

A relative index of 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* (large bird observations within 800 m (2,625 ft) of the observer or 100 m (328 ft) 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.

RESULTS

Surveys were completed from July through November 2009 and March through June 2010. Seventy-seven bird species and three mammal species were identified during avian use surveys and raptor nests surveys completed at the GRWP. Results of the fixed-point surveys and incidental wildlife observations, as well as the specific numbers of unique species for each survey type, are discussed in the sections below.

Fixed-Point Bird Use Surveys

A total of 156 twenty-minute fixed-point surveys were conducted at the GRWP (Table 2). Two different viewsheds, 800 m for large birds and 100 m for small birds, were utilized when calculating the different statistics - species richness, use, percent composition, percent frequency, and exposure index.

Bird Diversity and Species Richness

Sixty-nine unique species were observed over the course of all fixed-point bird use surveys, with a mean number of 1.32 large bird species/800-m plot/20-min survey and 1.36 small bird species/100-m plot/20-min survey (Table 1). More unique species were observed during the spring (51 species), followed by summer (48), and fall (23; Table 1). The mean number of large bird species per survey was higher in the spring (1.87 species/survey), followed by summer (1.11), and fall (0.92; Table 1). For small birds, the mean number of species per survey was higher in the summer (2.01 species/survey) compared to spring (1.44) and fall (0.46; Table 1).

A total of 2,597 individual bird observations within 453 separate groups were recorded during the fixed-point surveys (Table 2). Cumulatively, regardless of bird size, five species (5.8% of all species) composed 65.7% of the observations: unidentified sparrow, common grackle (*Quiscalus quiscula*), red-winged blackbird (*Agelaius phoeniceus*), Canada goose (*Branta canadensis*), and horned lark (*Eremophila alpestris*). All other species comprised less than 5% of the observations. The most abundant large bird species observed was Canada goose (291 individuals in 21 groups). A total of 52 individual raptors were recorded within the GRWP, representing five species (Table 2).

Bird Use, Composition, and Frequency of Occurrence by Season

Mean bird use, percent composition, and frequency of occurrence for by season were calculated (Tables 3a and 3b). The highest overall large bird use occurred in the fall (8.81 birds/plot/20-min survey), followed by spring (4.92), and summer (2.39; Table 3a). For small birds, use was highest in the fall (22.05), followed by the spring (9.53), and summer (6.78; Table 3b).

<u>Raptors</u>
Raptor use was highest in the spring (0.49 birds/plot/20-min survey), followed by fall (0.28), and summer (0.21; Table 3a). Higher use in the spring and fall was primarily due to high use of the area by red-tailed hawks (*Buteo jamaicensis*; 0.22 and 0.12, respectively) and northern harriers (*Circus cyaneus*; 0.19 and 0.14, respectively). Raptors comprised 9.9% of the overall bird use in spring, 8.9% during summer, and 3.2% during fall. Raptors were observed during 27.6% of surveys in the spring, 26.0% of surveys in the fall, and 17.6% of surveys during summer (Table 3a).

<u>Waterbirds</u>
Waterbird use was fairly low throughout the survey period. The highest use was in the spring (0.23 birds/plot/20-min survey), followed by fall (0.14), and summer (0.11; Table 3a). Double-crested cormorants (*Phalacrocorax auritus*) had the highest use among waterbirds during spring (0.18) and fall (0.06), while black tern (*Chlidonias niger*) had the highest use during summer (0.04). Waterbirds comprised 4.7% of the overall bird use during spring, 4.5% during summer, and 1.6% during fall. Waterbirds were observed during 6.5% of fall surveys, 5.2% of summer surveys, and 5.0% of spring surveys (Table 3a).

<u>Waterfowl</u>
Waterfowl had the highest use in fall (7.45 birds/plot/20-min survey), compared to other times of the year (spring 2.87 and summer 0.40; Table 3a). High waterfowl use in fall was due to several large groups of Canada geese which made up 73.5% of the overall fall waterfowl use. Mallards (*Anas platyrhynchos*) had the highest use among waterfowl during spring and summer (1.02 and 0.20, respectively). Waterfowl comprised 84.5% of the overall bird use during fall, 58.4% during

spring, and 16.9% during summer. Waterfowl were observed more frequently in the spring (54.1%), compared to 26.0% of fall surveys and 18.1% of surveys in summer (Table 3a).

Shorebirds
Shorebirds had the highest use in spring (0.36 birds/plot/20-min survey), followed by summer (0.23); no shorebirds were recorded during fall (Table 3a). Killdeer (*Charadrius vociferus*) made up the majority of shorebird use during both seasons. Shorebirds comprised 9.8% of the overall bird use during summer and 7.4% during spring. Shorebirds were observed during 19.1% of the surveys in the spring and 17.8% of summer surveys (Table 3a).

Rails/Coots
American coot (*Fulica americana*) was the only rail/coot species observed, and had the highest use during spring (0.73 birds/plot/20-min survey), followed by fall (0.20), and summer (0.09; Table 3a). Coots comprised 14.9% of the overall bird use during spring, compared to 3.9% during summer, and 2.3% during fall. Coots were observed during 6.7% of spring surveys, 2.5% of fall surveys, and 1.9% of summer surveys (Table 3a).

Owls
Owls were only observed during the summer, and use was relatively low (0.02 birds/plot/20-min survey; Table 3a). Great horned owl (*Bubo virginianus*) was the only owl species observed. Owls comprised 0.7% of overall bird use during summer, and were observed during 1.7% of summer surveys (Table 3a).

Upland Game Birds
Ring-necked pheasant (*Phasianus colchicus*) was the only upland game bird species observed, and was only observed during the spring (0.02 birds/plot/20-min survey; Table 3a). Upland game birds comprised 0.3% of overall bird use during spring, and were observed during 1.7% of spring surveys (Table 3a).

Large Corvids
Large corvids had the highest use during summer (0.10 birds/plot/20-min survey), followed by spring (0.09) and fall (0.06; Table 4a). American crow (*Corvus brachyrhynchos*) was the only large corvid species observed. Large corvids comprised 4.3% of the overall bird use during summer, 1.8% during spring, and 0.7% during fall. Large corvids were observed during 7.2% of spring surveys, 3.5% of summer surveys, and 2.0% of fall surveys (Table 4a).

Passerines
A 100-m viewshed was used for small birds, thus making them not directly comparable to the large bird types. Passerine use was highest in the fall (22.00 birds/plot/20-min survey), followed by spring (9.48), and summer (6.76; Table 3b). Common grackle had the highest use by any one indentified species in fall (5.22 birds/plot/20-min survey). Horned lark had the highest use by any passerine in spring (4.71 birds/20-min survey), while red-winged blackbird (1.94), and common grackle (1.84) had higher use during summer. Passerines were observed during 76.7% of summer surveys, 69.1% of spring surveys, and 37.0% of fall surveys (Table 3b).

Bird Flight Height and Behavior

Flight height characteristics were estimated for both bird types and bird species (Tables 4 and 5). During the study for large bird species, 147 individual large birds or groups totaling 578 individuals were observed flying within the 800-m plot (Table 4). Overall, 29.1% of large birds observed flying were recorded within the RSH for collision with turbine blades of 35 to 130 m (114 – 427 ft) AGL, 70.6% were below the RSH, and 0.3% were flying above the RSH (Table 4). The majority (80.4%) of flying raptors were observed below the RSH, 17.4% were within the RSH, and only 2.2% were above the RSH. Waterfowl had the highest percentage of flying birds within the RSH (39.1%). Waterbirds, shorebirds, doves/pigeons, and large corvids, were typically observed flying below the RSH (Table 4). All passerines and other small birds within the 100-m plot were observed below the estimate RSH (Table 4).

Of all large bird species, two species (mallard and northern harrier) had at least 20 groups observed flying. Of these two species, only the mallard was observed flying within the likely RSH during at least 25% of the observations (27.5%; Table 5a). Two species (tundra swan [*Cygnus columbianus*] and Swainson's hawk [*Buteo swainsonii*]) were always seen flying within the likely RSH; however, these were only based on one or two observations. Of all passerine and small bird species observed, none were recorded flying within the RSH while within 100 m of the observer (Table 5b).

Bird Exposure Index

A relative exposure index was calculated for each bird species (Tables 5a and 5b). This index is only based on initial flight height observations and relative abundance (defined as the use estimate) and does not account for other possible collision risk factors such as foraging or courtship behavior. Canada goose had an exposure index far higher than any other large bird species with 0.80, compared to 0.12 or less for all other large bird species. All raptors had a relatively low exposure index with red-tailed hawks being the highest at 0.05; all other raptor species had an exposure index of <0.01 or less (Table 5a).

Based on observations within 100 m, all passerines and other small bird species had zero exposure, due to no observations within the estimated RSH (Table 5b).

Spatial Use

For all large bird species combined, use was highest at points 10 and four (14.9 and 10.9 birds/20-min survey, respectively). Bird use at other points ranged from 1.38 to 6.76 birds/20-min survey (Figure 2). The high mean use estimates for points 10 and four was largely due to high waterfowl use at these points (8.00 and 10.6 birds/20-min survey, respectively).Waterfowl use at other points ranged from 0.08 to 4.76 birds/20-min survey. Waterbird use occurred at just four of the points (two, five, nine, and 10), with use ranging from 1.64 birds/20-min survey at point 10 to 0.06 birds/20-min survey at points two and nine. Shorebird use was highest at point 10 with 0.71 birds/20-min survey, while use at other points ranged from zero to 0.38 birds/20-min survey. Rail/coot use only occurred at points six (0.08 birds/20-min survey) and 10 (4.00 birds/20-min survey). Raptor use was highest at points eight and A, with 0.54 and 0.53 birds/20-min survey, respectively. Use at other points ranged from 0.14 to 0.47 birds/20-min survey. Owl use only occurred at point A, with 0.06 birds/20-min survey. Upland gamebird use also occurred at just one point (five), with 0.06 birds/20-min survey. Dove/pigeon use was highest at points one and five, with 1.71 and 1.41 birds/20-min survey, respectively. Dove/pigeon use ranged from 0.06 to 1.00 birds/20-min survey at other points. Large corvid use occurred at just three of the points (one, two and three), and use at those points ranged from 0.06 to 0.53 birds/20-min survey. Passerine use, focused within 100 m, was highest at points four and 10 (42.4 and 38.5 birds/20-min survey, respectively), and ranged from 1.31 to 10.7 at other points.

Sensitive Species Observations

A total of 10 sensitive species were recorded during fixed-point surveys (Table 6, NDGFD 2004). Six North Dakota critically imperiled species (NDGFD 2004) were recorded, including Swainson's hawk (two individuals), black tern (two individuals), upland sandpiper (*Bartramia longicauda*; two individuals), American white pelican (*Pelecanus erythrorhynchos*; one), grasshopper sparrow (*Ammodramus savannarum*; one), and willet (*Catoptrophorus semipalmatus*; one). Additionally, northern harrier, northern pintail (*Anas acuta*), boblink (*Dolichonyx oryzivorus*), and redhead (*Aythya Americana*), all North Dakota imperiled species (NDGFD 2004), were observed during fixed-point surveys.

Raptor Nest Surveys

One potential raptor nest was documented within a half mile of the GRWP within a live cottonwood along the western edge of a tree row (Figure 1). The approximate location of the structure is: Northing 5211649, Easting 583493 (NAD83, Zone 14).

Incidental Wildlife Observations

Fifteen bird species were observed while in-transit within the GRWP, totaling 1,559 birds within 44 separate groups (Table 7). Three mammal species were also observed incidentally at the GRWP.

Bird Observations

The most abundant bird species recorded as an incidental wildlife observation was snow goose (*Chen caerulescens*; 1,400 individuals in two groups). Eight species were only seen incidentally within the GRWP: snow goose, ferruginous hawk (*Buteo regalis*), black-billed cuckoo (*Coccyzus erythropthalmus*), yellow-rumped warbler (*Dendroica coronata*), sharp-tailed grouse (*Tympanuchus phasianellus*), Say's phoebe (*Sayornis saya*), rough-legged hawk (*Buteo lagopus*) and Lapland longspur (*Calcarius lapponicus*).

Mammal Observations

Three mammals were recorded incidentally within the LWRA: four white-tailed deer (*Odocoileus virginianus*), one coyote (*Canis latrans*), and one badger (*Taxidea taxus*).

Sensitive Species Observations

A total of five sensitive species (NDGFD 2004) were recorded incidentally (Table 7). Three North Dakota critically imperiled species (NDGFD 2004), Swainson's hawk (three individuals), black-billed cuckoo (one), and ferruginous hawk (one), were recorded incidentally. Additionally two North Dakota imperiled species (NDGFD 2004), northern harrier (10 individuals in nine groups) and sharp-tailed grouse (one), were also recorded incidentally at the GRWP.

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Data regarding bird use in the GRWP were collected using fixed point counts (20-minute point counts with surveys out to 100 m and 800 m) and incidentally. Most publically available data and most data related to potential wind resource development using pre-construction data have been collected utilizing methods similar to the fixed point counts.

Direct Effects

The most probable direct impact to birds from wind energy facilities is direct mortality or injury due to collisions with turbines or guy wires of meteorological (met) towers. Collisions may occur with resident birds foraging and flying within the GRWP or with migrant birds seasonally moving through the GRWP. Facility construction could affect birds through potential fatalities from construction equipment. 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-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.

Substantial data on bird mortality at wind energy facilities are available from studies in California and throughout the west and Midwest. During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised 2% of the wind energy facility-related fatalities and raptor mortality averaged 0.03/turbine/year (Erickson et al. 2002b). Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. Of 841 bird fatalities reported from California studies (more than 70% from the Altamont Pass facility in California), 39% were diurnal raptors, 19% were passerines (excluding house sparrows [*Passer domesticus*] and European starlings [*Sturnus vulgaris*]), and 12% were owls. Non-protected birds, including house sparrows, European starlings, and rock doves (*Columba livia*), comprised 15% of the fatalities. Other bird types generally made up less than 10% of the fatalities (Erickson et al. 2002b). Using mortality data from a 10-year period from wind energy facilities throughout the entire United States, the average number of bird collision fatalities is 3.1 per megawatt (MW) per year, or 2.3 fatalities per turbine per year (NWCC 2004).

<u>Raptor Use and Exposure Risk</u>

The annual mean raptor use (number of raptors divided by the number of 800-m plots and the total number of surveys) at the GRWP (0.33 raptors/plot/20-min survey) was compared with 39 other wind energy facilities that implemented similar protocols and had data for three seasons. Annual mean raptor use at these wind energy facilities ranged from 0.09 to 2.34 raptors/plot/20-min survey (Figure 3). Based on the results from these wind energy facilities, a ranking of seasonal raptor mean 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 (more than 3.0). Under this ranking, mean raptor use at the GRWP is considered to be low, ranking thirtieth compared to the other wind-energy facilities (Figure 3).

A regression analysis of raptor use and mortality for 13 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 = 69.9%; Figure 4). Using this regression to predict raptor collision mortality at the GRWP, based on an adjusted mean raptor use of 0.33 raptors/20-min survey, yields an estimated fatality rate of <0.01 fatalities/MW/year, or less than one raptor fatality per year for each 100-MW of wind energy development. A 90% prediction interval around this estimate is zero to 0.26 fatalities/MW/year. Based on the relative abundance of red-tailed hawks throughout the year and a higher exposure index than other raptor species, there is higher potential for red-tailed hawk fatalities compared to other species.

Overall raptor use was compared at four other wind energy facilities in the same geographic region (Midwest) as the GRWP (Table 8). Use values at the facilities ranged from zero raptors/MW/year at the Blue Sky Green Field wind energy facility in Wisconsin to 0.06 raptors /MW/year at the NPPD Ainsworth wind energy facility in Nebraska. Assuming a correlation between use and fatality rates exist, raptor fatality rates at the GRWP would be lower than the fatality rates observed in Nebraska, Ontario, or Minnesota (Table 8), which is similar to the regression analysis discussed above.

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. 2001a). 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 Altamont Pass 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 than predicted based on abundance. Thus far, only three northern harrier fatalities at existing wind energy facilities have been reported in publicly available documents, despite the fact they are commonly observed during point counts at these facilities (Erickson et al. 2001a, Whitfield and Madders 2006). Because northern harriers often forage close to the ground, risk of collision with turbine blades is considered low for this species. It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

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 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 observed during the surveys and within the study area. Actual risk for some species may be lower or higher than indicated by these data. At the GRWP, the raptor species with the highest exposure index was red-tailed hawk, which was influenced by the relatively high use estimates by this species. Other raptors ranked much lower, primarily due to the lower use estimates by these species or a relatively low proportion of flight heights observed in the RSH.

<u>Non-Raptor Use and Exposure Risk</u>

Unlike raptors, there is currently not a regression analysis or other quantitative means to correlate use to potential direct impacts for the non-raptor species. As if often seen, high use does not translate into high mortality (e.g., waterfowl). There are, however, qualitative assessments that can be made by looking at species information collected at other facilities in the US and elsewhere.

Most bird species in the US are protected by the Migratory Bird Treaty Act (MBTA 1918). Passerines (primarily perching birds) have been the most abundant bird fatality at wind energy facilities outside California (Erickson et al. 2001a, 2002b), often comprising 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 the baseline study, passerines would be expected to make up the largest proportion of fatalities at the GRWP. Based on observations within 100 m, no passerines were observed flying within the estimated RSH, suggesting that passerines and other small birds have a low risk for collisions within the RSH (Table 5b). Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely RSH. Due to the relatively low exposure risks at GRWP, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind energy facility.

Wind energy facilities with year-round use by water dependent species have shown the highest mortality, although the levels of waterfowl/waterbird/shorebird mortality appear insignificant compared to the use of the facilities by these groups. Of 1,033 bird carcasses collected at US wind energy facilities, waterbirds comprised about two percent, waterfowl comprised about three percent, and shorebirds comprised less than one percent (Erickson et al. 2002b). At the Klondike, Oregon, wind energy facility, only two Canada goose fatalities were documented (Johnson et al. 2003) even though 43 groups totaling 4,845 individual Canada geese were observed during pre-construction surveys (Johnson et al. 2002a). The recently constructed Top of Iowa wind energy facility is located in cropland between three Wildlife Management Areas (WMAs) with historically high bird use, including migrant and resident waterfowl. During a recent study, approximately one million goose-use days and 120,000 duck-use days were recorded in the WMAs during the fall and early winter, and no waterfowl fatalities were documented during concurrent and standardized wind energy facility fatality studies (Jain 2005). Similar findings were observed at the Buffalo Ridge wind energy facility in southwestern Minnesota, which is located in an area with relatively high waterfowl/waterbird use and some shorebird use. Snow geese, Canada geese, and mallards were the most common waterfowl observed. Three of the 55 fatalities observed during the fatality monitoring studies were waterfowl, including two mallards (*Anas platyrhynchos*) and one blue-winged teal (*Anas discors*). Two American coots (*Fulica americana*), one grebe, and one shorebird fatality were also found (Johnson et al. 2002b). Based on available evidence, waterfowl do not seem especially vulnerable to turbine collisions and significant impacts are not likely from development of the GRWP.

<u>Sensitive Species Use and Exposure Risk</u>

All sensitive species observed at the GRWP are summarized in Table 6. Federally-listed threatened and endangered species (NDFO 2008, USFWS 2010) occurring in Barnes County, North Dakota were not observed at the GRWP during fixed-point bird use surveys (Table 2). During all surveys and incidental observations, 13 sensitive species were observed including eight North Dakota critically imperiled species (NDGFD 2004): Swainson’s hawk, black tern, upland sandpiper, American white pelican, black-billed cuckoo, ferruginous hawk, grasshopper sparrow, and willet. Additionally, five North Dakota imperiled species (NDGFD 2004), northern harrier, northern pintail, bobolink, redhead, and sharp-tailed grouse, were all recorded during surveys within the GRWP. Based on the limited number of sensitive species observed, there is some limited potential for direct impacts; however, it is expected that direct impacts would be small in number.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the GRWP 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). The greatest concern with displacement impacts for wind energy facilities in the US has been where these facilities have been constructed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007), Although Crockford (1992) suggests that disturbance appears to impact feeding, resting, and migrating birds, rather than breeding birds, results from studies at the Stateline wind energy facility in Washington and Oregon (Erickson et al. 2004a) and the Buffalo Ridge wind energy facility in Minnesota (Johnson et al. 2000a) suggest that breeding birds are also affected by wind energy facility operations.

<u>Raptor Displacement</u>

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 habitat 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. 2000b, 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 (< 328 ft [100 m] from turbines) and 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.

The only published report of avoidance of wind turbines by nesting raptors occurred at the Buffalo Ridge facility in Minnesota, where raptor nest density on 101 mi^2 (262 km^2) of land surrounding a wind energy facility was 5.94 nests/39 mi^2 (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. 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 of turbines (Erickson et al. 2004a). 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 wind energy 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. In Oregon, a Swainson's hawk also nested within a quarter-mile (0.4 km) of a turbine string at the Klondike I wind energy facility after the facility was operational (Johnson et al. 2003). These observations suggest that there will be limited or no nesting displacement of raptors at the GRWP, although the creation of a buffer surrounding known nests when siting turbines will further reduce any impact.

<u>Displacement of Non-Raptor Bird Species</u>
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. The cause of this displacement is unknown but could be a combination of the birds avoiding turbine noise, presence of large structure, maintenance activities, and other activities associated with wind facilities. Construction also reduces habitat effectiveness 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 (CRP) 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 ft) 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 Buffalo Ridge wind energy facility in Minnesota. Results from the Stateline wind energy facility in Oregon and Washington (Erickson et al. 2004a), and the Combine Hills wind energy facility in 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 passerine use was significantly reduced within approximately 50 m (164 ft) of turbine strings, but areas further away from turbine strings did not have reduced bird use. Displacement of grassland passerines may be reduced by siting turbines away from grassland or natural habitats. Turbines sited within agricultural land, similar to the GRWP, should minimize displacement to impacts.

Displacement effects of wind energy facilities on waterfowl and shorebirds 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 in Minnesota, the abundance of several bird types, including shorebirds and waterfowl, were found to be significantly lower at survey plots with turbines than at reference plots without turbines (Johnson et al. 2000a). The report concluded that the area of reduced use was limited primarily to those areas within 100 m of the turbines. Disturbance tends to be greatest for migrating birds while feeding and resting (Crockford 1992, NRC 2007). Derby et al. (2009) documented similar use by Canada geese and other waterfowl within a constructed wind facility compared to an adjacent control area in agricultural land in central Illinois. The majority of waterfowl/waterbird use at the GRWP included several large groups of Canada geese and mallards, comprising a total of 376 individuals (72.9% of waterfowl/waterbird observations). Displacement impacts to either of these species are not expected to occur or to occur at a very large degree. In addition, the presence of similar habitat surrounding the GRWP means that any minimal displacement of these species, if any occurs, is unlikely to impact the population.

CONCLUSIONS AND RECOMMENDATIONS

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

Currently, few published studies are available from the Midwest that compare overall bird use to bird mortality rates. Compared to research conducted at wind energy facilities throughout the US, raptor use at the GRWP is generally lower than use levels recorded at other wind energy facilities. Raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. To date, no relationships have been observed between overall use by other bird types, and fatality rates of those bird groups at wind energy facilities. However, the flight characteristics and foraging habits of some species may result in increased exposure for these species at the GRWP. The surveys conducted for this proposed wind resource area also do not address the impacts of the proposed facility to nocturnal migrants, such as passerines. To date, overall fatality rates for birds (including nocturnal migrants) at wind energy facilities have been relatively low and consistent in the Midwest. The range of overall bird fatality estimates at three Midwest wind energy facilities has ranged from 0.7 to 3.4 fatalities/MW/year (Howe et al. 2002; Johnson et al. 2002b, Jain 2005). As more research is conducted at facilities in the Midwest, more information regarding the potential direct impacts of wind energy facilities to bird species will be obtained.

The proposed wind energy facility contains a diversity of habitats; cropland, pastures, planted grasslands, and deciduous forests. Some species considered to be sensitive or of conservation concern were observed within the GRWP. Several of these species tend to avoid cropland habitats, having a greater potential to occur in non-cropland areas, such as pastures, grasslands or deciduous forests. Some potential exists for wind turbines to displace birds within non-cropland habitats. Research concerning displacement impacts to songbirds, waterfowl and waterbirds and wind energy facilities is limited, but some studies show the potential for small scale (180 m [591 feet] or less) displacement, while impacts to densities of birds at larger scales has not been shown.

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Table 1. Summary of species richness (species/plot[a]/20-min survey), and sample size by season and overall during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Season	Number of Visits	# Surveys Conducted	# Unique Species	Species Richness	
				Large Birds	Small Birds
Summer	6	58	48	1.11	2.01
Fall	5	44	23	0.92	0.46
Spring	6	54	51	1.87	1.44
Overall	**17**	**156**	**69**	**1.32**	**1.36**

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

Table 2. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Glacier Ridge Wind Project[a] , July 16, 2009 – June 25, 2010.

		Summer		Fall		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**5**	**6**	**5**	**7**	**5**	**14**	**15**	**27**
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	1	0	0	1	1
black tern	*Chlidonias niger*	1	2	0	0	0	0	1	2
double-crested cormorant	*Phalacrocorax auritus*	1	1	2	3	3	11	6	15
great blue heron	*Ardea herodias*	1	1	0	0	1	1	2	2
great egret	*Ardea alba*	0	0	1	2	0	0	1	2
pied-billed grebe	*Podilymbus podiceps*	1	1	0	0	1	2	2	3
ring-billed gull	*Larus delawarensis*	1	1	1	1	0	0	2	2
Waterfowl		**13**	**22**	**15**	**299**	**66**	**168**	**94**	**489**
blue-winged teal	*Anas discors*	1	1	0	0	4	9	5	10
Canada goose	*Branta canadensis*	1	4	8	259	12	28	21	291
gadwall	*Anas strepera*	0	0	0	0	3	8	3	8
lesser scaup	*Aythya affinis*	0	0	0	0	1	6	1	6
mallard	*Anas platyrhynchos*	7	11	2	14	28	60	37	85
mottled duck	*Anas fulvigula*	1	3	0	0	0	0	1	3
northern pintail	*Anas acuta*	2	2	1	6	7	19	10	27
northern shoveler	*Anas clypeata*	0	0	0	0	7	14	7	14
redhead	*Aythya americana*	0	0	0	0	1	2	1	2
ring-necked duck	*Aythya collaris*	0	0	0	0	1	2	1	2
ruddy duck	*Oxyura jamaicensis*	0	0	0	0	1	2	1	2
tundra swan	*Cygnus columbianus*	0	0	2	16	0	0	2	16
unidentified duck		1	1	2	4	1	18	4	23
Shorebirds		**11**	**13**	**0**	**0**	**12**	**21**	**23**	**34**
killdeer	*Charadrius vociferus*	7	9	0	0	11	20	18	29

Table 2. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Glacier Ridge Wind Project[a] , July 16, 2009 – June 25, 2010.

		Summer		Fall		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
upland sandpiper	*Bartramia longicauda*	2	2	0	0	0	0	2	2
willet	*Catoptrophorus semipalmatus*	0	0	0	0	1	1	1	1
Wilson's snipe	*Gallinago delicata*	2	2	0	0	0	0	2	2
Rails/Coots		**1**	**5**	**1**	**8**	**4**	**44**	**6**	**57**
American coot	*Fulica americana*	1	5	1	8	4	44	6	57
Raptors		**10**	**12**	**12**	**12**	**22**	**28**	**44**	**52**
Accipiters		*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
Cooper's hawk	*Accipiter cooperii*	0	0	0	0	1	1	1	1
Buteos		*4*	*4*	*5*	*5*	*7*	*12*	*16*	*21*
red-tailed hawk	*Buteo jamaicensis*	2	2	5	5	7	12	14	19
Swainson's hawk	*Buteo swainsoni*	2	2	0	0	0	0	2	2
Northern Harrier		*6*	*8*	*6*	*6*	*11*	*11*	*23*	*25*
northern harrier	*Circus cyaneus*	6	8	6	6	11	11	23	25
Falcons		*0*	*0*	*1*	*1*	*3*	*4*	*4*	*5*
American kestrel	*Falco sparverius*	0	0	1	1	3	4	4	5
Owls		**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**
great horned owl	*Bubo virginianus*	1	1	0	0	0	0	1	1
Upland Game Birds		**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
ring-necked pheasant	*Phasianus colchicus*	0	0	0	0	1	1	1	1
Doves/Pigeons		**21**	**70**	**7**	**31**	**3**	**6**	**31**	**107**
mourning dove	*Zenaida macroura*	17	33	4	14	2	4	23	51
rock pigeon	*Columba livia*	4	37	3	17	1	2	8	56
Large Corvids		**2**	**6**	**1**	**3**	**3**	**4**	**6**	**13**
American crow	*Corvus brachyrhynchos*	2	6	1	3	3	4	6	13

Table 2. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Glacier Ridge Wind Project[a] , July 16, 2009 – June 25, 2010.

		Summer		Fall		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**121**	**386**	**19**	**912**	**87**	**512**	**227**	**1,810**
American goldfinch	*Carduelis tristis*	7	17	0	0	2	4	9	21
American robin	*Turdus migratorius*	2	2	0	0	4	7	6	9
American tree sparrow	*Spizella arborea*	0	0	0	0	1	8	1	8
barn swallow	*Hirundo rustica*	6	8	7	19	2	5	15	32
bobolink	*Dolichonyx oryzivorus*	9	13	0	0	1	2	10	15
Brewer's blackbird	*Euphagus cyanocephalus*	2	5	0	0	0	0	2	5
brown-headed cowbird	*Molothrus ater*	5	12	1	51	5	6	11	69
cedar waxwing	*Bombycilla cedrorum*	0	0	0	0	1	1	1	1
chipping sparrow	*Spizella passerina*	0	0	0	0	2	3	2	3
clay-colored sparrow	*Spizella pallida*	4	6	0	0	2	7	6	13
cliff swallow	*Petrochelidon pyrrhonota*	3	12	0	0	0	0	3	12
common grackle	*Quiscalus quiscula*	5	110	3	209	5	16	13	335
common yellowthroat	*Geothlypis trichas*	3	3	0	0	0	0	3	3
dark-eyed junco	*Junco hyemalis*	0	0	1	2	1	5	2	7
eastern kingbird	*Tyrannus tyrannus*	2	2	0	0	0	0	2	2
eastern wood-pewee	*Contopus virens*	1	1	0	0	0	0	1	1
European starling	*Sturnus vulgaris*	1	1	0	0	1	12	2	13
grasshopper sparrow	*Ammodramus savannarum*	1	1	0	0	0	0	1	1
horned lark	*Eremophila alpestris*	13	22	1	1	22	242	36	265
house sparrow	*Passer domesticus*	0	0	0	0	1	25	1	25
house wren	*Troglodytes aedon*	0	0	0	0	1	1	1	1
marsh wren	*Cistothorus palustris*	2	5	0	0	1	5	3	10
orchard oriole	*Icterus spurius*	2	2	0	0	0	0	2	2

Table 2. Total number of individuals and groups for each bird type and species[a], by season and overall, during the fixed-point bird use surveys at the Glacier Ridge Wind Project[a] , July 16, 2009 – June 25, 2010.

		Summer		Fall		Spring		Total	
Species/Type	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
red-winged blackbird	*Agelaius phoeniceus*	23	111	3	127	18	73	44	311
rusty blackbird	*Euphagus carolinus*	0	0	0	0	1	50	1	50
savannah sparrow	*Passerculus sandwichensis*	5	8	0	0	4	7	9	15
song sparrow	*Melospiza melodia*	7	7	0	0	3	3	10	10
tree swallow	*Tachycineta bicolor*	3	12	0	0	1	4	4	16
unidentified sparrow		0	0	2	502	1	3	3	505
vesper sparrow	*Pooecetes gramineus*	8	9	1	1	1	1	10	11
warbling vireo	*Vireo gilvus*	1	2	0	0	0	0	1	2
western meadowlark	*Sturnella neglecta*	1	1	0	0	1	1	2	2
white-throated sparrow	*Zonotrichia albicollis*	0	0	0	0	1	2	1	2
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	4	12	0	0	3	17	7	29
yellow warbler	*Dendroica petechia*	1	2	0	0	1	2	2	4
Woodpeckers		**1**	**1**	**1**	**2**	**3**	**3**	**5**	**6**
northern flicker	*Colaptes auratus*	1	1	1	2	3	3	5	6
Overall		**186**	**522**	**61**	**1,274**	**206**	**801**	**453**	**2,597**

Table 3a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

	Use			% Composition			% Frequency		
Species/Type	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**
Waterbirds	**0.11**	**0.14**	**0.23**	**4.5**	**1.6**	**4.7**	**5.2**	**6.5**	**5.0**
American white pelican	0	0.02	0	0	0.2	0	0	2.0	0
black tern	0.04	0	0	1.6	0	0	1.9	0	0
double-crested cormorant	0.02	0.06	0.18	0.8	0.7	3.7	1.9	4.0	5.0
great blue heron	0.02	0	0.02	0.7	0	0.3	1.7	0	1.7
great egret	0	0.04	0	0	0.5	0	0	2.0	0
pied-billed grebe	0.02	0	0.03	0.8	0	0.7	1.9	0	1.7
ring-billed gull	0.02	0.02	0	0.7	0.3	0	1.7	2.5	0
Waterfowl	**0.40**	**7.45**	**2.87**	**16.9**	**84.5**	**58.4**	**18.1**	**26.0**	**54.1**
blue-winged teal	0.02	0	0.15	0.7	0	3.1	1.7	0	6.9
Canada goose	0.07	6.47	0.50	3.1	73.5	10.1	1.9	17.5	19.8
gadwall	0	0	0.14	0	0	2.7	0	0	5.2
lesser scaup	0	0	0.10	0	0	2.0	0	0	1.7
mallard	0.20	0.34	1.02	8.5	3.9	20.8	11.1	4.5	41.1
mottled duck	0.06	0	0	2.3	0	0	1.9	0	0
northern pintail	0.04	0.15	0.32	1.6	1.7	6.6	3.7	2.5	12.0
northern shoveler	0	0	0.24	0	0	4.8	0	0	11.9
redhead	0	0	0.03	0	0	0.7	0	0	1.7
ring-necked duck	0	0	0.04	0	0	0.8	0	0	1.9
ruddy duck	0	0	0.03	0	0	0.7	0	0	1.7
tundra swan	0	0.40	0	0	4.5	0	0	5.0	0
unidentified duck	0.02	0.08	0.30	0.7	0.9	6.1	1.7	4.0	1.7
Shorebirds	**0.23**	**0**	**0.36**	**9.8**	**0**	**7.4**	**17.8**	**0**	**19.1**
killdeer	0.16	0	0.35	6.7	0	7.0	12.4	0	19.1
upland sandpiper	0.04	0	0	1.5	0	0	3.5	0	0
willet	0	0	0.02	0	0	0.3	0	0	1.7

Table 3a. Mean bird use (number of birds/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each large bird type and species by season during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

	Use			% Composition			% Frequency		
Species/Type	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**
Wilson's snipe	0.04	0	0	1.6	0	0	3.7	0	0
Rails/Coots	**0.09**	**0.20**	**0.73**	**3.9**	**2.3**	**14.9**	**1.9**	**2.5**	**6.7**
American coot	0.09	0.20	0.73	3.9	2.3	14.9	1.9	2.5	6.7
Raptors	**0.21**	**0.28**	**0.49**	**8.9**	**3.2**	**9.9**	**17.6**	**26.0**	**27.6**
Accipiters	*0*	*0*	*0.02*	*0*	*0*	*0.3*	*0*	*0*	*1.7*
Cooper's hawk	0	0	0.02	0	0	0.3	0	0	1.7
Buteos	*0.07*	*0.12*	*0.22*	*2.8*	*1.3*	*4.5*	*6.7*	*11.5*	*10.9*
red-tailed hawk	0.03	0.12	0.22	1.4	1.3	4.5	3.3	11.5	10.9
Swainson's hawk	0.03	0	0	1.4	0	0	3.3	0	0
Northern Harrier	*0.15*	*0.14*	*0.19*	*6.1*	*1.6*	*3.8*	*10.9*	*14.0*	*15.2*
northern harrier	0.15	0.14	0.19	6.1	1.6	3.8	10.9	14.0	15.2
Falcons	*0*	*0.02*	*0.07*	*0*	*0.3*	*1.4*	*0*	*2.5*	*3.3*
American kestrel	0	0.02	0.07	0	0.3	1.4	0	2.5	3.3
Owls	**0.02**	**0**	**0**	**0.7**	**0**	**0**	**1.7**	**0**	**0**
great horned owl	0.02	0	0	0.7	0	0	1.7	0	0
Upland Game Birds	**0**	**0**	**0.02**	**0**	**0**	**0.3**	**0**	**0**	**1.7**
ring-necked pheasant	0	0	0.02	0	0	0.3	0	0	1.7
Doves/Pigeons	**1.22**	**0.68**	**0.12**	**51.1**	**7.7**	**2.5**	**32.2**	**15.0**	**6.3**
mourning dove	0.56	0.28	0.07	23.3	3.2	1.4	28.7	8.0	3.5
rock pigeon	0.66	0.40	0.06	27.8	4.5	1.1	6.9	7.0	2.8
Large Corvids	**0.10**	**0.06**	**0.09**	**4.3**	**0.7**	**1.8**	**3.5**	**2.0**	**7.2**
American crow	0.10	0.06	0.09	4.3	0.7	1.8	3.5	2.0	7.2
Overall	**2.39**	**8.81**	**4.92**	**100**	**100**	**100**			

Table 3b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

	Use			% Composition			% Frequency		
Species/Type	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**
Passerines	**6.76**	**22.00**	**9.48**	**99.8**	**99.8**	**99.5**	**76.7**	**37.0**	**69.1**
American goldfinch	0.31	0	0.07	4.5	0	0.7	12.4	0	3.5
American robin	0.04	0	0.13	0.5	0	1.3	3.7	0	7.2
American tree sparrow	0	0	0.15	0	0	1.6	0	0	1.9
barn swallow	0.14	0.45	0.09	2.0	2.0	1.0	10.2	15.5	3.7
bobolink	0.24	0	0.04	3.5	0	0.4	12.8	0	1.9
Brewer's blackbird	0.09	0	0	1.4	0	0	3.7	0	0
brown-headed cowbird	0.22	1.02	0.10	3.3	4.6	1.1	9.3	2.0	7.0
cedar waxwing	0	0	0.02	0	0	0.2	0	0	1.7
chipping sparrow	0	0	0.05	0	0	0.5	0	0	3.3
clay-colored sparrow	0.11	0	0.12	1.6	0	1.3	7.0	0	3.5
cliff swallow	0.22	0	0	3.3	0	0	5.6	0	0
common grackle	1.84	5.22	0.29	27.2	23.7	3.0	8.7	7.5	8.7
common yellowthroat	0.06	0	0	0.8	0	0	5.6	0	0
dark-eyed junco	0	0.04	0.08	0	0.2	0.9	0	2.0	1.7
eastern kingbird	0.03	0	0	0.5	0	0	3.3	0	0
eastern wood-pewee	0.02	0	0	0.3	0	0	1.9	0	0
European starling	0.02	0	0.22	0.2	0	2.3	1.7	0	1.9
grasshopper sparrow	0.02	0	0	0.3	0	0	1.9	0	0
horned lark	0.40	0.02	4.71	5.9	0.1	49.4	21.7	2.5	32.8
house sparrow	0	0	0.46	0	0	4.9	0	0	1.9
house wren	0	0	0.02	0	0	0.2	0	0	1.7
marsh wren	0.09	0	0.08	1.3	0	0.9	3.5	0	1.7
orchard oriole	0.03	0	0	0.5	0	0	3.3	0	0
red-winged blackbird	1.94	2.67	1.24	28.7	12.1	13.1	35.0	7.0	25.9
rusty blackbird	0	0	0.93	0	0	9.7	0	0	1.9

Table 3b. Mean use (number of birds/100-m plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each small bird type and species by season during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

	Use			% Composition			% Frequency		
Species/Type	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**	**Summer**	**Fall**	**Spring**
savannah sparrow	0.15	0	0.12	2.2	0	1.2	9.3	0	6.7
song sparrow	0.12	0	0.05	1.8	0	0.5	12.2	0	5.2
tree swallow	0.20	0	0.07	3.0	0	0.7	5.0	0	1.7
unidentified sparrow	0	12.55	0.05	0	56.9	0.5	0	5.0	1.7
vesper sparrow	0.16	0.02	0.02	2.4	0.1	0.2	10.9	2.5	1.7
warbling vireo	0.04	0	0	0.5	0	0	1.9	0	0
western meadowlark	0.02	0	0.02	0.2	0	0.2	1.7	0	1.7
white-throated sparrow	0	0	0.03	0	0	0.3	0	0	1.7
yellow-headed blackbird	0.22	0	0.29	3.3	0	3.0	5.4	0	5.2
yellow warbler	0.04	0	0.04	0.5	0	0.4	1.9	0	1.9
Woodpeckers	**0.02**	**0.05**	**0.05**	**0.2**	**0.2**	**0.5**	**1.7**	**2.5**	**5.0**
northern flicker	0.02	0.05	0.05	0.2	0.2	0.5	1.7	2.5	5.0
Overall	**6.78**	**22.05**	**9.53**	**100**	**100**	**100**			

Table 4. Flight height characteristics by bird type during fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010. Large bird observations were limited to within 800 m and small birds were limited to within 100 m.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% within Flight Height Categories 0-35m	35-130 m	>130m
Waterbirds	9	13	14.22	48.1	100	0	0
Waterfowl	58	407	28.88	83.2	60.9	39.1	0
Shorebirds	10	11	27.40	32.4	81.8	9.1	9.1
Rails/Coots	0	0	0	0	0	0	0
Raptors	39	46	19.26	88.5	80.4	17.4	2.2
Accipiters	*1*	*1*	*7.00*	*100*	*100*	*0*	*0*
Buteos	*12*	*17*	*45.83*	*81.0*	*47.1*	*47.1*	*5.9*
Northern Harrier	*23*	*25*	*6.48*	*100*	*100*	*0*	*0*
Falcons	*3*	*3*	*15.00*	*60.0*	*100*	*0*	*0*
Owls	0	0	0	0	0	0	0
Upland Game Birds	0	0	0	0	0	0	0
Doves/Pigeons	26	89	6.46	83.2	100	0	0
Large Corvids	5	12	12.00	92.3	100	0	0
Large Birds Overall	**147**	**578**	**20.79**	**74.0**	**70.6**	**29.1**	**0.3**
Passerines	101	1,081	5.53	59.7	100	0	0
Woodpeckers	4	5	3.25	83.3	100	0	0
Small Birds Overall	**105**	**1,086**	**5.45**	**59.8**	**100**	**0**	**0**

RSH: The likely "rotor swept height" for potential collision with a turbine blade, or 35-130 m (114-427 ft) above ground level (AGL).

Table 5a. Relative exposure index and flight characteristics by large bird species during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
Canada goose	14	2.09	93.8	40.7	0.80	97.1
tundra swan	2	0.12	100	100	0.12	100
northern pintail	6	0.17	77.8	85.7	0.11	85.7
mallard	24	0.53	60.0	27.5	0.09	33.3
red-tailed hawk	11	0.12	84.2	43.8	0.05	68.8
Swainson's hawk	1	0.01	50.0	100	<0.01	100
Wilson's snipe	2	0.01	100	50.0	<0.01	50.0
rock pigeon	7	0.37	80.4	0	0	0
American coot	0	0.35	0	0	0	0
mourning dove	19	0.30	86.3	0	0	0
killdeer	7	0.18	27.6	0	0	0
northern harrier	23	0.16	100	0	0	0
unidentified duck	4	0.14	100	0	0	78.3
American crow	5	0.09	92.3	0	0	0
double-crested cormorant	4	0.09	46.7	0	0	0
northern shoveler	3	0.08	42.9	0	0	0
blue-winged teal	2	0.06	30.0	0	0	0
gadwall	1	0.05	62.5	0	0	0
lesser scaup	1	0.04	100	0	0	0
American kestrel	3	0.03	60.0	0	0	0
mottled duck	1	0.02	100	0	0	0
pied-billed grebe	0	0.02	0	0	0	0
black tern	1	0.01	100	0	0	0
great blue heron	1	0.01	50.0	0	0	0
great egret	0	0.01	0	0	0	0
redhead	0	0.01	0	0	0	0

Table 5a. Relative exposure index and flight characteristics by large bird species during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
ring-billed gull	2	0.01	100	0	0	0
ring-necked duck	0	0.01	0	0	0	0
ruddy duck	0	0.01	0	0	0	0
upland sandpiper	1	0.01	50.0	0	0	0
American white pelican	1	<0.01	100	0	0	0
Cooper's hawk	1	<0.01	100	0	0	0
great horned owl	0	<0.01	0	0	0	0
ring-necked pheasant	0	<0.01	0	0	0	0
willet	0	<0.01	0	0	0	0

RSH: The likely "rotor-swept height" for potential collision with a turbine blade, or 35-130 m (114-427 ft) above ground level (AGL).

Table 5b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
unidentified sparrow	3	3.69	100	0	0	0
common grackle	11	2.28	38.8	0	0	0
red-winged blackbird	25	1.91	35.4	0	0	22.7
horned lark	14	1.82	79.6	0	0	87.7
brown-headed cowbird	3	0.41	8.7	0	0	0
rusty blackbird	0	0.33	0	0	0	0
barn swallow	15	0.21	100	0	0	0
yellow-headed blackbird	3	0.18	17.2	0	0	0
house sparrow	1	0.16	100	0	0	0
American goldfinch	4	0.13	38.1	0	0	0
bobolink	6	0.10	66.7	0	0	0
savannah sparrow	0	0.09	0	0	0	0
tree swallow	4	0.09	100	0	0	0
clay-colored sparrow	0	0.08	0	0	0	0
cliff swallow	3	0.08	100	0	0	0
European starling	0	0.08	0	0	0	0
vesper sparrow	1	0.07	9.1	0	0	0
American robin	2	0.06	33.3	0	0	0
marsh wren	0	0.06	0	0	0	0
song sparrow	0	0.06	0	0	0	0
American tree sparrow	0	0.05	0	0	0	0
dark-eyed junco	1	0.04	28.6	0	0	0
northern flicker	4	0.04	83.3	0	0	0
Brewer's blackbird	0	0.03	0	0	0	0
yellow warbler	0	0.03	0	0	0	0
chipping sparrow	0	0.02	0	0	0	0
common yellowthroat	1	0.02	33.3	0	0	0

Table 5b. Relative exposure index and flight characteristics for small birds during the fixed-point bird use surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index	% Within RSH at anytime
eastern kingbird	2	0.01	100	0	0	0
orchard oriole	2	0.01	100	0	0	0
warbling vireo	0	0.01	0	0	0	0
western meadowlark	0	0.01	0	0	0	0
white-throated sparrow	0	0.01	0	0	0	0
cedar waxwing	0	<0.01	0	0	0	0
eastern wood-pewee	0	<0.01	0	0	0	0
grasshopper sparrow	0	<0.01	0	0	0	0
house wren	0	<0.01	0	0	0	0

RSH: The likely "rotor-swept height" for potential collision with a turbine blade, or 35-130 m (114-427 ft) above ground level (AGL).

Table 6. Summary of sensitive species observed at the Glacier Ridge Wind Project during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.), July 16, 2009 – June 25, 2010.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# of grps**	**# of obs**	**# of grps**	**# of obs**	**# of grps**	**# of obs**
northern harrier	*Circus cyaneus*	S2	23	25	9	10	32	35
northern pintail	*Anas acuta*	S2	10	27	0	0	10	27
bobolink	*Dolichonyx oryzivorus*	S2	10	15	0	0	10	15
Swainson's hawk	*Buteo swainsoni*	S1	2	2	3	3	5	5
black tern	*Chlidonias niger*	S1	1	2	0	0	1	2
redhead	*Aythya americana*	S2	1	2	0	0	1	2
upland sandpiper	*Bartramia longicauda*	S1	2	2	0	0	2	2
American white pelican	*Pelecanus erythrorhynchos*	S1	1	1	0	0	1	1
black-billed cuckoo	*Coccyzus erythropthalmus*	S1	0	0	1	1	1	1
ferruginous hawk	*Buteo regalis*	S1	0	0	1	1	1	1
grasshopper sparrow	*Ammodramus savannarum*	S1	1	1	0	0	1	1
sharp-tailed grouse	*Tympanuchus phasianellus*	S2	0	0	1	1	1	1
willet	*Catoptrophorus semipalmatus*	S1	1	1	0	0	1	1
Total	**13 Species**		**52**	**78**	**15**	**16**	**67**	**94**

S1 = critically imperiled; S2= imperiled (Data from NDGFD 2004).

Table 7. Incidental wildlife observed while conducting all surveys at the Glacier Ridge Wind Project, July 16, 2009 – June 25, 2010.

Species	Scientific Name	#grps	# obs
snow goose	*Chen caerulescens*	2	1,400
Lapland longspur	*Calcarius lapponicus*	1	100
double-crested cormorant	*Phalacrocorax auritus*	1	15
red-tailed hawk	*Buteo jamaicensis*	12	13
northern harrier	*Circus cyaneus*	9	10
American kestrel	*Falco sparverius*	6	7
great horned owl	*Bubo virginianus*	2	3
Swainson's hawk	*Buteo swainsoni*	3	3
rough-legged hawk	*Buteo lagopus*	2	2
black-billed cuckoo	*Coccyzus erythropthalmus*	1	1
Canada goose	*Branta canadensis*	1	1
ferruginous hawk	*Buteo regalis*	1	1
Say's phoebe	*Sayornis saya*	1	1
sharp-tailed grouse	*Tympanuchus phasianellus*	1	1
yellow-rumped warbler	*Dendroica coronata*	1	1
Bird Total	**15 Species**	**44**	**1,559**
white-tailed deer	*Odocoileus virginianus*	3	4
badger	*Taxidea taxus*	1	1
coyote	*Canis latrans*	1	1
Mammal Total	**3 Species**	**5**	**6**

Table 8. Wind energy facilities in North America with fatality data for raptor species, grouped by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality[B]	No. of Turbines	Total MW
Glacier Ridge, ND	0.33	-	-	-
Midwest				
NPPD Ainsworth, NE		0.06	36	59.4
Wolfe Island, Ont.		0.04	86	197.8
Buffalo Ridge, MN	0.64	0.02	281	210.75
Blue Sky Green Field, WI		0	88	145
Western				
Diablo Winds, CA	2.16	0.87	31	20
SMUD, CA		0.53		15
High Winds, CA	2.34	0.39	90	162
Leaning Juniper, OR	0.52	0.21	67	100.5
Big Horn, WA	0.51	0.15	133	199.5
Hopkins Ridge, WA	0.70	0.14	83	150
Klondike II, OR	0.50	0.11	50	75
Stateline, OR/WA (2002)	0.23	0.09	454	300
Stateline, OR/WA (2003)	0.21	0.09	454	300
Wild Horse, WA	0.29	0.09	127	229
Klondike III, OR		0.06	122	375
Zintel, WA	0.43	0.05	38	50
Nine Canyon, WA		0.05	37	48
Marengo II, WA		0.05	39	70.2
Biglow Canyon I, WA (2009)		0.04	76	125.4
Biglow Canyon I, WA (2008)		0.03	76	125.4
Combine Hills, OR	0.75	0	41	41
Vansycle, OR	0.66	0	38	24.9
Klondike, OR	0.50	0	16	24
Marengo I, WA		0	78	140.4
Dillon, CA		0	45	45
Rocky Mountains				
Summerview, Alb. (2005/2006)		0.11	39	70.2
Judith Gap, MT		0.09	90	135
Foote Creek Rim, WY (Phase I; 1999)		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				
Buffalo Gap, TX		0.10	67	134

Table 8. Wind energy facilities in North America with fatality data for raptor species, grouped by geographic region.

Wind Energy Facility	Use Estimate[A]	Raptor Fatality[B]	No. of Turbines	Total MW
		Northeastern		
Noble Ellenburg, NY (2009)		0.49	54	80
Noble Ellenburg, NY (2008)		0.32	54	80
Noble Clinton, NY (2008)		0.29	67	100.5
Maple Ridge, NY (2007)		0.25	195	321.75
Noble Clinton, NY (2009)		0.24	67	100
Noble Bliss, NY (2008)		0.19	67	100
Noble Bliss, NY (2009)		0.18	67	100
Maple Ridge, NY (2006)		0.04	120	198
Buffalo Mountain, TN (2006)		0	18	29
Buffalo Mountain, TN (2000-2003)		0	3	1.98
Mount Storm, WV (2008)		0	82	164

A=number of raptors/plot/20min survey
B=number of fatalities/MW/year
Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
NPPD Ainsworth, NE		Derby et al. 2007	Vansycle, OR	WCIA and WEST 1997	Erickson et al. 2000
Wolfe Island, Ont.		Stantec Ltd. 2010	Klondike, OR	Johnson et al. 2002a	Johnson et al. 2003
Buffalo Ridge, MN	Erickson et al. 2002b	Erickson et al. 2002b	Marengo I, WA		URS Corporation 2010a
Blue Sky Green Field, WI		Gruver et al. 2009	Dillon, CA		Chatfield et al. 2009
Diablo Winds, CA	WEST 2006	WEST 2008	Summerview, Alb. (05/06)		Brown and Hamilton 2006
SMUD, CA		URS et al. 2005	Judith Gap, MT		TRC 2008
High Winds, CA	Kerlinger et al. 2005	Kerlinger et al. 2006	Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003c
Leaning Juniper, OR	Kronner et al. 2005	Gritski et al. 2008	Foote Creek Rim, WY (Phase I; 00)		Young et al. 2003c
Big Horn, WA	Johnson and Erickson 2004	Kronner et al. 2008	Foote Creek Rim, WY (Phase I; 01/02)		Young et al. 2003c
Hopkins Ridge, WA	Young et al. 2003a	Young et al. 2007a	Buffalo Gap, TX		Tierney 2007
Klondike II, OR	Johnson 2004	NWC and WEST 2007	Noble Ellensburg, NY (09)		Jain et al. 2010c
Stateline, OR/WA (02)	Erickson et al. 2002b	Erickson et al. 2004b	Noble Ellensburg, NY (08)		Jain et al. 2009a
Stateline, OR/WA (03)	Erickson et al. 2003b	Erickson et al. 2004b	Noble Clinton, NY (08)		Jain et al. 2009b
Wild Horse, CA	Erickson et al. 2003d	Erickson et al. 2008	Maple Ridge, NY (07)		Jain et al. 2008
Klondike III, OR		Gritski et al. 2009	Noble Clinton, NY (09)		Jain et al. 2010b
Zintel, WA	Erickson et al. 2002a	Erickson et al. 2008	Noble Bliss, NY (08)		Jain et al. 2009c
Nine Canyon, WA	Erickson et al. 2001b	Erickson et al. 2003c	Noble Bliss, NY (09)		Jain et al. 2010a
Marengo II, WA		URS Corporation 2010b	Maple Ridge, NY (06)		Jain et al. 2007
Biglow Canyon I, WA (09)		Enk et al. 2010	Buffalo Mountain, TN (06)		Fiedler et al. 2007
Biglow Canyon I, WA (08)		Jeffrey et al. 2009	Buffalo Mountain, TN (00-03)		Nicholson 2003, 2005
Combine Hills, OR	Young et al. 2003d	Young et al. 2006	Mount Storm, WV (08)		Young et al. 2009

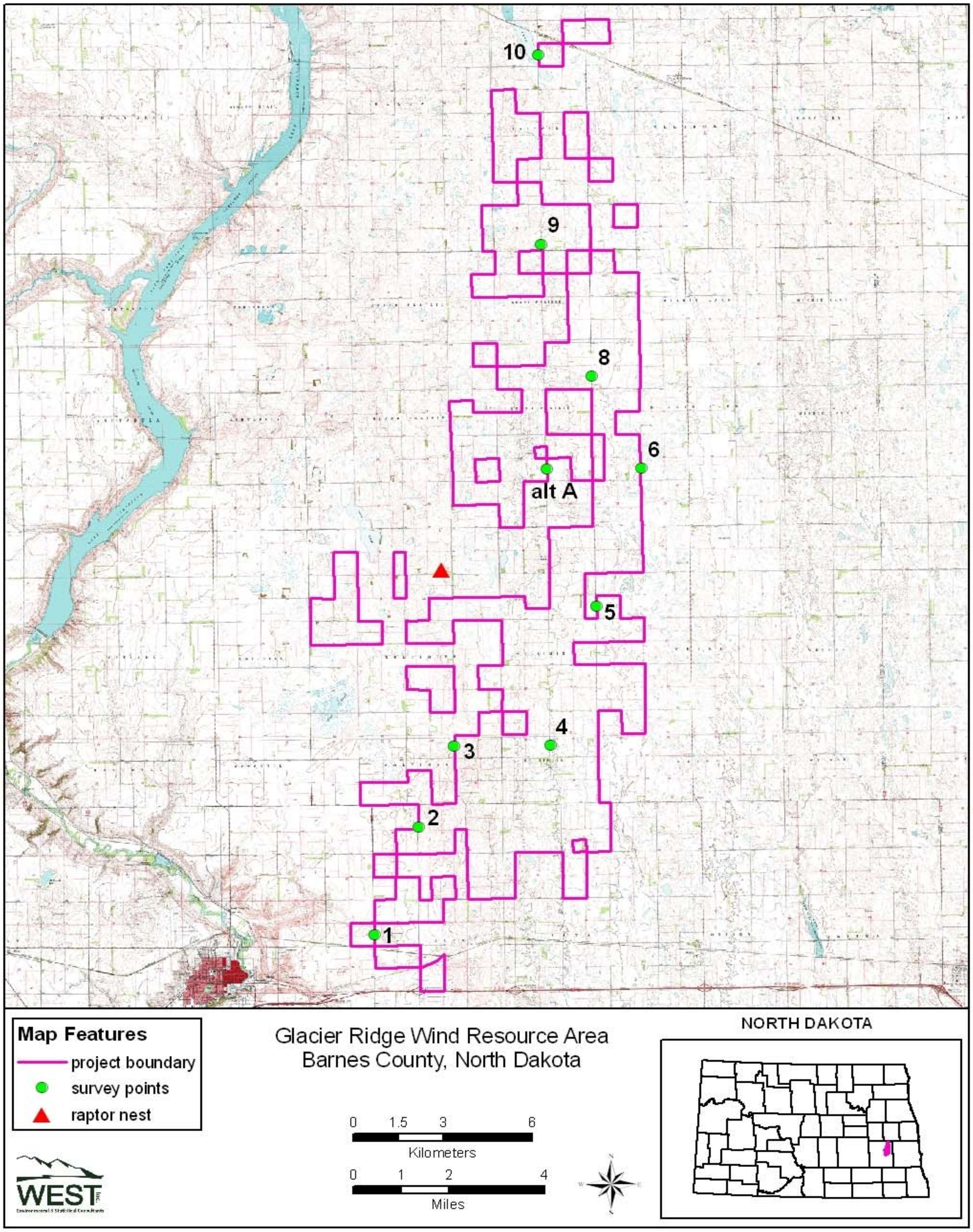


Figure 1. Location of the Glacier Ridge Wind Project.

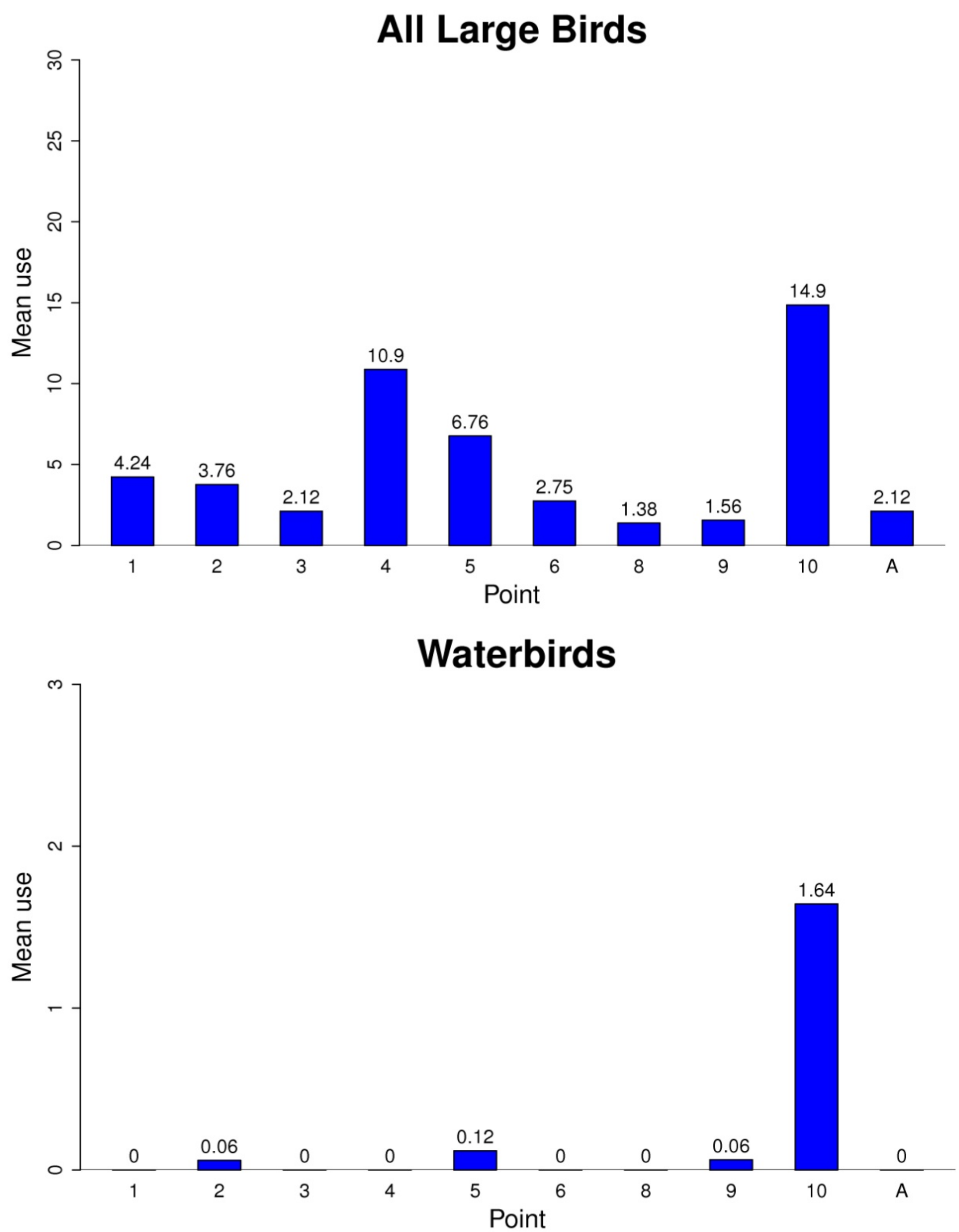


Figure 2. Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.

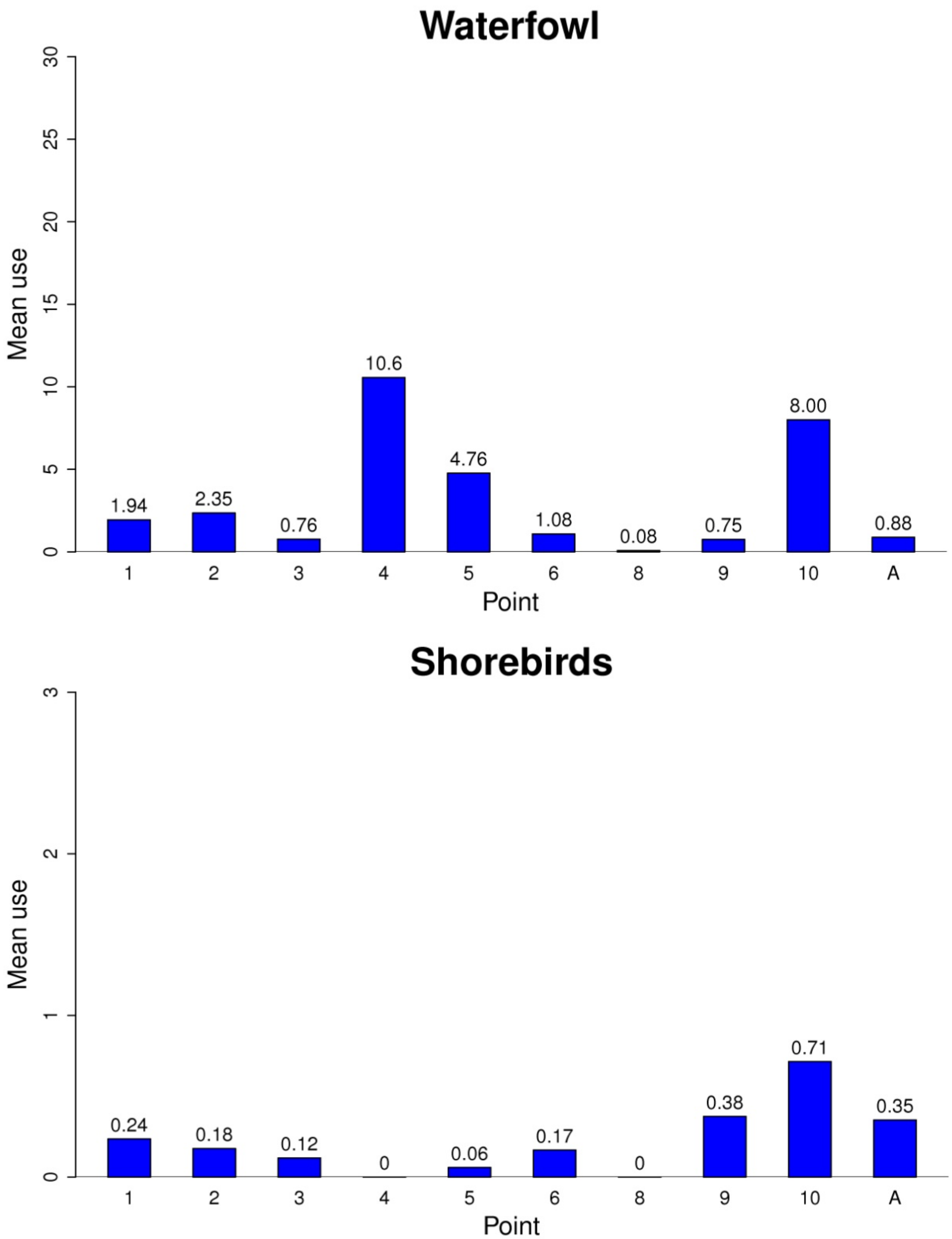
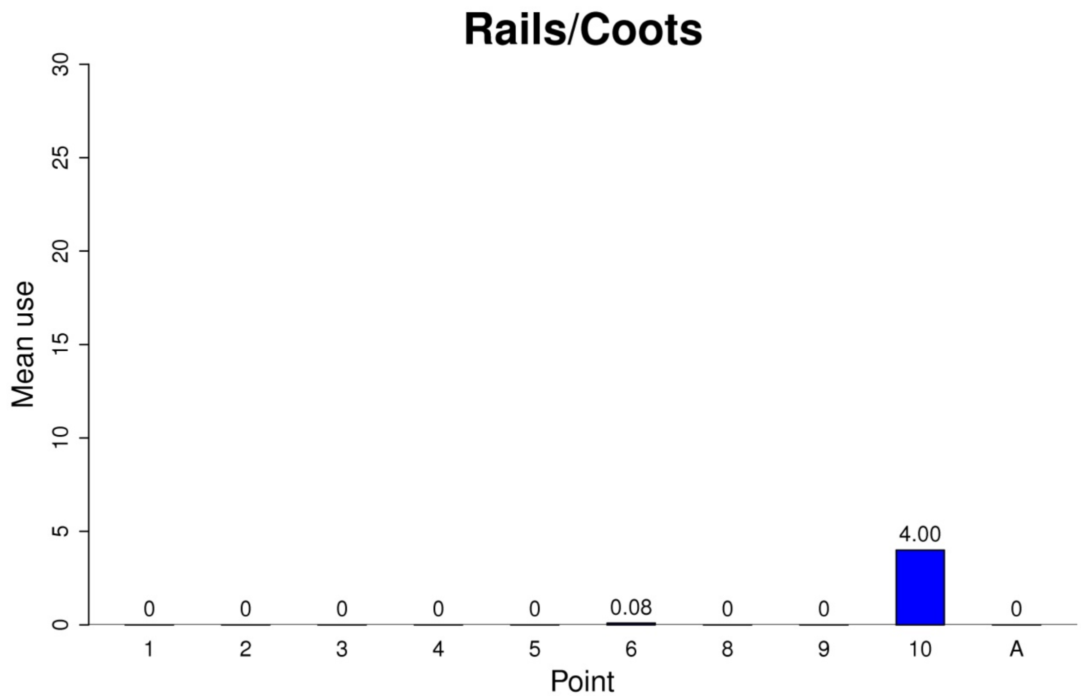


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.



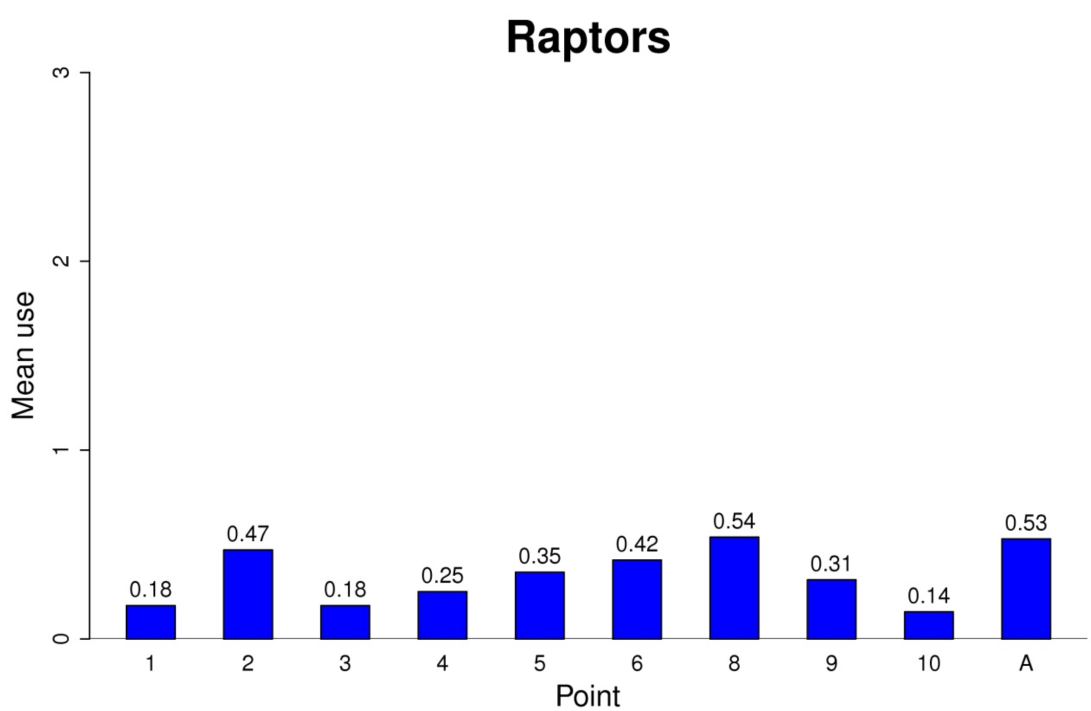


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.

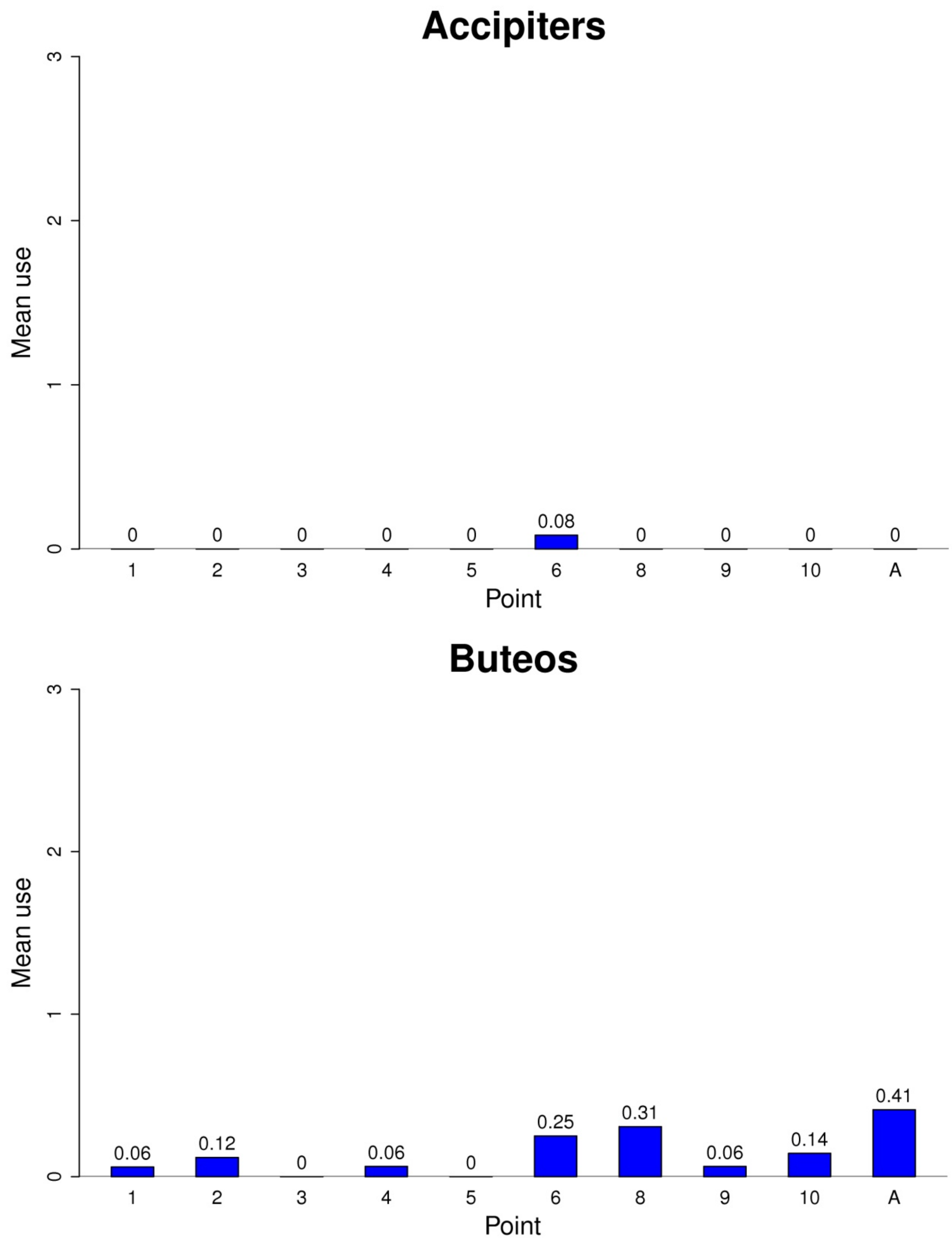
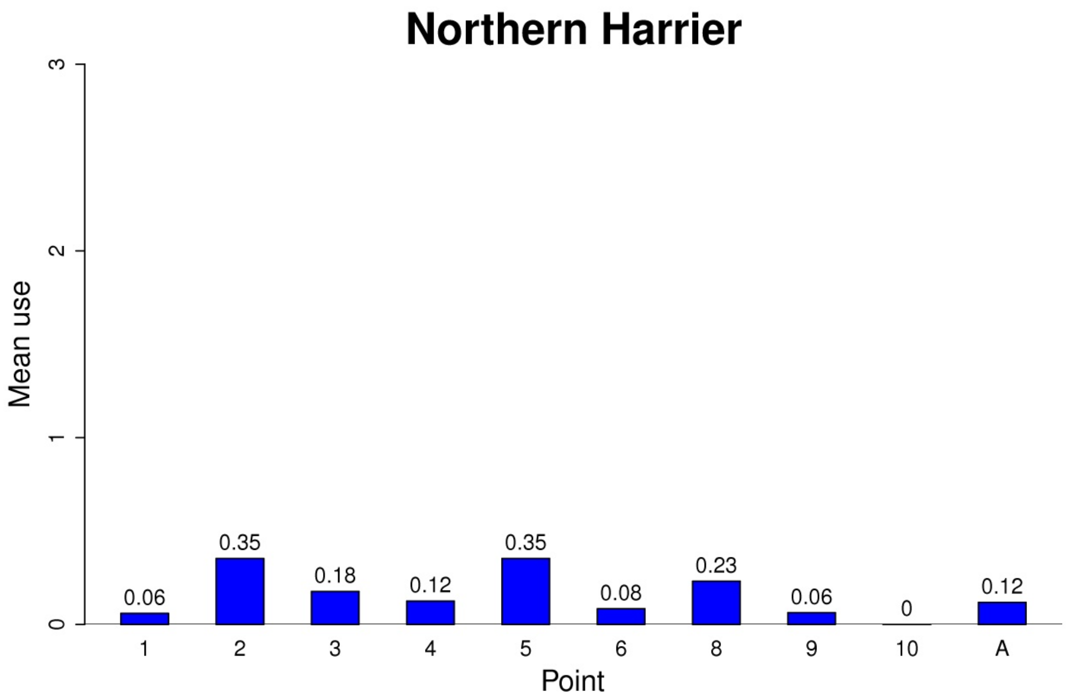


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.



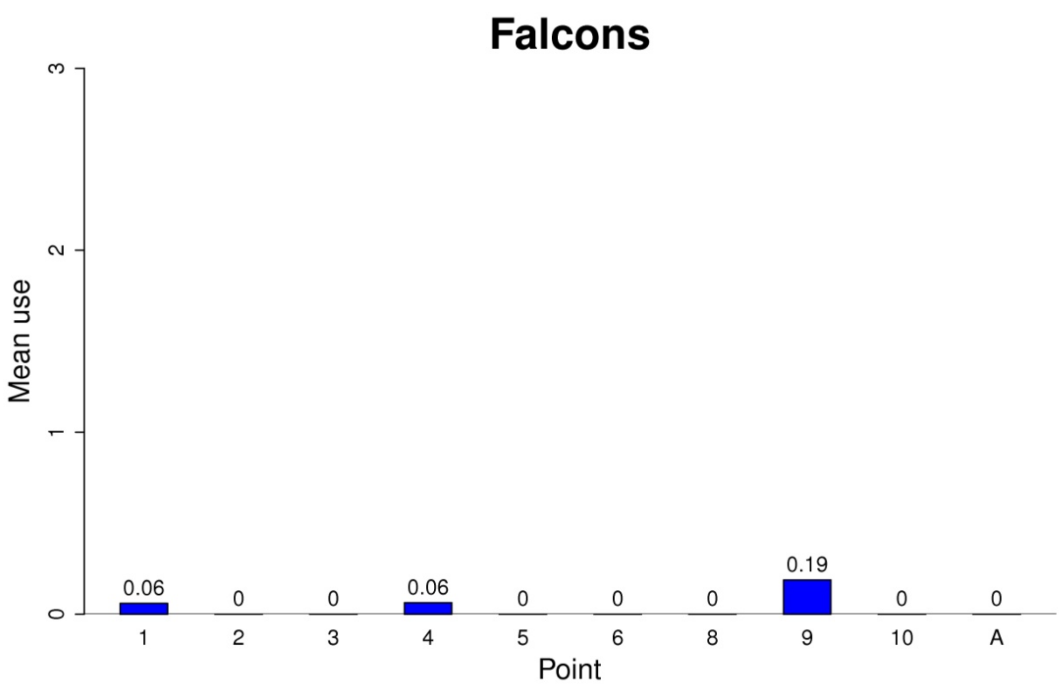
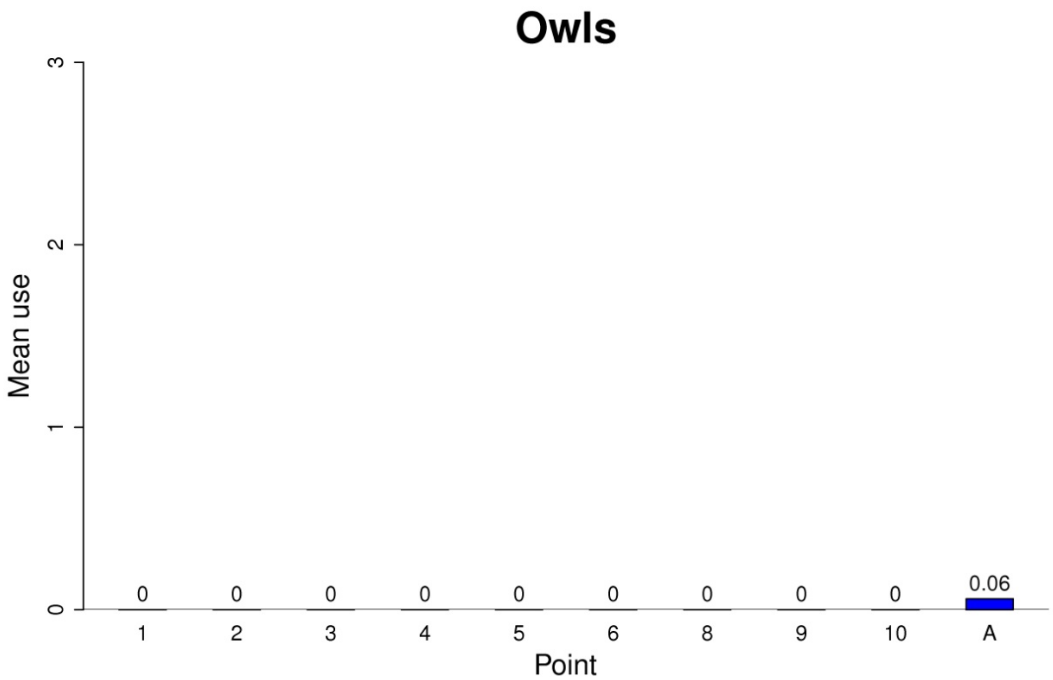


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.



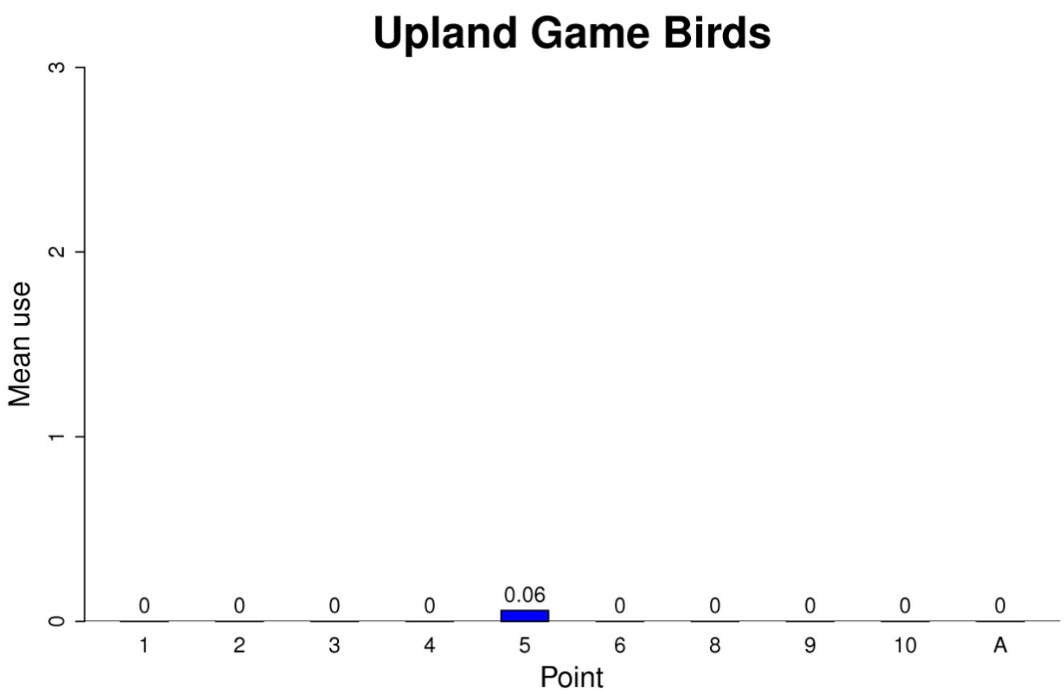
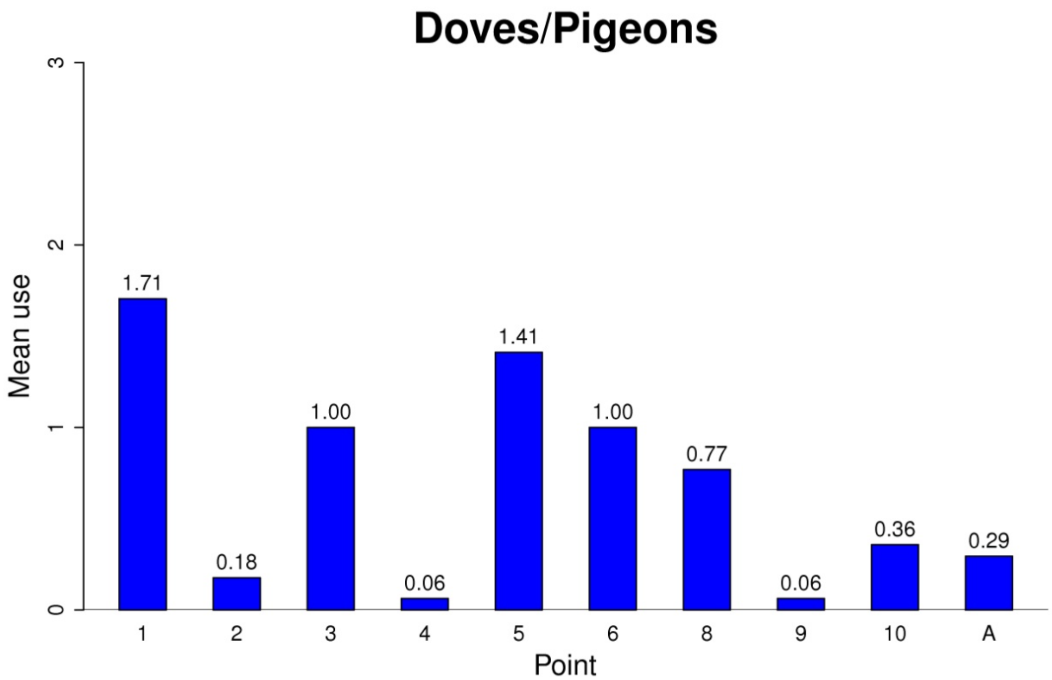


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.



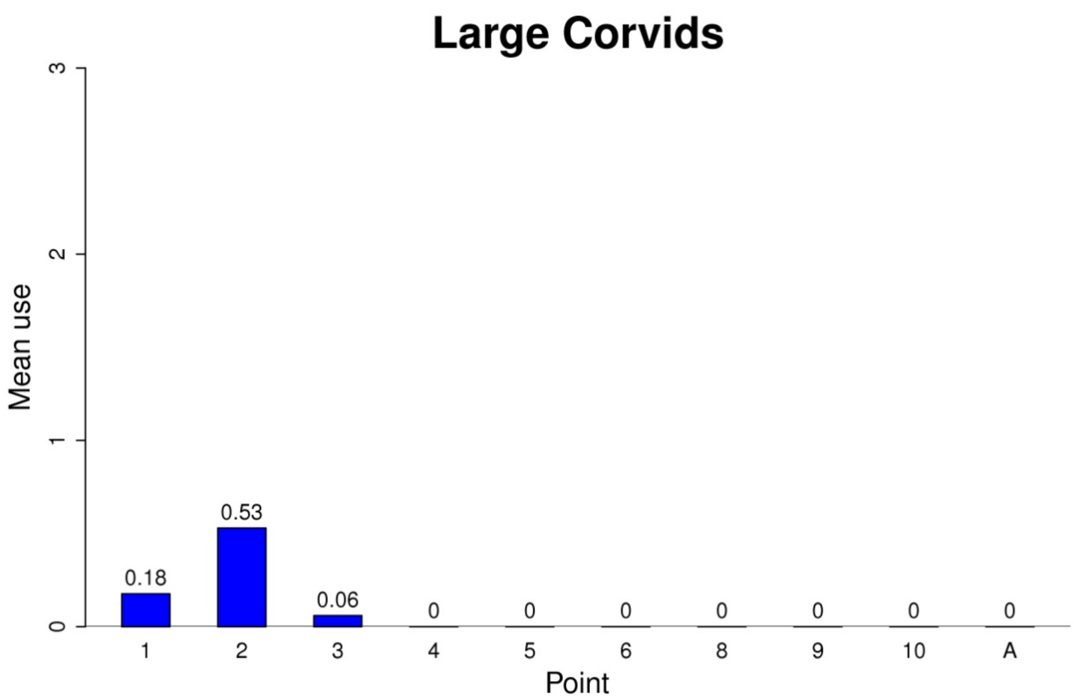


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project.

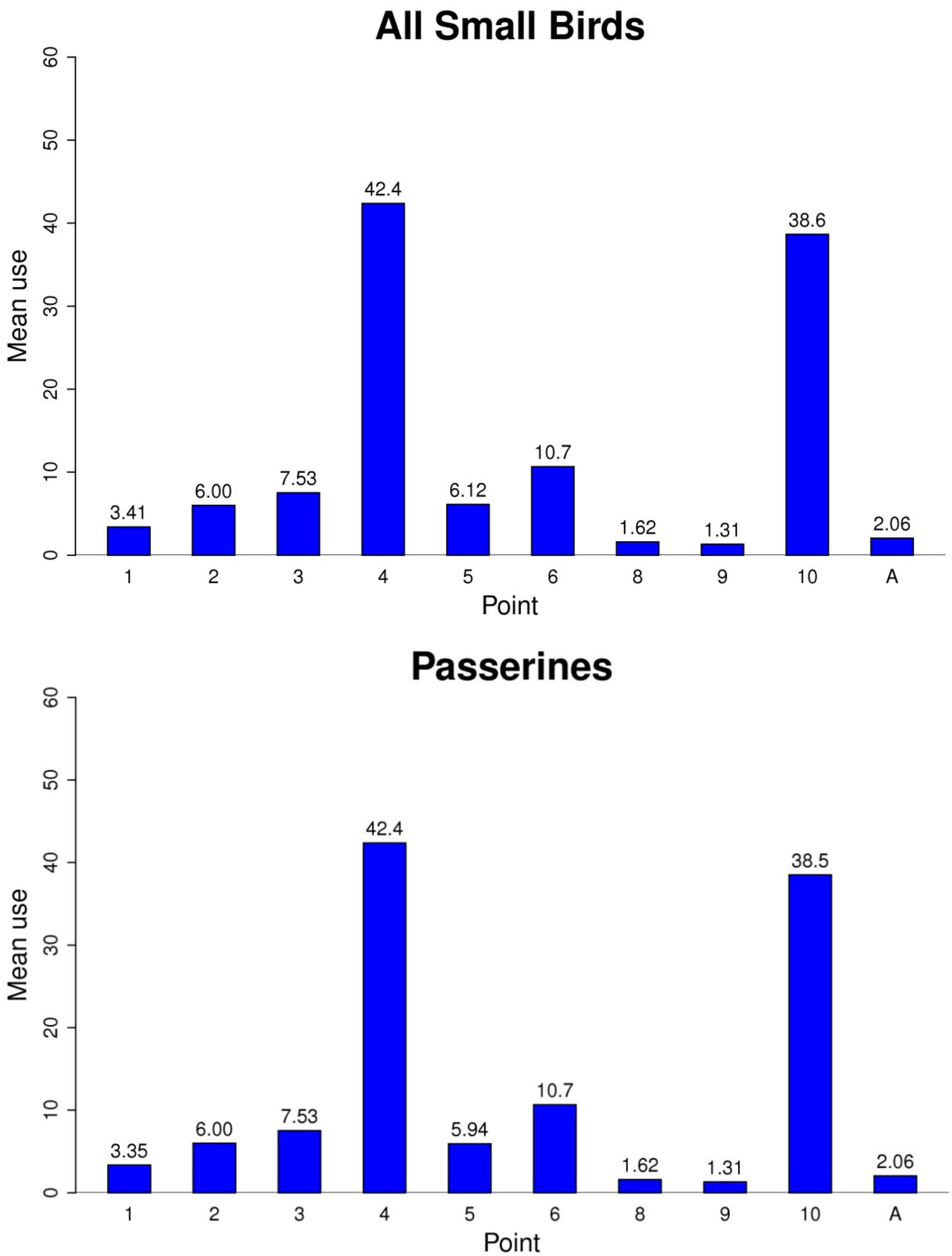


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project. Observations of passerines and other small birds were focused within 100-m viewsheds.

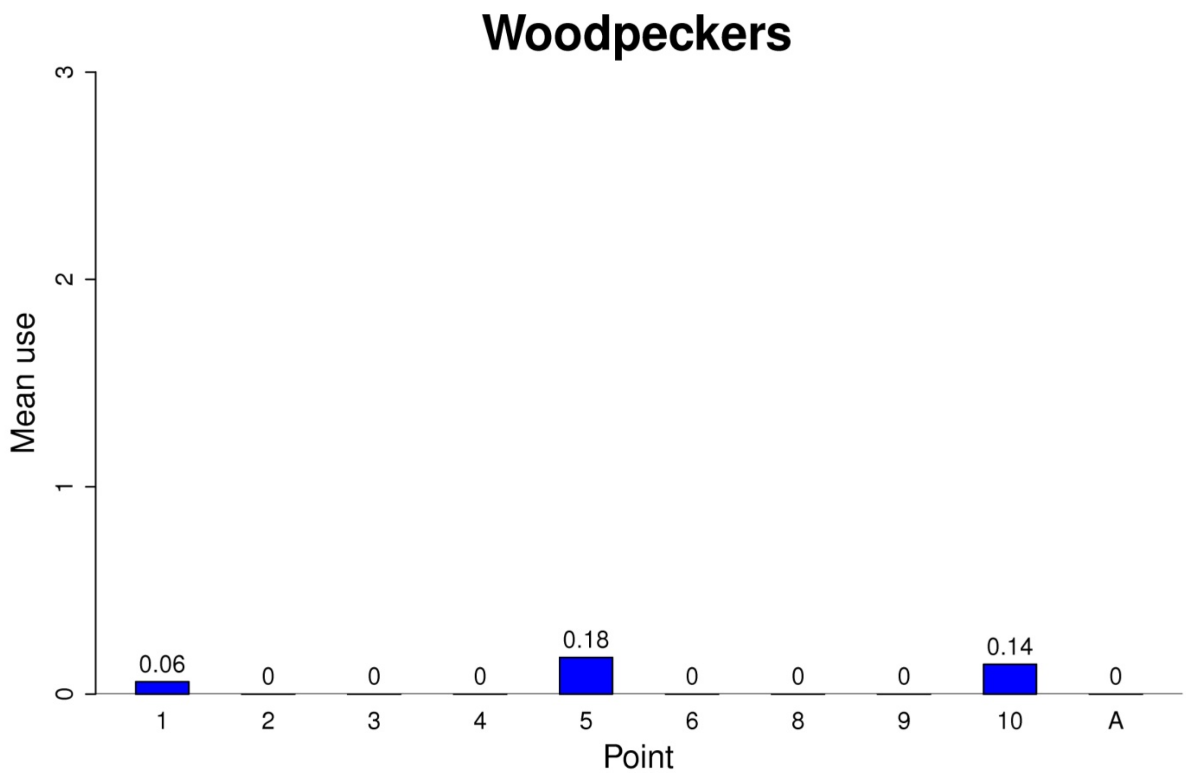


Figure 2 (*continued*). Mean use (number of birds/20-min survey) at each fixed-point bird use survey point for all birds and major bird types at the Glacier Ridge Wind Project. Observations of passerines and other small birds were focused within 100-m viewsheds.

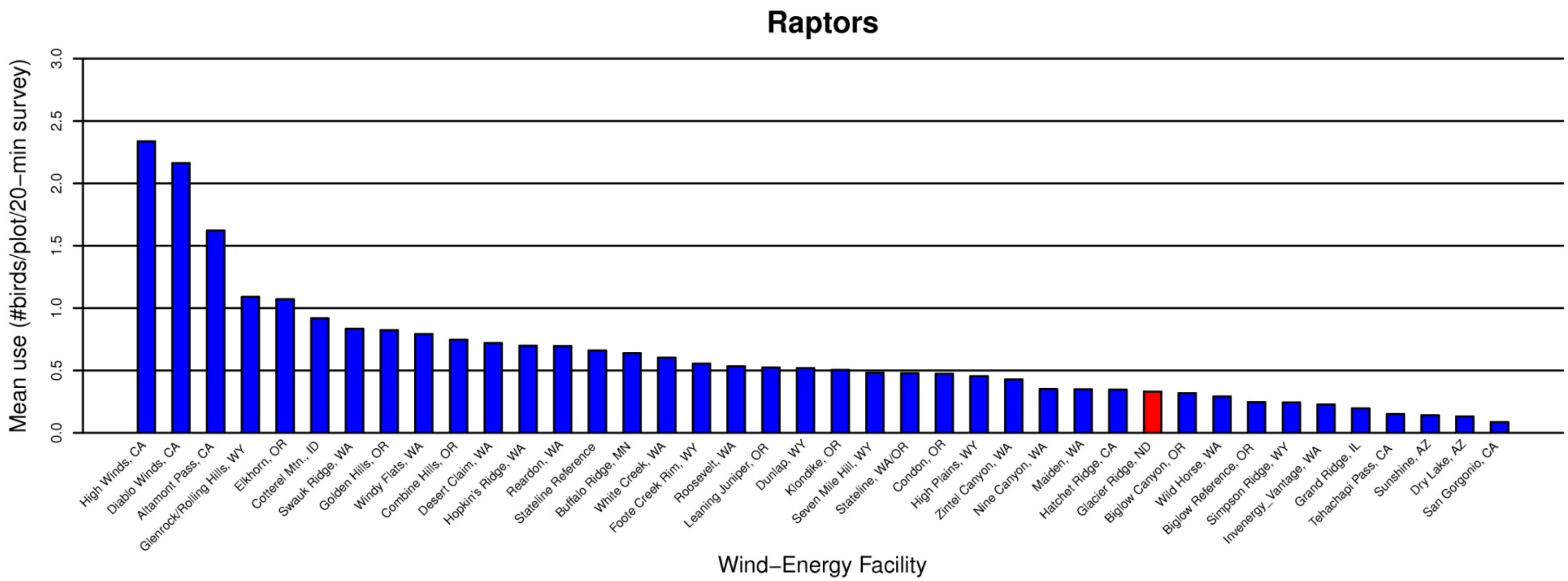
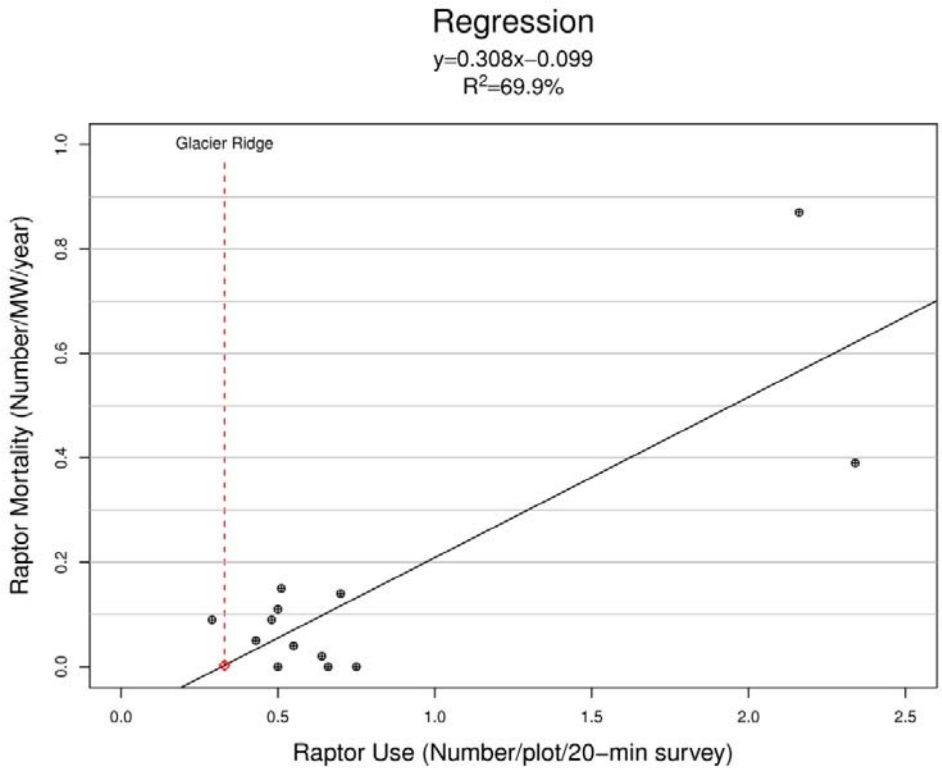


Figure 3. Comparison of annual raptor use between the Glacier Ridge Wind Project and other US wind energy facilities.

Data from the following sources:

Glacier Ridge, ND	This study.				
High Winds, CA	Kerlinger et al. 2005	Stateline Reference	URS et al. 2001	Nine Canyon, WA	Erickson et al. 2001b
Diablo Winds, CA	WEST 2006	Buffalo Ridge, MN	Erickson et al. 2002b	Maiden, WA	Erickson et al. 2002b
Altamont Pass, CA	Erickson et al. 2002b	White Creek, WA	NWC and WEST 2005	Hatchet Ridge, CA	Young et al. 2007b
Glenrock/Rolling Hills, WY	Johnson et al. 2008a	Foote Creek Rim, WY	Erickson et al. 2002b	Biglow Canyon, OR	WEST 2005c
Elkhorn, OR	WEST 2005a	Roosevelt, WA	NWC and WEST 2004	Wild Horse, WA	Erickson et al. 2003d
Cotterel Mtn., ID	BLM 2006	Leaning Juniper, OR	Kronner et al. 2005	Biglow Reference, OR	WEST 2005c
Swauk Ridge, WA	Erickson et al. 2003a	Dunlap, WY	Johnson et al. 2009a	Simpson Ridge, WY	Johnson et al. 2000b
Golden Hills, OR	Jeffrey et al. 2008	Klondike, OR	Johnson et al. 2002a	Invenergy_Vantage, WA	WEST 2007
Windy Flats, WA	Johnson et al. 2007	Seven Mile Hill, WY	Johnson et al. 2008b	Grand Ridge, IL	Derby et al. 2009
Combine Hills, OR	Young et al. 2003d	Stateline, WA/OR	Erickson et al. 2002b	Tehachapi Pass, CA	Erickson et al. 2002b
Desert Claim, WA	Young et al. 2003b	Condon, OR	Erickson et al. 2002b	Sunshine, AZ	WEST and the CPRS 2006
Hopkin's Ridge, WA	Young et al. 2003a	High Plains, WY	Johnson et al. 2009b	Dry Lake, AZ	Young et al. 2007c
Reardon, WA	WEST 2005b	Zintel Canyon, WA	Erickson et al. 2002a	San Gorgonio, CA	Erickson et al. 2002b



Overall Raptor Use 0.33
Predicted Fatality Rate <0.01/MW/year
90.0% Prediction Interval (0, 0.26/MW/year)

Figure 4. Regression analysis comparing raptor use estimations versus estimated raptor mortality.

Data from the following sources:

Study and Location	Raptor Use (birds/plot /20-min survey)	Source	Raptor Mortality (fatalities/MW/yr)	Source
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003d	0.00	Young et al. 2006
Diablo Winds, CA	2.161	WEST 2006	0.87	WEST 2008
Foote Creek Rim, WY	0.55	Johnson et al. 2000b	0.04	Young et al. 2003c
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge, WA	0.70	Young et al. 2003a	0.14	Young et al. 2007a
Klondike II, OR	0.50	Johnson 2004	0.11	NWC and WEST 2007
Klondike, OR	0.50	Johnson et al. 2002a	0.00	Johnson et al. 2003
Stateline, WA/OR	0.48	Erickson et al. 2004b	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2000
Wild Horse, WA	0.29	Erickson et al. 2003d	0.09	Erickson et al. 2008
Zintel, WA	0.43	Erickson et al. 2002a	0.05	Erickson et al. 2002b
Bighorn, WA	0.51	Johnson and Erickson 2004	0.15	Kronner et al. 2008

ENVIRONMENTAL & STATISTICAL CONSULTANTS
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June 28, 2016

Sean Flannery
Glacier Wind Farm, LLC
330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401 USA

RE: Glacier Ridge Winter/Spring Eagle/Avian Use Survey Summary

Dear Mr. Flannery,

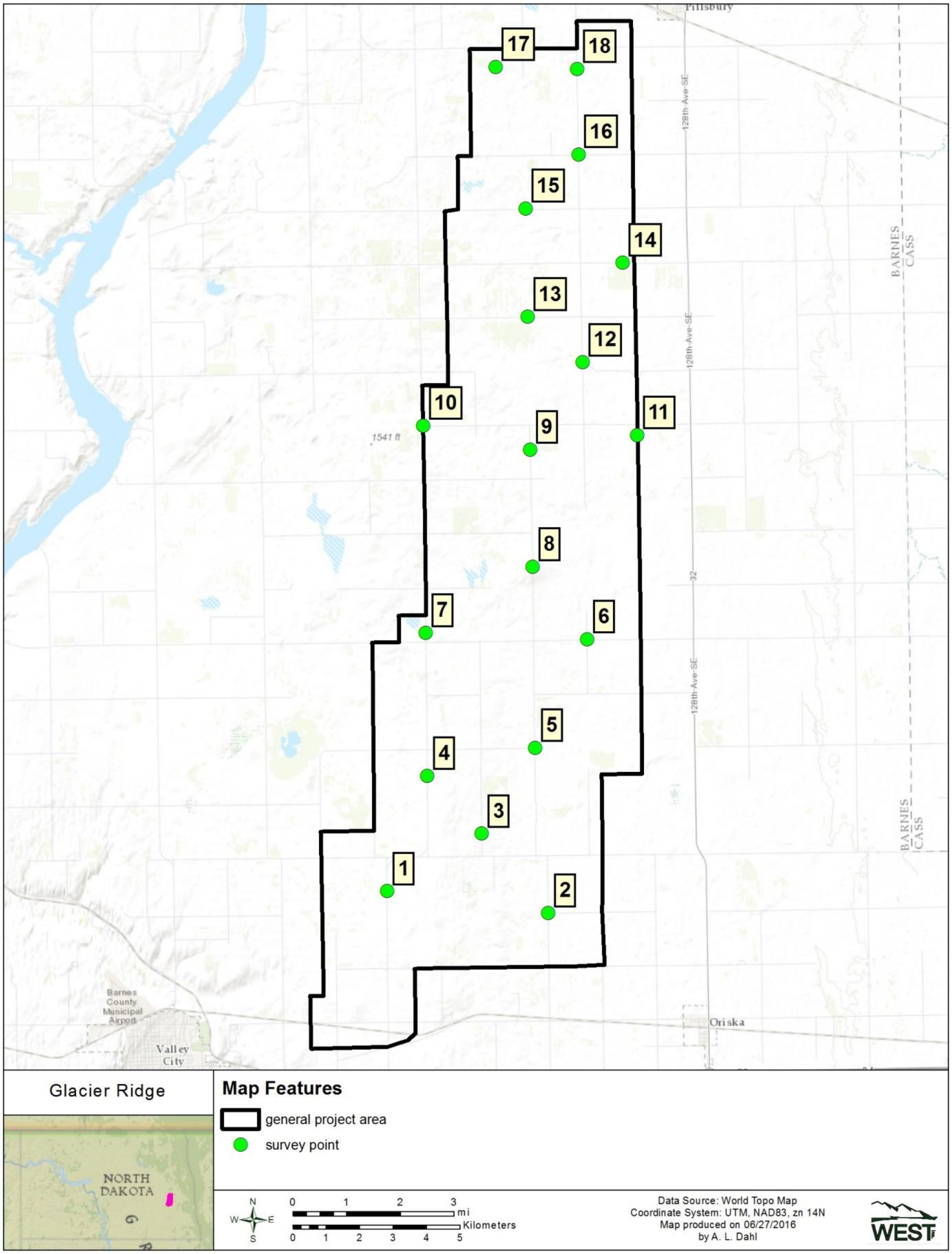
Western EcoSystems Technology, Inc. (WEST) is completed the winter/spring eagle/avian use survey for the Glacier Ridge Wind Project (Project) located in eastern North Dakota. The use survey was completed following the study plan, as discussed and agreed upon with the North Dakota Game and Fish Department on April 28, 2016, and as provided to the US Fish and Wildlife Service for their review. The use survey consisted of 18 survey points (see attached figure), each with an 800-m survey radius, to achieve approximately 30% spatial coverage of the Project to meet the survey level recommended in the USFWS Eagle Conservation Plan Guidance[1].

The winter/spring use survey period was defined as February to May 2016. During this time period, WEST completed 68 hours of survey; a few points were inaccessible periodically due to winter road conditions. Surveys were completed one time per month at each point. Five adult bald eagles were recorded throughout the survey period. One bald eagle was observed at Point 16 on February 24, 2016, three total eagles were observed at Point 1, 3, and 5 on March 10, 2016, and one eagle was observed March 24, 2016 at point 10. Two eagle flight minutes were recorded within the defined 800-m survey radius and below 200-m in flight height. Bald eagles were observed incidentally on three occasions: one eagle on March 24 and three eagles on March 25. The bald eagle and Swainson's hawk are listed on the Birds of Conservation Concern list for the Prairie Pothole Region and were recorded in the Project. Data from this study suggest low levels of winter/spring bald eagle use in the Project area.

Sincerely,

Clayton Derby
Senior Manager

[1] US Fish and Wildlife Service (USFWS). 2013. Eagle Conservation Plan Guidance. Module 1 - Land-Based Wind Energy. Version 2. Division of Migratory Bird Management, USFWS. April 2013. Available online at: http://www.fws.gov/migratorybirds/Eagle_Conservation_Plan_Guidance-Module%201.pdf



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Glacier Ridge
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Map Features
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Data Source: World Topo Map
Coordinate System: UTM, NAD83, zn 14N
Map produced on 06/27/2016
by A. L. Dahl
WEST

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June 28, 2016

Sean Flannery
Glacier Ridge Wind Farm, LLC
330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401 USA

RE: Glacier Ridge Wind Energy Project Raptor Nest Survey

Dear Mr. Flannery,

As part of Tier 3 baseline survey efforts for the Glacier Ridge Wind Energy Project (Project), one aerial raptor nest survey was conducted on April 5 - 7, 2016, by a biologist from Western EcoSystems Technology, Inc. (WEST). The aerial survey was completed using a helicopter before trees had leaves and when most raptors would be actively tending to a nest or incubating eggs, and was conducted in accordance with the guidance provided in the U.S. Fish and Wildlife Service Inventory and Monitoring Protocols[1].

Aerial raptor nest surveys focused on locating large, stick nest structures, in suitable nesting substrates (trees, transmission lines, cliff faces, etc.); raptors are defined here as, accipiters, buteos, falcons, harriers, kites, owls, and eagles. Non-eagle raptor nests were recorded within the Project area and associated 1-mile (mi) buffer; eagle nests were recorded within the Project area and associated 10-mi buffer (Figure 1). The total surveyed area of 542,943.8 acres (ac; 219,721 hectares [ha]) included the Project area and the 1-mi and 10-mi buffers. To the greatest extent possible, care was taken to minimize disturbance to raptors at nest sites during surveys. Photographs were taken of eagle nests and potential eagle nests and are available to you upon request.

In general, all potential eagle and raptor nest habitat was surveyed by flying meandering transects at speeds of 60-75 mph, throughout the proposed Project and associated buffers. Surveys were conducted during daylight hours. All potential and confirmed raptor nests detected during surveys, regardless of their activity status, were assigned a unique identification number and their locations were

[1] Pagel, J.E., D.M. Whittington, and G.T. Allen. 2010. Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance. US Fish and Wildlife Service (USFWS). February 2010. Available online at: http://steinadlerschutz.lbv.de/fileadmin/www.steinadlerschutz.de/terimGoldenEagleTechnicalGuidanceProtocols25March2010_1_.pdf

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recorded using a hand-held Global Positioning System (GPS); coordinates were set at Universal Transverse Mercator (UTMs) North American Datum (NAD) 83 unit. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or whitewash. Raptor species, nest type, nest status, nest condition, and substrate, were recorded at each nest location to the extent possible.

In addition, information on known historic eagle nests within the area of interest was gathered from the North Dakota Game and Fish Department (NDGFD); these historic nest locations were surveyed for nest status and condition.

Nest status was categorized consistent with definitions in the USFWS Eagle Conservation Plan Guidance.[2] Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position; (2) eggs; (3) nestlings or fledglings; (4) occurrence of a pair of adults (or, sometimes sub-adults); (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor was observed or had been observed early in the breeding season; or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs had been laid or nestlings were observed, or inactive if no eggs or chicks were present. A nest that did not meet the above criteria for “occupied” was classified as “unoccupied”.

A total of 36 raptor nests representing three species were documented during the aerial survey conducted within the Glacier Ridge Wind Energy Project and associated buffers; raptor nest Unique ID (ID), locations (NAD83, Zone 14), and nest features are shown in Table 1. The identified nests were categorized as follows: three occupied bald eagle (*Haliaeethus leucocephalus*) nests (two of which were also historical nests), 11 occupied great-horned owl (*Bubo virginianus*) nests, one occupied red-tailed hawk (*Buteo jamaicensis*) nest, and 21 unoccupied unknown raptor nests. Two additional occupied bald eagle nests (GR-09 and GR-38) were located outside the 10-mi buffer (Figure 1, Table 1).

If you have any questions or require additional information, please call me at 701-250-1756.

Sincerely,

Clayton Derby
CSO / Wildlife Biologist

[2] US Fish and Wildlife Service (USFWS). 2013. Eagle Conservation Plan Guidance. Module 1 - Land-Based Wind Energy. Version 2. Division of Migratory Bird Management, USFWS. April 2013. Available online at: http://www.fws.gov/migratorybirds/Eagle_Conservation_Plan_Guidance-Module%201.pdf

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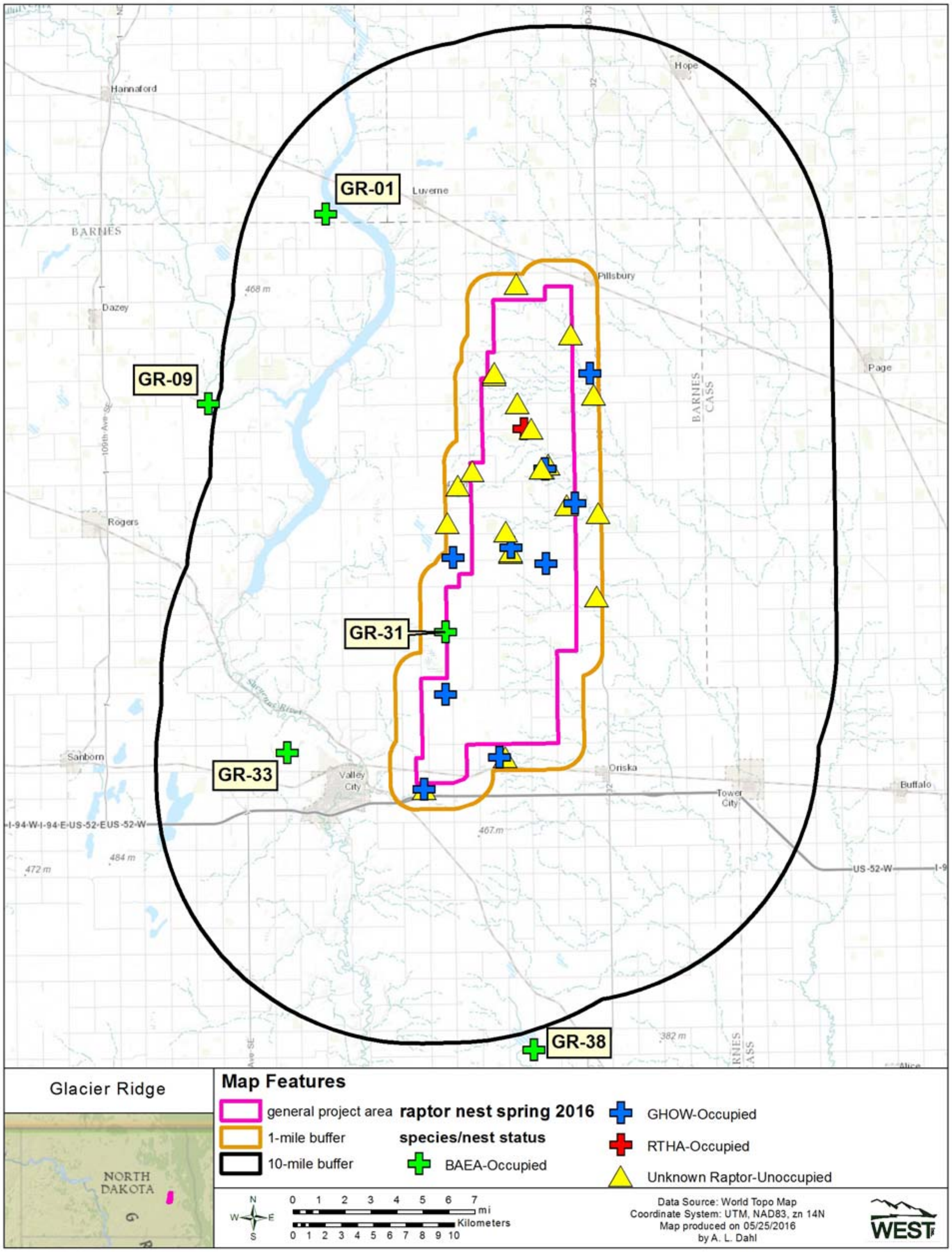

Figure 1. Locations of raptor nests recorded during the aerial survey conducted in April 2016 within the Glacier Ridge Wind Energy Project, Barnes County, North Dakota, and associated buffers.

ENVIRONMENTAL & STATISTICAL CONSULTANTS

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Table 1. Raptor nests identified during the aerial survey conducted in April 2016 within the Glacier Ridge Wind Project, Barnes County, North Dakota, and associated buffers.

ID	Species[1]	Easting	Northing	Status at time of survey	Condition	Substrate
GR-01*,**	BAEA	574792	5232920	occupied	excellent	tree
GR-02	UNRA	586594	5228596	unoccupied	poor	tree
GR-03	UNRA	589982	5225474	unoccupied	good	tree
GR-04	UNRA	585250	5223086	unoccupied	good	tree
GR-05	UNRA	585238	5222955	unoccupied	good	tree
GR-06	GHOW	591137	5223072	occupied	excellent	tree
GR-07	UNRA	586662	5221212	unoccupied	good	tree
GR-08	UNRA	591400	5221742	unoccupied	good	tree
GR-09*	BAEA	567550	5221195	occupied	excellent	tree
GR-10	RTHA	587083	5219631	occupied	good	tree
GR-11	UNRA	587544	5219647	unoccupied	good	tree
GR-12	UNRA	583889	5216998	unoccupied	poor	tree
GR-13	UNRA	588598	5217415	unoccupied	good	tree
GR-14	UNRA	588156	5217181	unoccupied	fair	tree
GR-15	UNRA	588255	5217164	unoccupied	poor	tree
GR-16	GHOW	588376	5217168	occupied	good	tree
GR-17	GHOW	588403	5217144	occupied	good	tree
GR-18	UNRA	582994	5216112	unoccupied	good	tree
GR-19	UNRA	589721	5214899	unoccupied	excellent	tree
GR-20	GHOW	590210	5215029	occupied	good	tree
GR-21	UNRA	591668	5214427	unoccupied	fair	tree
GR-22	UNRA	582353	5213796	unoccupied	fair	tree
GR-23	UNRA	585964	5213284	unoccupied	good	tree
GR-24	GHOW	586269	5212295	occupied	good	tree
GR-25	GHOW	586269	5212273	occupied	good	tree
GR-26	UNRA	586263	5212025	unoccupied	good	tree
GR-27	UNRA	586258	5211935	unoccupied	good	tree
GR-28	GHOW	582693	5211676	occupied	excellent	tree
GR-29	GHOW	588426	5211309	occupied	good	tree
GR-30	UNRA	591587	5209269	unoccupied	fair	tree
GR-31*	BAEA	582220	5207062	occupied	excellent	tree
GR-32	GHOW	582228	5203191	occupied	excellent	tree
GR-33*,**	BAEA	572407	5199596	occupied	excellent	tree
GR-34	GHOW	585566	5199309	occupied	excellent	tree
GR-35	UNRA	585922	5199296	unoccupied	good	tree
GR-36*	GHOW	580880	5197315	occupied	excellent	tree

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Table 1. Raptor nests identified during the aerial survey conducted in April 2016 within the Glacier Ridge Wind Project, Barnes County, North Dakota, and associated buffers.

ID	Species[1]	Easting	Northing	Status at time of survey	Condition	Substrate
GR-37	UNRA	580934	5197313	unoccupied	fair	tree
GR-38	BAEA	587699	5181199	occupied	excellent	tree

[1] BAEA: bald eagle (*Haliaeethus leucocephalus*), GHOW: great-horned owl (*Bubo virginianus*), RTHA: red-tailed hawk (*Buteo jamaicensis*), UNRA: Unknown raptor species.

* denotes potential eagle nest, ** denotes historical nest

Raptor and Eagle Nest Survey Results for the Glacier Ridge Wind Resource Area Barnes County, North Dakota

Final Report

May 2012

Glacier Ridge Wind LLC
12 South 6th Street, Suite 930
Minneapolis, Minnesota 55402

Prepared by:

Kristen Chodachek

Western EcoSystems Technology, Inc.
4007 State Street, Suite 109
Bismarck, North Dakota 58503

May 17, 2012

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

Glacier Ridge LLC has proposed a wind energy facility in Barnes County, North Dakota referred to as the Glacier Ridge Wind Resource Area (GRWRA). Glacier Ridge LLC contracted Western EcoSystems Technology, Inc. (WEST) to conduct raptor and eagle nest surveys for the GRWRA and respective one and ten mile buffers to estimate the impacts of facility construction and operations on wildlife. The following report contains the results of the spring 2012 raptor and eagle nest surveys conducted.

The principal objectives of this nest survey were to: 1) identify the species and estimate the density of nesting raptors in the study area, 2) estimate any potential impact to raptors that could result from construction and operation of the proposed wind-energy facility, and 3) identify potential project modifications and mitigation measures that could reduce negative impact.

The objective of the ground raptor nest survey was to locate nests that may be subject to disturbance and displacement effects from the wind-energy facility construction and operation, with a focus on eagle nests. Surveys for nests were conducted from the ground on April 11, April 12, April 13, and April 17, 2012. No raptor nests were located during 2012 surveys.

Nest density within the GRWRA, the 1-mile buffer, and between the 1-mile and 10-mile buffer was 0 in 2012, while overall nest density in the 1-mile buffer area in 2010 was 0.01 nests/mi^2 (<0.01 nests/km^2). Nesting raptor density at GRWRA and associated buffers was compared to sixteen other wind energy facilities in similar habitats, where active raptor nest density ranged from 0.03 to 0.43 nests/mi^2 (0.01 to 0.12 nests/km^2) and averaged 0.19 nests/mi^2 (0.06 nests/km^2). Nesting density within the GRWRA and associated 1-mile and 10-mile buffers were lower than average in comparison to the other wind energy facilities evaluated.

No sensitive raptor species were observed nesting within the project area or associated buffers. As no eagle nests were identified during surveys in 2010 or 2012 and no use was documented by eagles during surveys in 2010, risk to nesting eagles may be considered negligible.

STUDY PARTICIPANTS

Western EcoSystems Technology

Kristen Chodachek	Project Manager, Wildlife Biologist
Karen Seginak	Biological Technician
Ann Dahl	GIS Technician
Andrea Palochak	Technical Editor

REPORT REFERENCE

Chodachek, K. 2012. Raptor and Eagle Nest Survey Results for the Glacier Ridge Wind Resource Area, Barnes County, North Dakota. Final Report: May 2012. Prepared for Glacier Ridge Wind, LLC, Minneapolis, Minnesota. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

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INTRODUCTION

In January 2012, Glacier Ridge LLC contracted Western EcoSystems Technology, Inc. (WEST) to conduct ground raptor nest surveys, with a focus on eagles, in the Glacier Ridge Wind Resource Area (GRWRA) to estimate the impacts of wind energy facility construction and operations on nesting raptors.

The principal objectives of this raptor nest survey were to; 1) identify the species and estimate the density of nesting raptors in the study area; 2) estimate any potential impact to raptors that could result from construction and operation of the proposed wind-energy facility; and 3) identify potential project modifications and mitigation measures that could reduce negative impact.

This report provides results of the general raptor and eagle nest surveys conducted on GRWRA from April 11 through April 17, 2012. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities.

STUDY AREA

The 30,288-acre (47.3-square mile [mi^2]) GRWRA is located in Barnes County, North Dakota, approximately three miles (4.8 kilometers [km]) northeast of Valley City. Northern Glaciated Plains Ecoregion, which covers much of eastern North Dakota and portions of eastern South Dakota (Bryce et al. 1996; ftp://ftp.epa.gov/wed/ecoregions/nd_sd/ndsd_front.pdf). Historically covered by a grassland transitional between the tall- and shortgrass prairie, the Northern Glaciated Plains Ecoregion has largely been converted to tilled agriculture, predominantly spring wheat (*Triticum* spp.), barley (*Hordeum vulgare*), sunflowers (*Helianthus annuus*), corn (*Zea maize*) and alfalfa (*Medicago sativa*). Topography in the region is nearly flat to gently rolling hills with elevations in the GRWP ranging from 1,270 to 1,522 feet (ft; 387 to 464 meters [m]).

METHODS

Raptor and eagle nest surveys were conducted from a vehicle from public roads on April 11, April 12, April 13, and April 17, 2012, a period before leaf out when raptors would be actively tending to a nest or incubating eggs. Raptors are defined here as kites, accipiters, buteos, harriers, eagles, falcons, and owls. However, the main focus of the survey was to identify eagle nests. Eagle nest surveys focused on locating eyries (large, stick nest structures) in suitable eagle nesting substrate (trees, transmission lines, etc.) within the GRWRA and a 10-mile buffer; while the general raptor nest surveys focused on locating stick or cavity nests within suitable nesting substrate (trees, rock outcrops, etc.) within the GRWRA and a 1-mile buffer (Figure 1). Efforts were made to minimize disturbance to breeding raptors; the greatest possible distance at which the species could be identified was maintained, with distances varying depending upon nest location.

In general, potential eagle and raptor nest habitat was surveyed, throughout the GRWRA and associated buffers. Surveys were typically conducted between 0800 hours and 2000 hours. The location of all potential raptor nests was recorded using a hand-held Global Positioning System (GPS); coordinates were set at Universal Transverse Mercator (UTMs) North American Datum (NAD) 27 unit. This included all confirmed and potential nests regardless of their activity status. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or whitewash. Additionally, date, nest condition, and habitat were recorded.

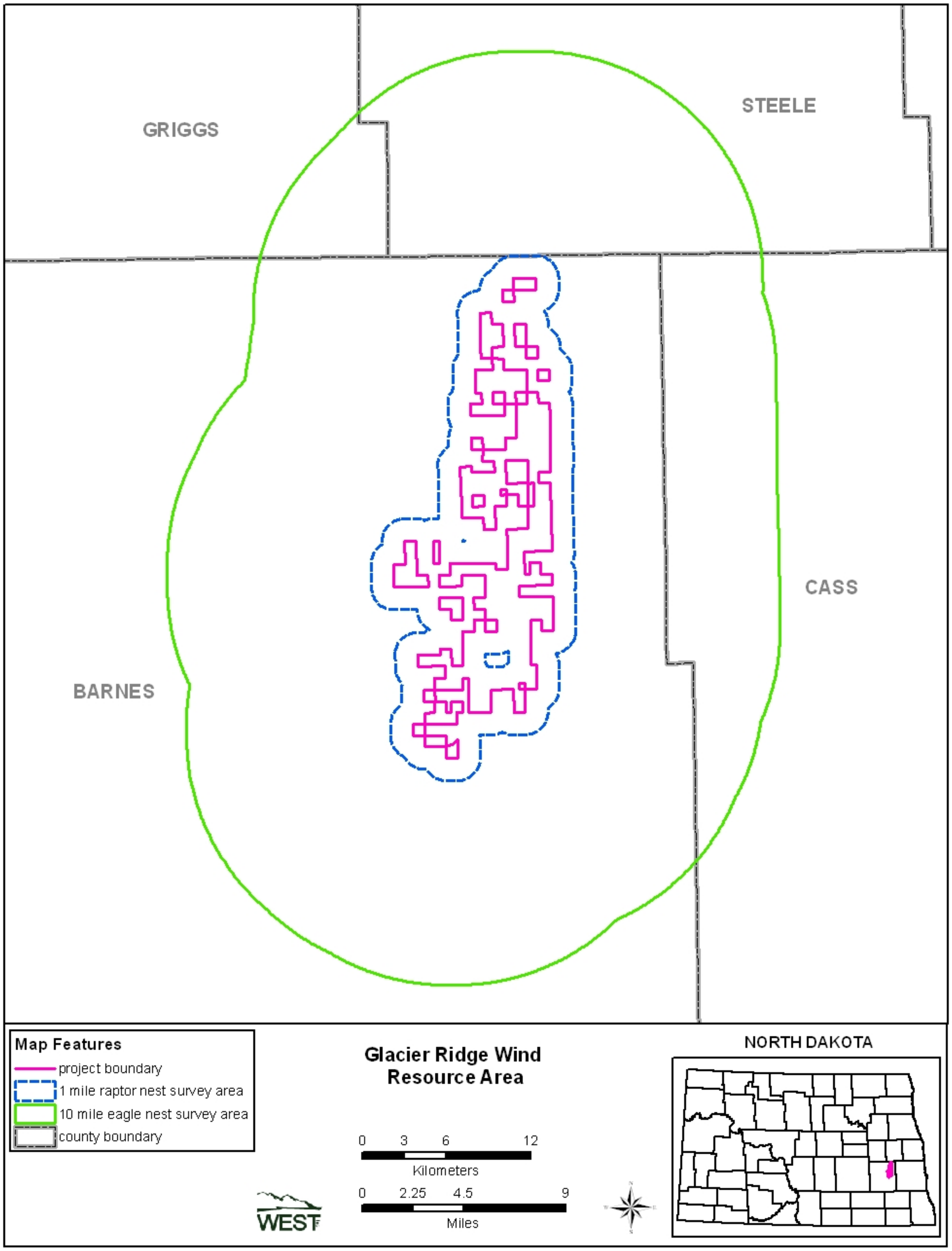

Figure 1. Overview of the Glacier Ridge Wind Resource Area.

RESULTS

Surveys for raptor nests were conducted from the ground in a vehicle from public roads April 11 through April 17, 2012. No new nests were located within the GRWRA or respective 1-mile and 10-mile buffers (Figure 2). Nest density in 2012 within the GRWRA and associated 1-mile and 10-mile buffers was 0. The overall nest density in the 1-mile buffer area was 0.01 nests/mi^2 ($<$0.01 nests/km^2) in 2010. No eagle nests were found during any survey effort in 2010 or 2012.

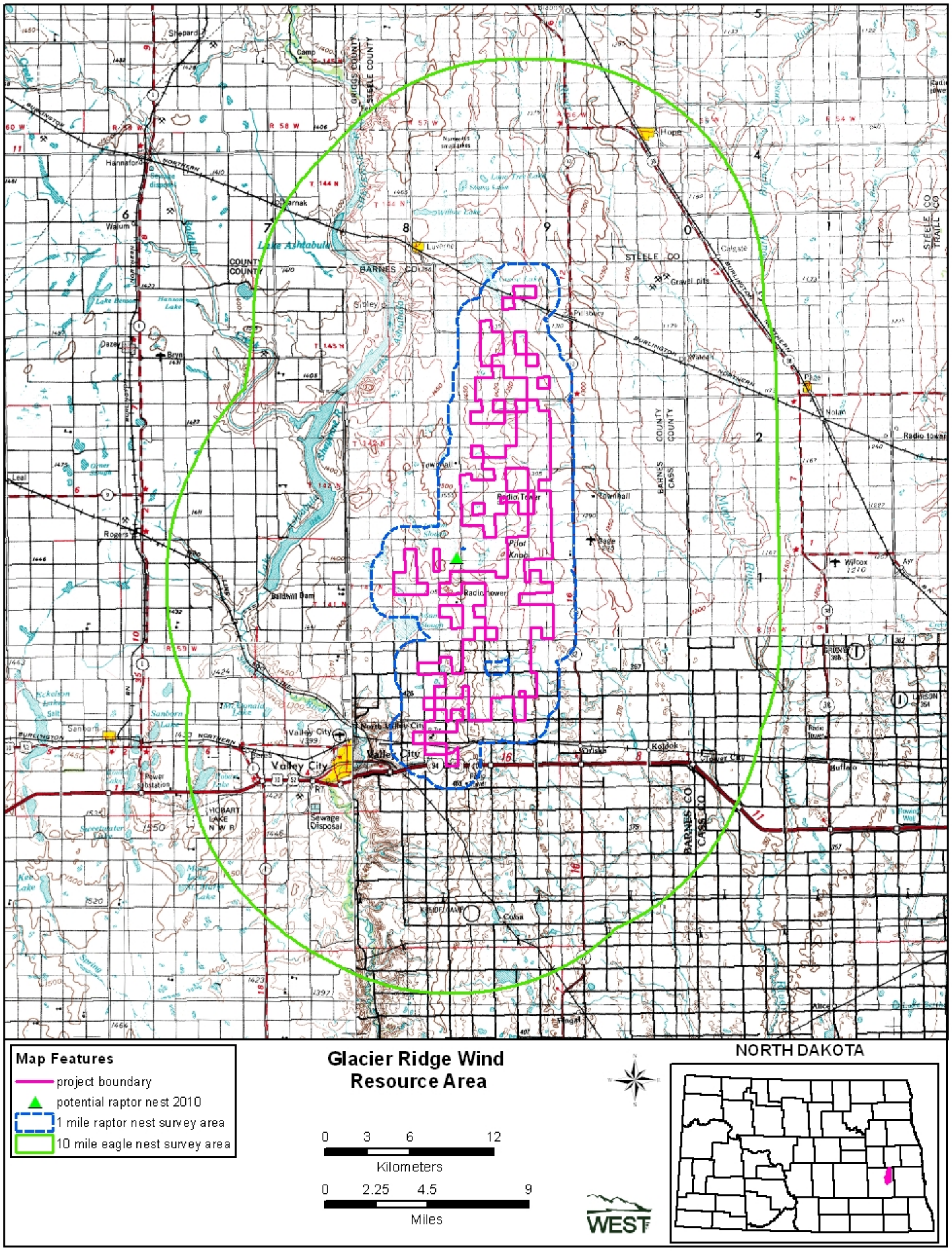

Figure 2. Location of raptor nest observed during spring 2010 and spring 2012 within the Glacier Ridge Wind Resource Area and associated 1-mile and 10-mile buffers.

DISCUSSION

Direct Impacts

The most probable direct impact to raptors from wind energy facilities is mortality or injury due to collisions with turbines. 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 affect birds through loss of habitat, or potential fatalities from construction equipment. 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 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.

Raptor nest density at GRWRA and associated 1-mile and 10-mile buffers were compared to sixteen other WRAs in similar habitats, where active raptor nest density ranged from 0.03 to 0.43 nests/mi^2 (0.01 to 0.12 nests/km^2) and averaged 0.19 nests/mi^2 (0.06 nests/km^2). Nesting density within the GRWRA and the two associated buffers was lower than average in comparison to the other WRAs evaluated (Table 1). Since few raptor species targeted during nest surveys have been observed as fatalities at newer wind-energy facilities, correlations are very low between the number of collision fatalities and raptor nest density within one mile of project facilities. It is likely that raptors nesting near turbines have a higher probability of collision with turbines but data on nests within ½ mile of turbines are currently inadequate to determine potential impact. The existing wind-energy facility with the highest reported nest density is Foote Creek Rim, Wyoming. Most of the nests within two miles of the wind energy facility are red-tailed hawks (Johnson et al. 2000cb) but no red-tailed hawk fatalities have been documented at this facility (Young et al. 2003c).

Table 1. Estimated raptor nest densities from other existing and proposed wind-energy facilities located primarily in agricultural landscapes.

Facility and Location	Raptor Nest Density (#/mi²)							
	All Raptors	SWHA[a]	RTHA[b]	FEHA[c]	GOEA[d]	PRFA[e]	GHOW[f]	SSHA[g]
Glacier Ridge WRA, North Dakota	0	0	0	0	0	0	0	0
Biglow, Oregon[1]	0.15	0.04	0.08	0	0	0	0.02	0
Klondike III,Oregon[2]	0.16	0.04	0.08	0	0	0	0.04	0
Leaning Juniper, Oregon[3]	0.41	0.18	0.16	0.03	0	0.02	0.02	0
Stateline, Oregon-Washington[4]	0.21	0.03	0.08	0.03	0	0	0.07	0
Nine Canyon, Washington[5]	0.03	0	0	0	0	0	0	0
Zintel Canyon, Washington[6]	0.08	0.04	0.02	0.02	0	0	0	0
Buffalo Ridge, Minnesota[7]	0.15	0.07	0.06	0.01	0	0	0.02	0
Klickitat County, Washington[8]	0.12	0	0.09	0	0	0.01	0.03	0
Combine Hills, Oregon[9]	0.24	0.06	0.11	0.01	0	0	0	0
Columbia Hills, Washington[10]	0.3	0.04	0.18	0	0.02	0.02	0.02	0.02
Ponnequin, Colorado[11]	0.06	0.06	0	0	0	0	0	0
Hopkins Ridge, Washington[12]	0.43	0.01	0.27	0.01	0	0	0.08	0
Maiden, Washington[13]	0.18	0.05	0.04	0.03	0	0.03	0.02	0
Wild Horse, Washington[14]	0.16	0.12	0	0	0	0.02	0.02	0
Kittitas Valley, Washington[15]	0.09	0.09	0	0	0	0	0	0
Desert Claim, Washington[16]	0.34	0.23	0	0	0	0	0.04	0
Average	**0.19**	**0.06**	**0.08**	**0.01**	**<0.01**	**0.01**	**0.02**	**<0.01**

[†]Includes only those nests within the boundaries of each WRA.

[a] Swainson's hawk (*Buteo swainsoni*); [b] red-tailed hawk (*Buteo jamaicensis*) ; [c] ferruginous hawk (*Buteo regalis*); [d] Eagle (*Aquila chrysaetos*); [e] prairie falcon (*Falco mexicanus*); [f] great-horned owl (*Bubo virginianus*); [g] sharp-shinned hawk (*Accipiter striatus*).

[1]WEST 2005b; [2]Mabee et al. 2005; [3]NWC and WEST 2005b; [4]URS and WEST 2001; [5]Erickson et al. 2001b; [6]WEST and NWC 2002b; [7]Johnson et al. 2000a; [8]Erickson et al. 1999; [9] Young et al. 2003d; [10]BPA 1995; [11]Kerlinger et al. 2000; [12]Young et al. 2003a; [13]WEST and NWC 2002a; [14]Erickson et al. 2003b; [15]Erickson et al. 2003a; [16]Young et al. 2003b

Indirect Impacts

In addition to the possible direct effects to raptors discussed above, indirect effects caused by disturbance, such as construction activity near an active nest or primary foraging area, may also have an impact. Birds displaced from wind-energy facilities may move to lower quality habitat with fewer disturbances and, possibly, the overall effect of reduced breeding success.

The only published report of avoidance of wind turbines by nesting raptors occurred at Buffalo Ridge, Minnesota, where raptor nest density on 101 mi^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 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. If the nests were distributed uniformly, only two would be expected for an area 12 mi^2 in size; no nests were found within the project area. Based on extensive monitoring using helicopter flights and ground observations at an eastern Washington wind-energy facility, raptors were found to nest in the area of the facility at approximately the same levels before and after construction, with several nests located within 0.5 mi (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 mi (0.5 km) of the turbine strings. Additionally, seven red-tailed hawk nests and one great horned owl and one golden eagle nest within one mile of the wind facility successfully fledged young (Johnson et al. 2000b). The golden eagle pair successfully nested 0.5 mi from the wind farm for three different years after it became operational. A Swainson's hawk also nested within 0.25 mi (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). These observations suggest that there will be limited nesting displacement of raptors at the GRWRA, although the creation of a buffer surrounding known raptor nests when siting turbines will further reduce any impact.

Sensitive Species

No federal or state-listed sensitive species occurring in Barnes County, North Dakota were observed nesting in the GRWRA.

Assessing Eagle Risk at GRWRA

As no eagle nests were identified in 2010 or 2012, and no use was documented by eagles during surveys in 2010, risk to nesting eagles may be considered negligible.

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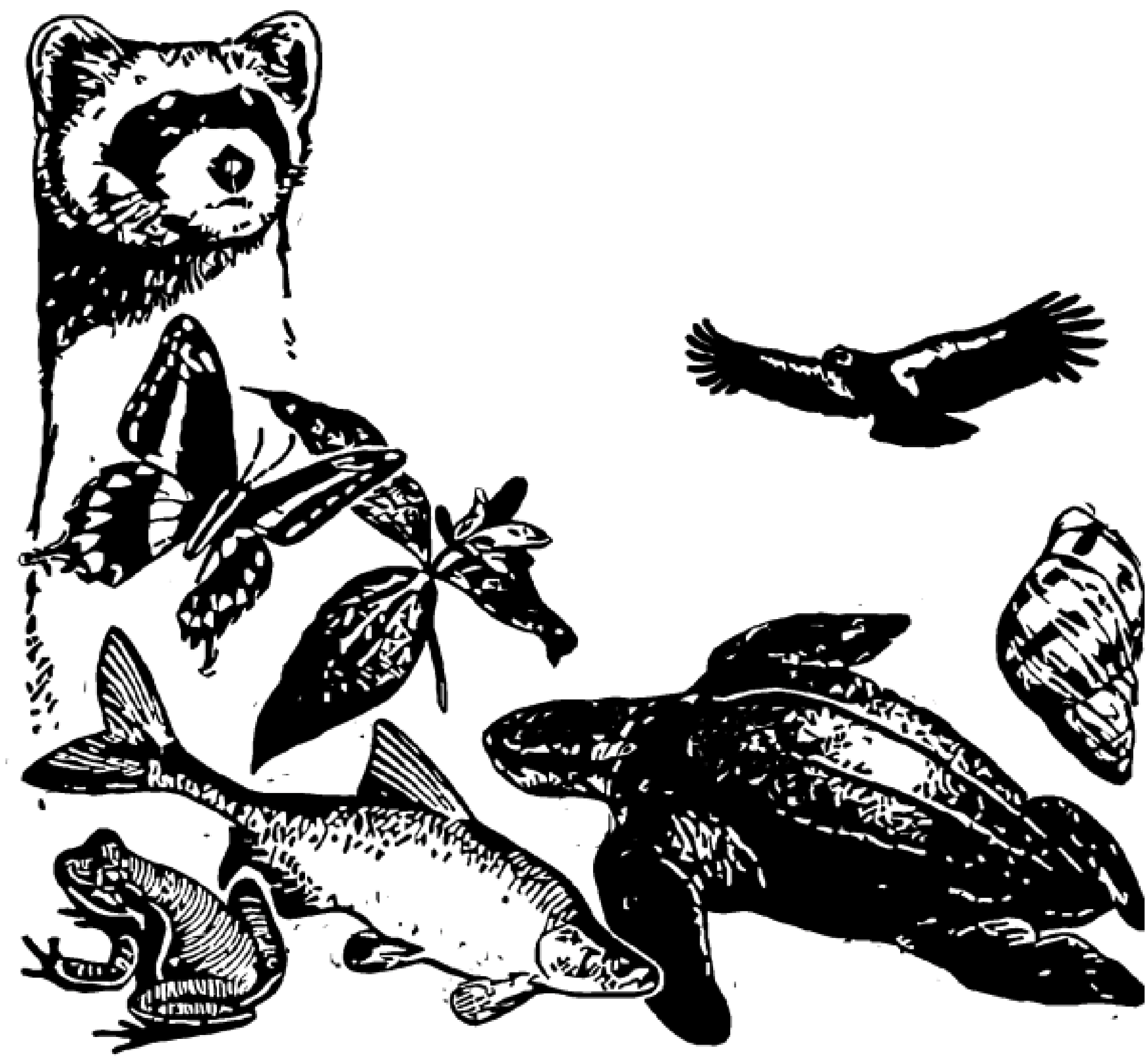
U.S. Fish & Wildlife Service

Glacier Ridge

IPaC Trust Resources Report

Generated June 27, 2016 12:24 PM MDT, IPaC v3.0.8

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (https://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

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U.S. Fish & Wildlife Service

IPaC Trust Resources Report

NAME

Glacier Ridge

LOCATION

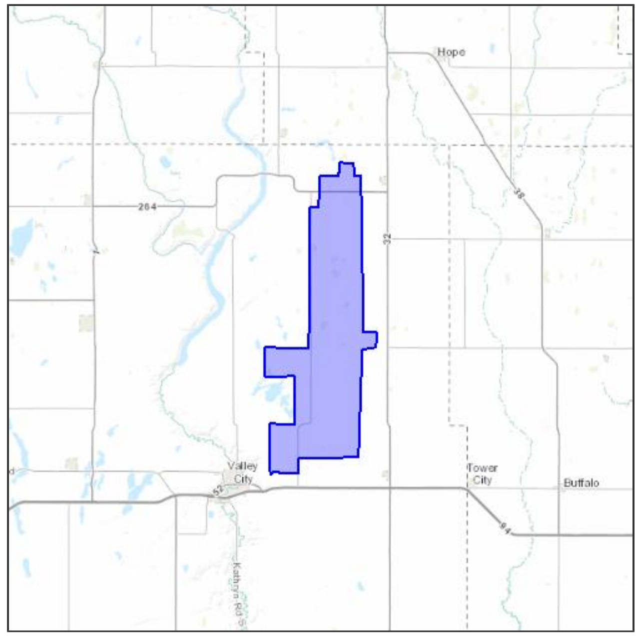
Barnes County, North Dakota

DESCRIPTION

Proposed 300 MW wind farm in Barnes County

IPAC LINK

https://ecos.fws.gov/ipac/project/KY72F-KFYFV-CJNNK-7OE6F-CQZKJQ



U.S. Fish & Wildlife Service Contact Information

Trust resources in this location are managed by:

North Dakota Ecological Services Field Office
3425 Miriam Avenue
Bismarck, ND 58501-7926
(701) 250-4481

Endangered Species

Proposed, candidate, threatened, and endangered species are managed by the Endangered Species Program of the U.S. Fish & Wildlife Service.

This USFWS trust resource report is for informational purposes only and should not be used for planning or analyzing project level impacts.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list from the Regulatory Documents section.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can only be obtained by requesting an official species list either from the Regulatory Documents section in IPaC or from the local field office directly.

The list of species below are those that may occur or could potentially be affected by activities in this location:

Birds

Whooping Crane Grus americana — Endangered

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B003

Insects

Dakota Skipper Hesperia dacotae — Threatened

CRITICAL HABITAT
There is **final** critical habitat designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=I011

Mammals

Gray Wolf Canis lupus

Endangered

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A00D

Northern Long-eared Bat Myotis septentrionalis

Threatened

CRITICAL HABITAT

No critical habitat has been designated for this species.

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=A0JE

Critical Habitats

There are no critical habitats in this location

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish & Wildlife Service.[1] There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures.

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1. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern
  http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Conservation measures for birds
  http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Year-round bird occurrence data
  http://www.birdscanada.org/birdmon/default/datasummaries.jsp

The following species of migratory birds could potentially be affected by activities in this location:

American Bittern Botaurus lentiginosus — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0F3

Baird's Sparrow Ammodramus bairdii — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B09B

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B008

Black Tern Chlidonias niger — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B09F

Black-billed Cuckoo Coccyzus erythropthalmus — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HI

Common Tern Sterna hirundo — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B09G

Dickcissel Spiza americana — Bird of conservation concern
Season: Breeding

Ferruginous Hawk Buteo regalis — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B06X

Golden Eagle Aquila chrysaetos — Bird of conservation concern
Season: Wintering
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0DV

Grasshopper Sparrow Ammodramus savannarum — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0G0

Hudsonian Godwit Limosa haemastica — Bird of conservation concern
Season: Migrating

Least Bittern Ixobrychus exilis
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B092

Loggerhead Shrike Lanius ludovicianus — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0FY

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JL

Nelson's Sparrow Ammodramus nelsoni — Bird of conservation concern
Season: Breeding

Red-headed Woodpecker Melanerpes erythrocephalus — Bird of conservation concern
Season: Breeding

Short-eared Owl Asio flammeus — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HD

Swainson's Hawk Buteo swainsoni — Bird of conservation concern
Season: Breeding
http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B070

Upland Sandpiper Bartramia longicauda — Bird of conservation concern

Season: Breeding

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0HC

Western Grebe aechmophorus occidentalis — Bird of conservation concern

Season: Breeding

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0EA

Willow Flycatcher Empidonax traillii — Bird of conservation concern

Season: Breeding

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0F6

Yellow Rail Coturnicops noveboracensis — Bird of conservation concern

Season: Breeding

http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B0JG

Wildlife refuges and fish hatcheries

There are no refuges or fish hatcheries in this location

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Wetland data is unavailable at this time.

Bat Acoustic Studies for the Glacier Ridge Wind Project Area Barnes County, North Dakota

Interim Bat Report
July – October 2009

Prepared for:

Renewable Energy Systems Americas, Inc.

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Broomfield, Colorado 80021

Prepared by:

Kristen Chodachek, Kimberly Bay, Donald Solick, and Ann Dahl

Western **E**co**S**ystems **T**echnology**,** Inc.

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WEST, Inc.
Specializing in Ecological Field Studies

May 20, 2010

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ACRONYMS AND ABBREVIATIONS

AGL	above ground level
Anabat detector/unit	Anabat ultrasonic bat detector
bat use	bat passes per detector-night
BCI	Bat Conservation International
BLM	Bureau of Land Management
BWEC	Bats and Wind Energy Cooperative
EME Systems	Electronically Monitored EcoSystems
ft	feet
HF	high-frequency
kHz	kilohertz
km	kilometer
LF	low-frequency
m	meter
met tower	meteorological tower
MF	mid-frequency
MW	megawatt
NWCC	National Wind Coordinating Collaborative
pers. comm	personal communication
Project	Glacier Ridge Wind Energy Project
PVC	polyvinyl chloride
RES	Renewable Energy Systems Americas, Inc.
RSH	rotor swept height
SD1	Anabat detector model number
SE	standard error
US	United States
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WEST	Western EcoSystems Technology, Inc.

STUDY PARTICIPANTS

Western EcoSystems Technology

Kristen Chodachek	Project Manager, Report Compiler, Field Supervisor
Donald Solick	Bat Biologist
Lisa Kentner	Bat Data Compiler
Kimberly Bay	Data Analyst and Report Manager
Andrew Merrill	Statistician
Ann Dahl	GIS Technician
Andrea Palochak	Technical Editor
Lori Lundin	Field Technician

REPORT REFERENCE

Chodachek, K., K. Bay, D. Solick, and A. Dahl. 2010. Bat Acoustic Studies for the Glacier Ridge Wind Project Area, Barnes County, North Dakota. Interim Bat Report: July – October 2009. Prepared for Renewable Energy Systems Americas, Inc. (RES), Broomfield, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Bismarck, North Dakota.

EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc. initiated surveys in July 2009 designed to assess bat use within the proposed Glacier Ridge Wind Project Area, Barnes County, North Dakota. Acoustic surveys for bats using four Anabat™ SD1 ultrasonic detectors at five stations (three ground units and two raised units) were conducted from July 29 to October 20, 2009. Equipment failures prevented data collection between August 5 and 12, 2009, so bat activity during this period is unknown. Bat use (bat passes per detector-night) was similar between all five stations, ranging between 0.83 and 1.86 bat passes per detector-night, with an overall mean of 1.28 bat passes per detector-night.

The majority (79.9%) of bat calls recorded belonged to low frequency bats (e.g., big brown bat, hoary bat, silver-haired bat), followed by high frequency bat species (23.2%; e.g. northern long-eared bat), and mid-frequency bat species (2.9%; e.g. eastern red bat). Species identification was possible for both the eastern red bat and hoary bat. Similar activity pattern were recorded for mid-frequency and high-frequency species groups, with the majority of calls recorded between August 12 and August 25, 2009. Although low-frequency species shared a minor peak in activity during the latter time period, a second larger peak in activity for low-frequency species was also recorded September 9 to September 22, 2009. Eastern red bats are likely migrating through the area in mid-August; while hoary bats likely pass through a few weeks later as suggested by the major peaks in activity.

Bat use was compared to existing data from several other wind projects in North America where both bat use and mortality levels have been measured. The level of bat use documented at the Glacier Ridge Wind Project Area was similar to projects in Minnesota and Wyoming, where reported bat mortalities are relatively low. Assuming that a relationship between bat use and bat mortality exists, and that it applies to the Midwestern US, relatively low levels of bat mortality would be expected to occur in the Glacier Ridge Wind Project Area. However, impacts will likely vary with season, with the greatest impacts most likely occurring late August to mid-September. Furthermore, impacts are expected to vary by species due to behavioral factors, relative abundance, and documented patterns in collision mortality.

INTRODUCTION

Renewable Energy Systems Americas, Inc (RES) is proposing to develop a wind project in Barnes County, North Dakota. RES requested Western EcoSystems Technology, Inc. (WEST) to develop and implement a standardized protocol for baseline studies of bat use in the Glacier Ridge Wind Energy Project (Project) for the purpose of estimating the impacts of the wind project on bats and to assist with siting turbines to minimize impacts to bats. The protocol for this baseline study is similar to protocols used at other projects in the United States. The protocol has been developed based on WEST's experience studying wildlife and wind turbines at wind projects throughout the US and included passive acoustic sampling using Anabat™ bat detectors to quantify bat use in the study area.

The following is a final report describing the results of Anabat surveys during the 2009 study season within the proposed wind project area. In addition to site-specific data, this report presents existing information and results of bat monitoring studies conducted at other wind projects. Where possible, comparisons with regional and local studies were made.

STUDY AREA

The proposed wind project is in southeast Barnes County, approximately three miles (4.8 kilometers [km]) northeast of Valley City, North Dakota (Figure 1). The Project falls within the Northern Glaciated Plains Ecoregion, which covers much of eastern North Dakota and portions of eastern South Dakota (Bryce et al. 1996). Historically covered by a grassland transitional between the tall- and shortgrass prairie, the Northern Glaciated Plains Ecoregion has largely been converted to tilled agriculture, predominantly spring wheat (*Triticum* spp.), barley (*Hordeum vulgare*), sunflowers (*Helianthus annuus*), and alfalfa (*Medicago sativa*). Topography in the region is nearly flat to gently rolling hills with elevations in the wind project area ranging from 1,270 to 1,522 feet (ft; 387 to 464 meters [m]).

METHODS

Bat Acoustic Surveys

The objective of the bat use surveys was to estimate the seasonal and spatial use of the Project by bats. Bats were surveyed using Anabat™ SD1 bat detectors (Titley Scientific™, Australia). Bat detectors are a recommended method to index and compare habitat use by bats. The use of bat detectors for calculating an index to bat impacts is a primary bat risk assessment tool for baseline wind development surveys (Arnett 2007, Kunz et al. 2007a). Bat activity was surveyed using four detectors (three fixed units and one roaming unit) from July 29 to October 20, 2009, a period corresponding to likely fall bat migration at this wind project area.

On July 29, 2009, two fixed detectors (GR1g and GR2g) were placed at the base of two different meteorological (met) towers and one roaming detector was placed at the base of the third met tower (GR3g; Figure 1). On September 16, 2009, an additional bat detector (GR1h) was paired with detector GR1g on the met tower using a fixed Bat-Hat (EME Systems, Berkeley, California) with a deflector plate system (described below) and the microphones were installed at approximately 40 m [131 ft] above ground level (AGL) to compare bat activity at different heights (ground versus raised) and monitor bat activity at the rotor swept height (RSH). Additionally, the roaming bat detector (GR3g) was moved from the base of the met tower to a height of 40 m on the same met tower using a fixed Bat-Hat with a deflector plate system (GR3h; Figure 1). This raised bat detector was to monitor bat activity at the RSH and increase spatial coverage. Data collected from the roaming detectors were analyzed separately from the other detectors.

Anabat detectors record bat echolocation calls with a broadband microphone. The echolocation sounds are then translated into frequencies audible to humans by dividing the frequencies by a predetermined ratio. A division ratio of 16 was used for the study. Bat echolocation detectors also detect other ultrasonic sounds, such as those sounds made by insects, raindrops hitting vegetation, and other sources. A sensitivity level of six was used to reduce interference from these other sources of ultrasonic noise. Calls were recorded to a compact flash memory card with large storage capacity. The detection range of Anabat detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the bat, atmospheric conditions; Limpens and McCracken 2004), but is generally less than 30 m (98 ft) due to atmospheric absorption on echolocation pulses (Fenton 1991). To ensure similar detection ranges among detectors, microphone sensitivities were calibrated using a BatChirp (Tony Messina, Las Vegas, Nevada) ultrasonic emitter as described in Larson and Hayes (2000). All units were programmed to turn on each night an approximate half-hour before sunset and turn off an approximate half-hour after sunrise.

Ground Anabat detectors were placed inside plastic weather-resistant containers with a hole cut in the side of the container for the microphone to extend through. Microphones were encased in polyvinyl chloride (PVC) tubing that had drain holes and that curved skyward at 45 degrees outside the container to minimize the potential for water damage due to rain. Containers were raised approximately one m (3.3 ft) off the ground to minimize echo interference and lift the unit above vegetation. The raised Anabat microphones were mounted 40 m on met towers and encased in a Bat-Hat weatherproof housing system. The microphone of a raised detector was attached to a coaxial cable that transmitted ultrasonic sounds to an Anabat unit at the base of the tower. The Bat-Hat weatherproof housing was modified by replacing the Plexiglas reflector plate with a 45-degree angle PVC elbow for better comparability with data collected by detectors on the ground.

Statistical Analysis

Bat Acoustic Surveys

The units of bat 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 more than one second (White and Gehrt 2001, Gannon et al. 2003). 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 for effort by dividing by the number of detector-nights.

For each station, bat passes were sorted into three groups, based on their minimum frequency, that correspond roughly to species groups of interest. For example, most species of *Myotis* bats echolocate at frequencies above 40 kilohertz (kHz), whereas species such as the eastern red bat (*Lasiurus borealis*) typically have echolocation calls that fall between 30 and 40 kHz, and species such as big brown (*Eptesicus fuscus*), silver-haired (*Lasionycteris noctivagans*), and hoary bat (*Lasiurus cinereus*), have echolocation frequencies that fall at or below 25 kHz. Therefore, passes were classified as high-frequency (HF; more than 40 kHz), mid-frequency (MF; 30 to 40 kHz), or low-frequency (LF; less than 30 kHz). To establish which species may have produced passes in each category, a list of species expected to occur in the wind project area was compiled from range maps (Table 1; Harvey et al. 1999, BCI website). 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.

Within these categories, an attempt was made to identify passes made by two *Lasiurus* species: hoary and eastern red bats. Passes 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. 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.

Bat use for this report is defined as the total number of bat passes per detector night, and was used as an index representing bat activity in the Project. 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 assess potential for bat mortality, the mean number of bat passes per detector-night (averaged across ground-based monitoring stations) was compared to existing data from wind projects where both bat activity and mortality levels have been measured.

RESULTS

Bat Acoustic Surveys

Bat activity was monitored at five sampling locations on a total of 84 nights during the period July 29 to October 20, 2009. Anabat units were operable for 84.3% of the sampling period (Figure 2). Equipment failures compromised data collection for ground Anabat units GR1g, GR2g, and GR3g from August 5 to August 11, 2009. Levels of wind and insect noise were moderately high for the first four weeks of the study. However, after August 26 noise levels decreased significantly (Figure 3). Anabat units recorded 314 bat passes on 242 detector-nights (Table 2). Averaging bat passes per detector-night (bat use) across locations, a mean (mean ± standard error [SE]) of 1.28 ± 0.17 bat passes per detector-night was recorded. The average bat use for ground stations was 1.46 ± 0.16 bat passes per detector-night, and for raised stations was 1.01 ± 0.31 bat passes per detector-night.

Spatial Variation

Bat use was similar among the five stations in the Project (Table 2; Figures 1, 4), ranging between 0.83 and 1.86 bat passes per detector-night among ground stations, and between 0.89

and 1.14 bat passes per detector-night among raised stations. Overall, use was lowest at station GR1g (0.83 bat passes per detector-night) and highest at station GR2g (1.86). At the roaming station, detector GR3g recorded slightly more bat activity than the raised detector GR3h (Table 2; Figure 4).

Comparing paired stations on just the nights that both ground and raised detectors were operating, bat use at GR1h was nearly double the use at station GR1g (Figure 5).

Temporal Variation

For all stations combined, bat activity was low from late July through mid-August, when use increased about three-fold (Table 3, Figure 6). Approximately 83% of all bat passes were recorded between August 12 and September 22 (Table 3). The first major peak in bat activity occurred from August 12 to August 25, accounting for 38.9% of overall activity at all stations; followed by a second peak from September 9 to September 22, accounting for 30.2% of all activity. After mid-September, bat activity steadily declined (Table 3, Figure 6). Cumulatively, nearly half (49.6%) of all bat activity was detected by the third week in August. No bat passes were recorded the week of October 7 to October13.

Nightly bat use at paired station GR1 differed between the ground and raised detector during the period that both were operating (Figure 7). Activity peaked at both detectors in mid-September, as indicated by the median line (Figure 7), yet the raised detector recorded more bat passes than the ground detector overall.

Species Composition

At all stations combined, passes by LF bats (79.9% of all passes) outnumbered passes by HF bats (23.2%), and MF bats (2.9%; Table 2). Among raised stations, LF bats comprised about 22.0% of passes (Table 2). Patterns of use were similar between HF and MF species groups during the study period (Figure 6), with most passes recorded between August 12 and August 25 (60.8% of HF passes and 77.7% of MF passes; Table 3). Although LF species were recorded during the latter time period (20.9 % of LF passes), a second larger peak of bat activity by LF bat species was recorded between September 9 and September 22 (40.5% of LF passes; Table 3). Activity by HF and MF species appeared to peak slightly earlier than activity by LF species, while LF species appeared to remain in the wind project area longer than the other species groups (Table 3; Figure 6). For all species groups, the number of bat passes generally increased sharply to their respective activity peaks, with a gradual decline in bat activity through the duration of the study period.

Hoary bats comprised 11.1% of all passes for all stations and 15.1% of all LF passes for all stations (Table 2; Figure 8). Raised stations accounted for most (62.9%) hoary bat passes at all stations. Station GR3h recorded most of the hoary bat activity (40.0%). Most of the hoary bat activity was recorded between September 16 and September 29 (54.3%; Table 4 and Figure 9). No hoary bats were recorded after September 30.

Eastern red bat comprised 1.9% of all passes detected within the wind project area and 66.7% of all MF bat passes (Table 2; Figure 8). All of the eastern red bat passes were recorded at ground stations. The majority of eastern red bat passes (68.2%) were recorded from August 12 to August 25 (Table 4; Figure 9). No eastern red bats were recorded after September 9.

DISCUSSION

Potential Impacts

Assessing the potential impacts of wind-energy development to bats in the Project is complicated because the proximate and ultimate causes of bat fatalities at turbines are poorly understood (Kunz et al. 2007b, Baerwald et al. 2008, Cryan and Barclay 2009), and because monitoring elusive, night-flying animals is inherently difficult (O'Shea et al. 2003). In addition, because installed capacity for wind has increased rapidly in recent years, the availability of well-designed studies from existing wind projects lags development of proposed projects (Kunzet al. 2007b). To date, monitoring studies of wind projects suggest that:

a) bat mortality shows a rough correlation with bat use (Table 5);

b) the majority of fatalities occur during the post-breeding or fall migration season (roughly August and September);

c) migratory tree-roosting species (eastern red, hoary, and silver-haired bats) comprise almost 75% of reported bats killed, and;

d) the highest reported fatalities occur at wind projects located along forested ridge tops in the eastern and northeastern US. However, recent studies in agricultural regions of Iowa and Alberta, Canada, report relatively high fatalities as well (Table 5).

Based on these patterns, current guidance to estimate potential mortality levels at a proposed wind project involves evaluation of the on-site bat acoustic data in terms of activity levels, seasonal variation, and species composition (Kunzet al. 2007b), as well as comparison to regional patterns.

Overall Bat Activity

To date, few studies of wind projects have recorded both Anabat detections per night and bat mortality (Table 5). While these studies show correlation between activity and fatalities, the expectation amongst the scientific and resource management communities is that a similar relationship holds for pre-construction activity and post-construction fatalities. The addition of data sets like this one will contribute to understanding of the relationship between bat activity near wind turbines and bat fatalities. To our knowledge, data for these studies were collected using Anabat detectors placed near the ground (i.e., none raised on met towers) and none of the detectors were located near features attractive to bats. Thus, this report relies on the mean bat activity for ground-based detectors placed near met towers and/or potential turbine locations to assess potential risk of bat fatality at the Project relative to other studies with similar data.

Overall, activity at all ground detectors averaged 1.46 bat passes per detector-night, which was slightly lower than the use estimates recorded at the Buffalo Ridge wind project in Minnesota, where bat mortality was relatively low (Johnson et al. 2000, 2004). Thus, based on the expected relationship between pre-construction bat activity and post-construction fatalities, bat mortality rates at the Project would be expected to be similar to the 1.73 bat fatalities per megawatt (MW) per year reported at the Buffalo Ridge project in Minnesota in 2002, but much lower than the 39.70 bat fatalities/MW/year reported at the Buffalo Mountain project in Tennessee (Table 5).

Spatial Variation

The proposed wind project is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. Bat activity was uniformly low among all five stations, ranging from 0.83 to 1.86 bat passes per detector-night. Furthermore, overall bat use at ground and raised stations was similar; suggesting similar bat activity at heights near and away from the proposed rotor swept area.

Temporal Variation

Approximately 83% of all bat activity was recorded during mid-August, with a second smaller peak recorded September 9 September 22, 2009. Activity during these time periods may represent movement of migrating bats through the area; particularly low-frequency bats. After late September, activity was relatively very low, indicating that most bats had left the area for winter hibernacula or warmer climates.

Fatality studies of bats at wind projects in the US have shown a peak in mortality in August and September and generally lower mortality earlier in the summer (Johnson 2005, Arnett et al. 2008). While the survey effort varies among the different studies, the studies that combine Anabat surveys and fatality surveys show a general association between the timing of increased bat call rates and timing of mortality, with both call rates and mortality peaking during the fall. Based on the available data, it is expected that bat mortality at the Project will be highest in mid-to-late August.

Species Composition

Of the six species of bat likely to occur in the study area, all are known fatalities at wind projects (Table 1). Acoustic bat surveys were able to classify bat calls to frequency groups that roughly correspond to groups of relative risk. Approximately 80% of passes were by LF bats, suggesting higher relative abundance of species such as hoary, big brown, and silver-haired bats.

The MF and HF bat species were most common in mid-August; while LF species were most abundant in late-August and September. This change in species composition probably reflects the movement of MF and HF species out of the area. The greater proportion of LF species in September may indicate movement of these species through the area at this time.

Passes by LF bats outnumbered MF and HF passes at all stations and heights, which is likely a reflection of behavioral factors and relative abundance.

Hoary bats made up 15.1% of all low-frequency passes, and were most active the last two weeks in September, suggesting migration through the area. To date, some low-frequency species, (e.g., hoary, Mexican free-tailed bats and silver-haired bats) have been found as fatalities in higher proportions than other low-frequency species (e.g., Arnettet al. 2008). Approximately 3% of all passes were classified as MF passes and 66.7% of those passes were eastern red bats. In some regions, eastern red bats comprise the majority of bat fatalities found during searches (e.g., Arnett et al. 2008). Although both hoary bats and eastern red bats were documented during the study, it is likely that hoary bats will constitute a larger percentage of the bat mortalities within the Project area. Most high-frequency calls were likely comprised of northern long-eared bats (*Myotis septentrionalis*).

Regional Fatality Studies

Bat mortality studies at wind projects across North America show a vast range of bat mortality rates, ranging from zero to 39.70 bat fatalities/MW/year (Table 5). In general, fatality rates are 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, no fatality data have been made public for the Southwest or Southeast regions. Compared to other fatality surveys in the Midwest region, fatalities at the Project could range between 0.76 and 24.57 bat fatalities/MW/year.

CONCLUSIONS

Bat use in the Project was similar among all stations during the fall survey period. Bat pass activity collected during this study showed similarities to activity measured at other prospective wind projects in the Midwest; in particular the Buffalo Ridge project in Minnesota. Overall, bat use rates were much lower than those observed at forested ridge top projects in the east with high bat mortalities. Based on peaks in bat use, most mortality would be expected to occur in September. As well, based on species composition of calls, eastern red bats would be expected to have the greatest fatality rates.

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Table 1. Bat species determined from range-maps (Harvey et al. 1999, BCI website) as likely to occur within the Glacier Ridge Wind Project Area, sorted by call frequency.

Common Name	Scientific Name
High-Frequency (> 40 kHz)	
northern long-eared bat[2]	*Myotis septentrionalis*
Mid-Frequency (30-40 kHz)	
eastern red bat[1,2,3]	*Lasiurus borealis*
little brown bat[2]	*Myotis lucifugus*
Low-Frequency (< 30 kHz)	
big brown bat[2,3]	*Eptesicus fuscus*
silver-haired bat[1,2]	*Lasionycteris noctivagans*
hoary bat[1,2]	*Lasiurus cinereus*

[1]long-distance migrant
[2]species known to have been killed at wind projects
[3]species occurrence based upon a single source

Table 2. Results of acoustic bat surveys conducted at the Glacier Ridge Wind Project Area, July 29 - October 20, 2009, separated by call frequency (HF = high frequency, MF = mid frequency, LF = low frequency).

Anabat Station	Location	# of HF Bat Passes	# of MF Bat Passes	# of LF Bat Passes	# of Eastern Red Bat Passes*	# of Hoary Bat Passes**	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
GR1g	Ground	12	1	45	1	2	58	70	0.83±0.14
GR1h	Raised	1	1	29	0	8	31	35	0.89±0.26
GR2g	Ground	54	7	80	5	8	141	76	1.86±0.33
GR3g	Ground	6	0	38	0	3	44	26	1.69±0.37
GR3h	Raised	0	0	40	0	14	40	35	1.14±0.35
Total Ground		**72**	**8**	**163**	**6**	**13**	**243**	**172**	**1.46±0.16**
Total Raised		**1**	**1**	**69**	**0**	**22**	**71**	**70**	**1.01±0.31**
Grand Total		**73**	**9**	**232**	**6**	**35**	**314**	**242**	**1.28±0.17**

*Passes by eastern red bats included in mid-frequency (MF) numbers.
**Passes by hoary bats are included in low-frequency (LF) numbers;
***± bootstrapped standard error.

Table 3. Weekly bat use and the contribution of each week (%) to total recorded activity for high-frequency (HF), mid-frequency (MF), low-frequency (LF), and all bats within the Glacier Ridge Wind Project Area from July 29 - October 20, 2009.

Week	HF Pass Rate	HF % Composition	MF Pass Rate	MF % Composition	LF Pass Rate	LF % Composition	All Bats Pass Rate	All Bats % Composition	Cumulative % Composition
07/29/09 to 08/04/09	0.21	3.8	0.05	6.1	1.26	10.2	1.53	8.2	8.2
08/05/09 to 08/11/09	0.12	2.3	0	0	0.38	3	0.5	2.7	10.8
08/12/09 to 08/18/09	1.67	30.4	0.17	19.4	2.58	20.9	4.42	23.6	34.4
08/19/09 to 08/25/09	1.67	30.4	0.5	58.3	0.67	5.4	2.83	15.1	49.6
08/26/09 to 09/01/09	0.86	15.7	0.05	5.5	0.67	5.4	1.57	8.4	58
09/02/09 to 09/08/09	0.28	5.1	0.06	6.5	0.78	6.3	1.11	5.9	63.9
09/09/09 to 09/15/09	0.39	7.1	0	0	2.72	22	3.11	16.6	80.5
09/16/09 to 09/22/09	0.21	3.9	0.04	4.2	2.29	18.5	2.54	13.6	94.1
09/23/09 to 09/29/09	0.07	1.3	0	0	0.93	7.5	1	5.3	99.4
09/30/09 to 10/06/09	0	0	0	0	0.04	0.3	0.04	0.2	99.6
10/07/09 to 10/13/09	0	0	0	0	0	0	0	0	99.6
10/14/09 to 10/20/09	0	0	0	0	0.07	0.6	0.07	0.4	100

Table 4. Weekly bat use and the contribution of each week (%) to total recorded activity for eastern red bats and hoary bats within the Glacier Ridge Wind Project Area, from July 29 - October 20, 2009.

Week	Eastern Red Bat Use	Eastern Red Bat % Composition	Hoary Bat Use	Hoary Bat % Composition	All Bats Use	All Bats % Composition	Cumulative % Composition
07/29/09 to 08/04/09	0.05	10.8	0.05	3.3	1.53	8.2	8.2
08/05/09 to 08/11/09	0	0	0	0	0.5	2.7	10.8
08/12/09 to 08/18/09	0.17	34.1	0.42	26.4	4.42	23.6	34.4
08/19/09 to 08/25/09	0.17	34.1	0	0	2.83	15.1	49.6
08/26/09 to 09/01/09	0.05	9.7	0.14	9	1.57	8.4	58
09/02/09 to 09/08/09	0.06	11.4	0.06	3.5	1.11	5.9	63.9
09/09/09 to 09/15/09	0	0	0.06	3.5	3.11	16.6	80.5
09/16/09 to 09/22/09	0	0	0.46	29.4	2.54	13.6	94.1
09/23/09 to 09/29/09	0	0	0.39	24.9	1	5.3	99.4
09/30/09 to 10/06/09	0	0	0	0	0.04	0.2	99.6
10/07/09 to 10/13/09	0	0	0	0	0	0	99.6
10/14/09 to 10/20/09	0	0	0	0	0.07	0.4	100

Table 5. Wind projects in North America with mortality data for bat species, grouped by geographic region. Bat activity rates are included where available. To date, no bat fatality estimates or studies from Southwestern or Southeastern wind projects have been made public.

Wind Energy Facility	Bat Use Estimate[A]	Mortality Estimate[B]	No. of Turbines	Total MW
Glacier Ridge, ND	1.46			
Midwest				
Cedar Ridge, WI		30.61[C]	41	68
Blue Sky Green Field, WI	7.7[D]	24.57	88	145
Top of Iowa, IA (2004)	34.9[E]	10.27	89	80
Top of Iowa, IA (2003)	34.9[E]	7.16	89	80
Kewaunee County, WI		6.55	31	20
Buffalo Ridge, MN (Phases II & III; 2001)	2.2	4.03	281	210.75
Crescent Ridge, IL		3.27	33	49.5
Buffalo Ridge, MN (Phase III; 1999)		2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)		2.59	143	107.25
Buffalo Ridge, MN (Phase II; 1998)		2.16	143	107.25
Buffalo Ridge, MN (Phases II & III; 2002)	1.9	1.73	281	210.75
NPPD Ainsworth, NE		1.16	36	59.4
Buffalo Ridge, MN (Phase I; 1999)		0.76	73	25
Rocky Mountains				
Summerview, Alb. (2006)	5.3	14.62	39	70.2
Summerview, Alb. (2005/2006)		10.27	39	70.2
Judith Gap, MT		8.93	90	135
Summerview, Alb. (2007)		8.23	39	70.2
Foote Creek Rim, WY (Phase I; 1999)		3.97	69	41.4
Foote Creek Rim, WY (Phase I; 2001/2002)		1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2	1.05	69	41.4
Western				
Stateline, OR/WA (2003)		2.52	454	300
High Winds, CA (2004)		2.51	90	162
Nine Canyon, WA		2.47	37	48
Leaning Juniper, OR		1.98	67	100.5
Big Horn, WA		1.90	133	199.5
Combine Hills, OR		1.88	41	41
High Winds, CA (2005)		1.52	90	162
Stateline, OR/WA (2002)		1.20	454	300
Vansycle, OR		1.12	38	24.9
Klondike, OR		0.77	16	24
Hopkins Ridge, WA		0.63	83	150
Klondike II, OR		0.41	50	75
Wild Horse, WA		0.39	127	229
SMUD, CA		0.07		15

Table 5. Wind projects in North America with mortality data for bat species, grouped by geographic region. Bat activity rates are included where available. To date, no bat fatality estimates or studies from Southwestern or Southeastern wind projects have been made public.

Southern Plains				
Oklahoma Wind Energy Center, OK		0.53	68	102
Buffalo Gap, TX		0.10	67	134
Northeastern				
Buffalo Mountain, TN (2006)		39.70	18	29
Mountaineer, WV	38.3	31.69	44	66
Buffalo Mountain, TN (2000-2003)	23.7	31.54	3	2
Meyersdale, PA		18.00	20	30
Casselman, PA		15.66	23	34.5
Maple Ridge, NY (2006)		15.00	120	198
Noble Bliss, NY		14.66	67	100
Mount Storm, WV (2008)	35.2	12.11	82	164
Maple Ridge, NY (2007)		9.42	195	321.75
Noble Ellenburg, NY		5.45	54	80
Noble Clinton, NY		3.63	67	100.5
Mars Hill, ME (2007)		2.91	28	42

A=bat passes per detector night
B=number of bat fatalities/MW/year
C=no annual estimate provided in report, survey period is only for spring and fall, no summer data.
D=bat activity not measured concurrently with bat mortality studies
E=averaged across phases and/or study years, and may not be directly related to mortality estimates.
Data from the following sources:

Facility	Use Estimate	Mortality Estimate	Facility	Use Estimate	Mortality Estimate
Cedar Ridge, WI		BHE Environmental 2010	Combine Hills, OR		Young et al. 2006
Blue Sky Green Field, WI	Gruver 2008	Gruver et al. 2009	High Winds, CA (05)		Kerlinger et al. 2006
Top of Iowa, IA (2004)	Jain 2005	Jain 2005	Stateline, OR/WA (02)		Erickson et al. 2004
Top of Iowa, IA (2003)	Jain 2005	Jain 2005	Vansycle, OR		Erickson et al. 2000
Kewaunee County, WI		Howe et al. 2002	Klondike, OR		Johnson et al. 2003
Buffalo Ridge, MN (Phase II& III; 01)		Johnsonet al. 2004	Hopkins Ridge, WA		Young et al. 2007
Crescent Ridge, IL		Kerlinger et al. 2007	Klondike II, OR		NWC and WEST 2007
Buffalo Ridge, MN (Phase III; 99)		Johnsonet al. 2004	Wild Horse, WA		Erickson et al. 2008
Buffalo Ridge, MN (Phase II; 99)	Johnsonet al. 2000	Johnsonet al. 2004	SMUD, CA		URS et al. 2005
Buffalo Ridge, MN (Phase II; 98)	Johnsonet al. 2000	Johnsonet al. 2004	Oklahoma Wind Energy Center, OK		Piorkowski 2006
Buffalo Ridge, MN (Phase II& III; 02)		Johnsonet al. 2004	Buffalo Gap, TX		Tierney 2007
NPPD Ainsworth, NE		Derby et al. 2007	Buffalo Mountain, TN (2006)		
Buffalo Ridge, MN (Phase I; 99)		Johnsonet al. 2000	Mountaineer, WV	Arnett (pers comm. 2005)	Kerns and Kerlinger 2004
Summerview, Alb. (06)		Baerwald 2008	Buffalo Mountain, TN (2000-2003)	Fiedler 2004	Nicholson et al. 2005
Summerview, Alb. (05/06)		Brown and Hamilton 2006	Meyersdale, PA		Arnett et al. 2005
Judith Gap, MT		TRC 2008	Casselman, PA		Arnett et al. 2009
Summerview, Alb. (07)		Baerwald 2008	Maple Ridge, NY (2006)		Jain et al. 2007
Foote Creek Rim, WY (Phase I; 99)		Young et al. 2003	Noble Bliss, NY		Jain et al. 2009c
Foote Creek Rim, WY (Phase I; 01/02)	Gruver 2002	Younget al. 2003	Mount Storm, WV (2008)	Young et al. 2009	Younget al. 2009
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Younget al. 2003	Maple Ridge, NY (2007)		Jain et al. 2008
Stateline, OR/WA (03)		Ericksonet al. 2004	Noble Ellensburg, NY		Jain et al. 2009a
High Winds, CA (04)		Kerlingeret al. 2006	Noble Clinton, NY		Jain et al. 2009b
Nine Canyon, WA		Erickson et al. 2003	Mars Hill, ME (2007)		Stantec 2008
Big Horn, WA		Kronner et al. 2008	Stetson Mountain, ME	Stantec 2009	Stantec 2009

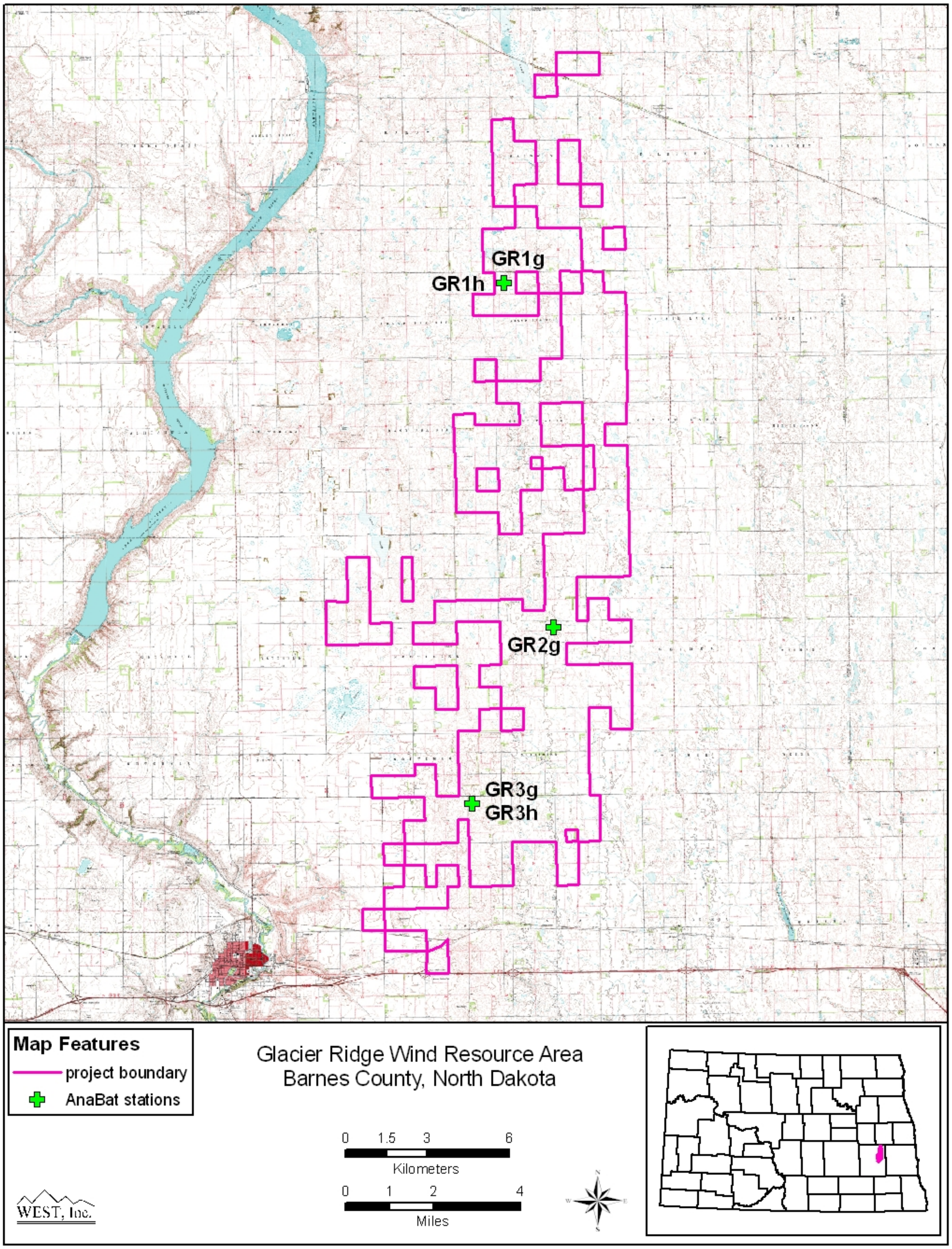


Figure 1. Study area map and Anabat sampling stations at the Glacier Ridge Wind Project Area.

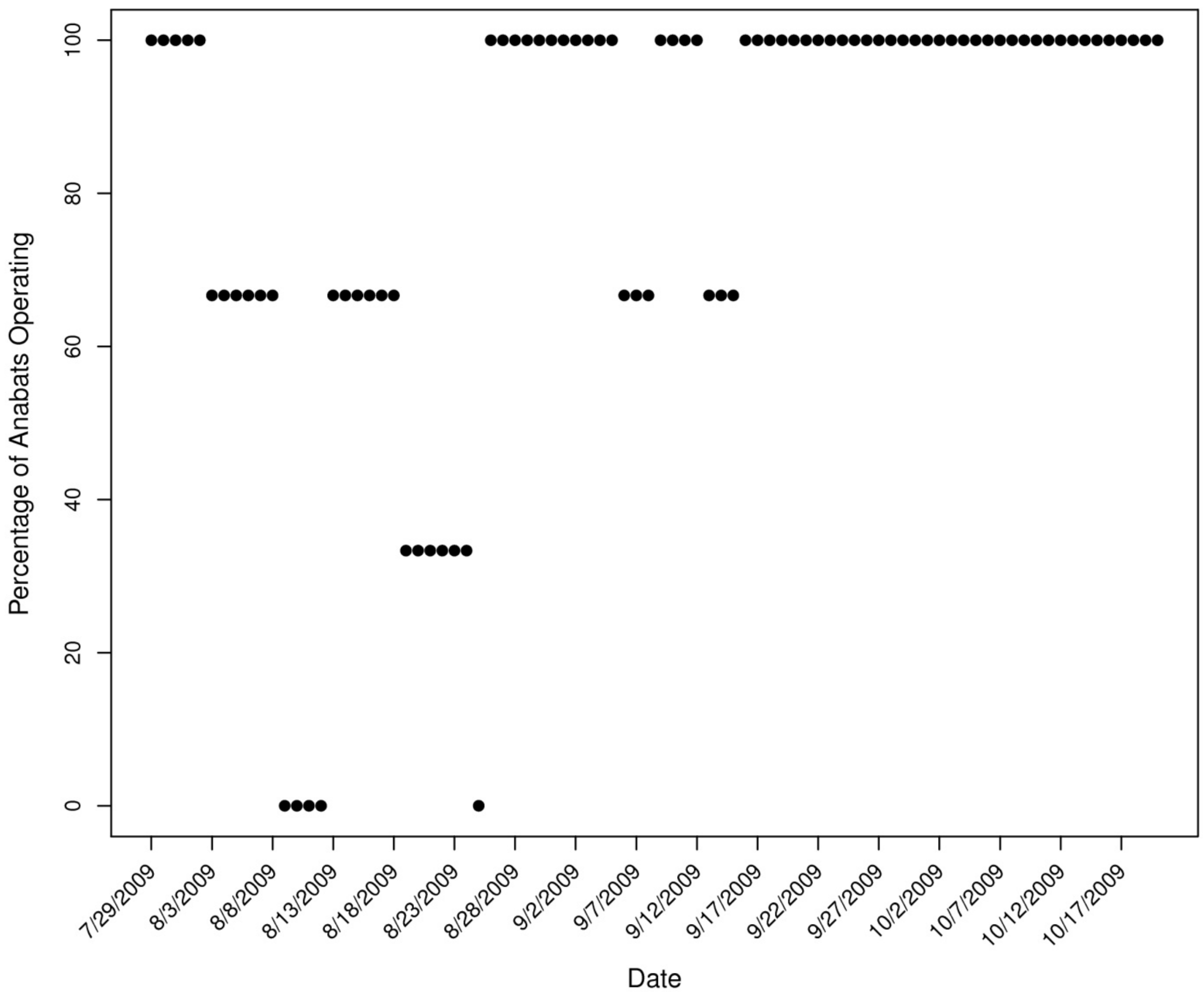


Figure 2. Percentage of Anabat detectors (n = 4) at the Glacier Ridge Wind Project Area operating during each night of the study period July 29 – October 20, 2009.

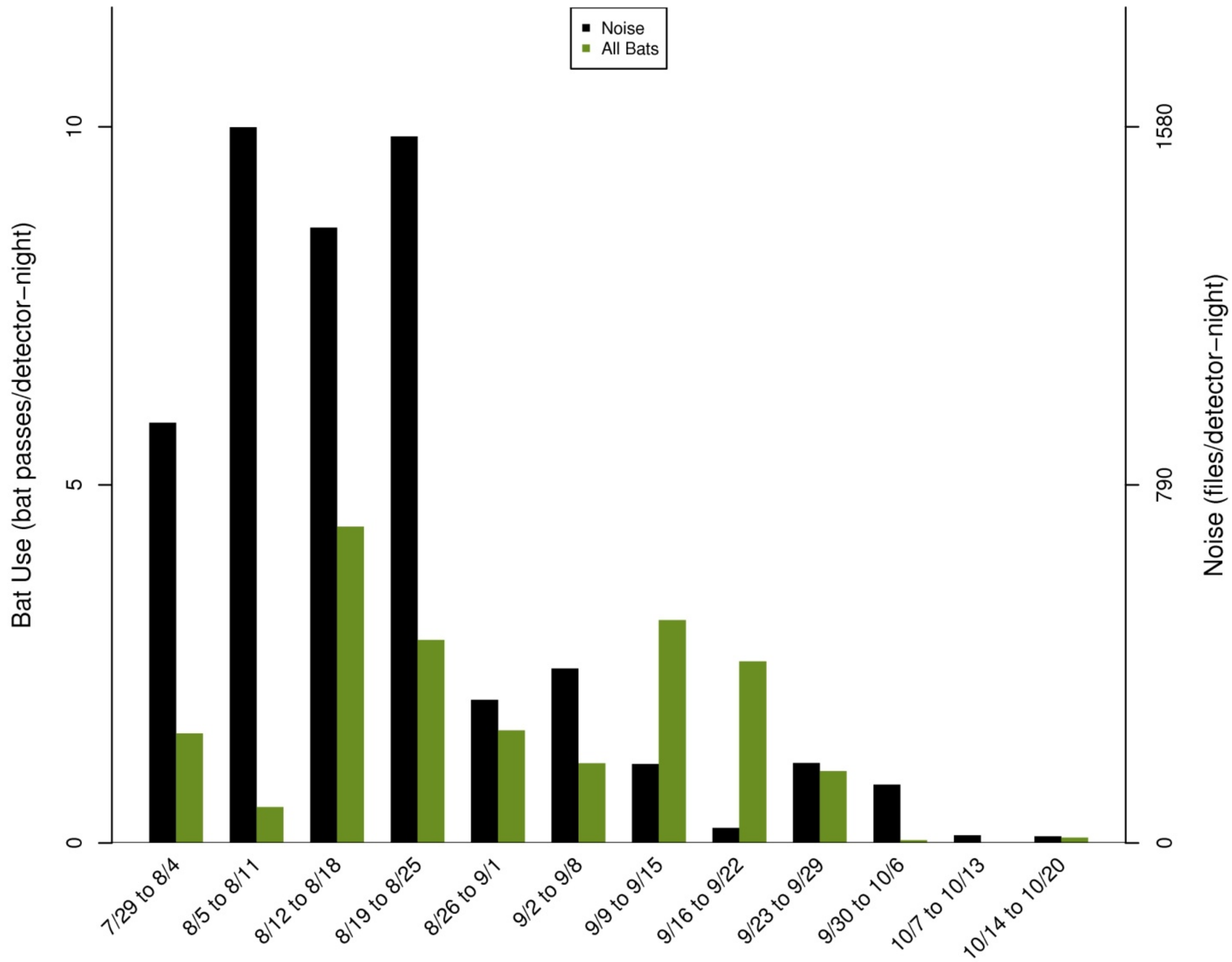


Figure 3. Bat use and noise files detected per detector-night at the Glacier Ridge Wind Project Area for the study period July 29 – October 20, 2009, presented by week. Noise files are indicated on the second axis.

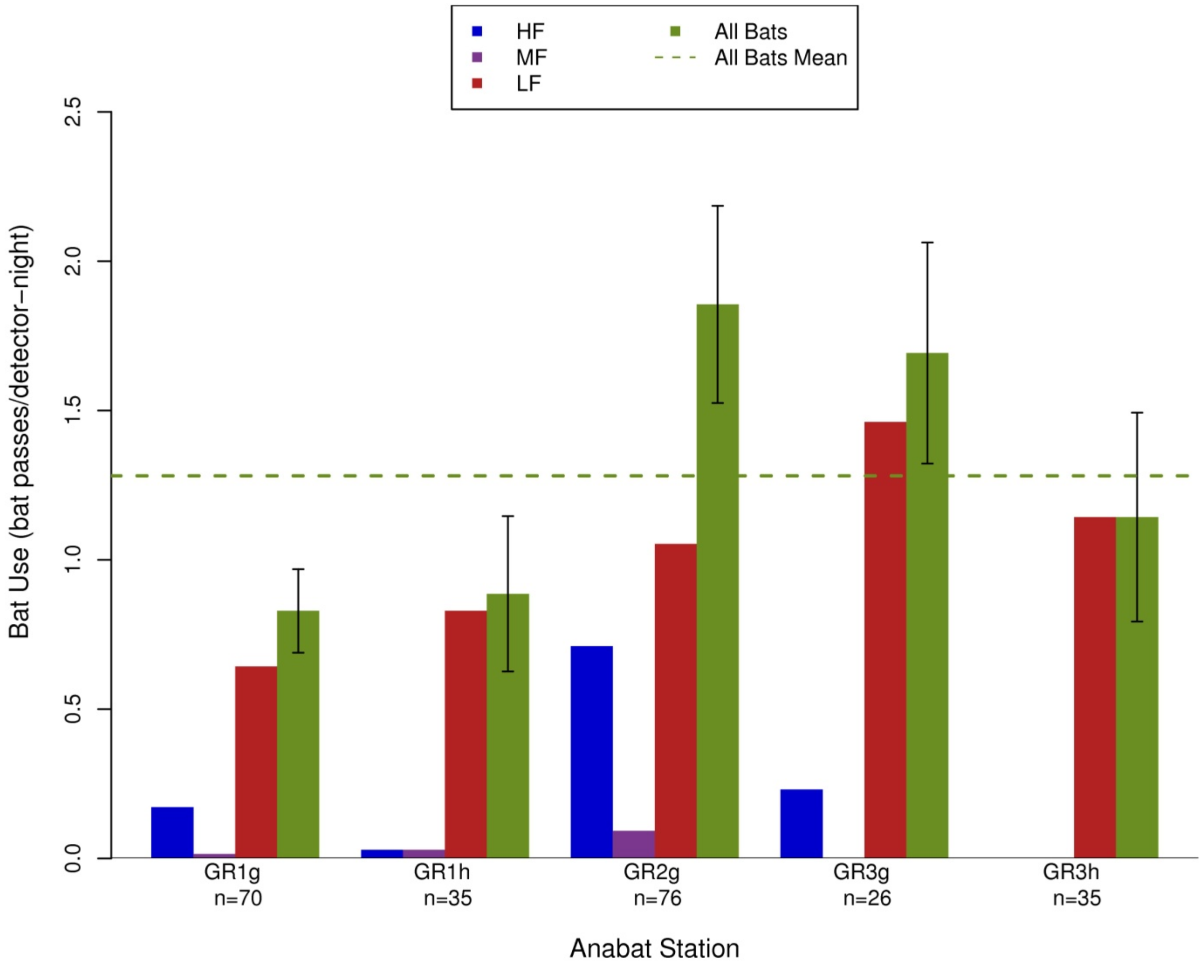


Figure 4. Number of bat passes per detector-night (bat use) by Anabat location at the Glacier Ridge Wind Project Area for the study period July 29 – October 20, 2009. For this study, stations GR1g and GR1h were paired ground and raised detectors, respectively, and stations GR3g and GR3h were roaming stations. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

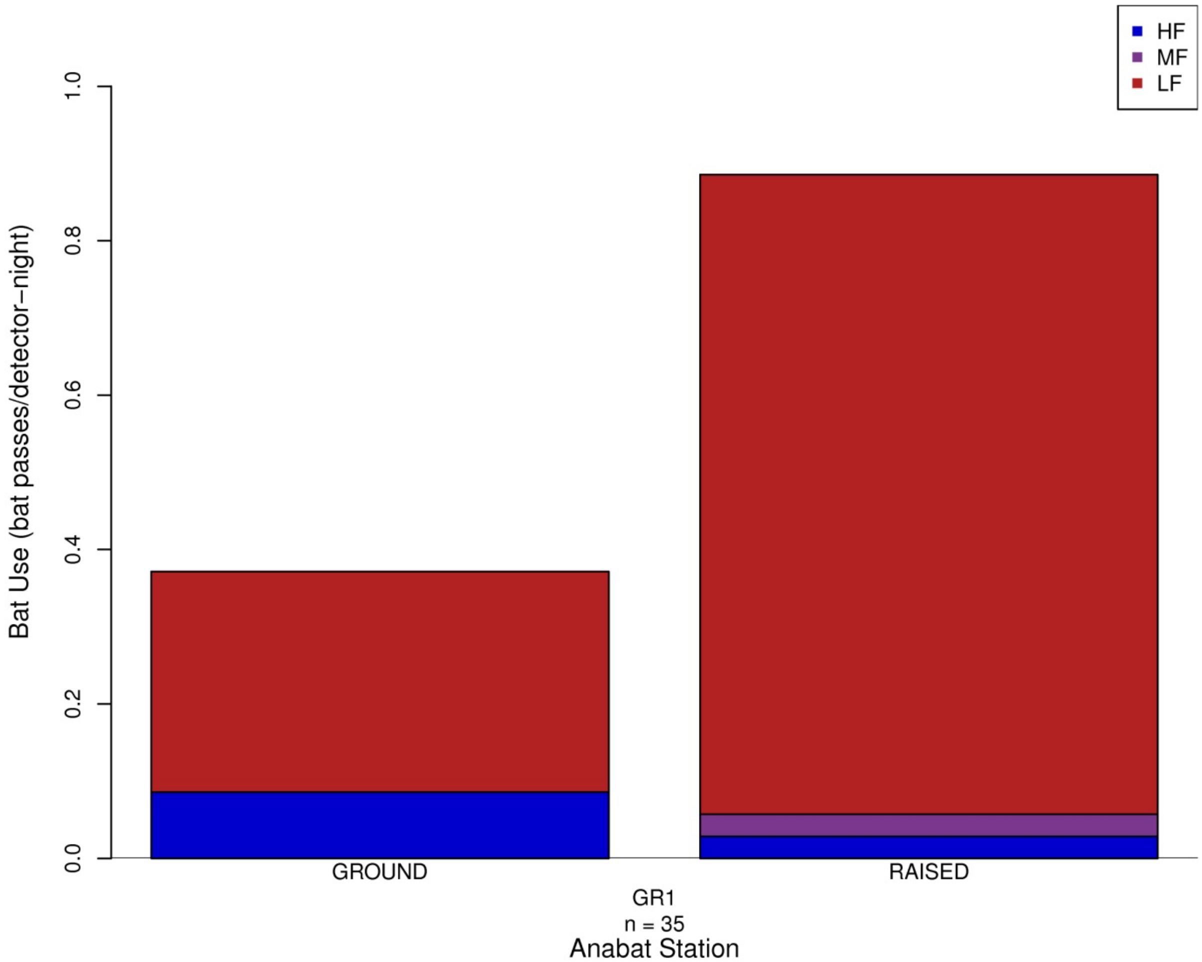


Figure 5. Number of high-frequency (HF), mid-frequency (MF), and low-frequency (LF) bat passes per detector-night (bat use) recorded at paired ground and raised Anabat detectors at station GR1 at the Glacier Ridge Wind Project Area for the study period July 29 – October 20, 2009.

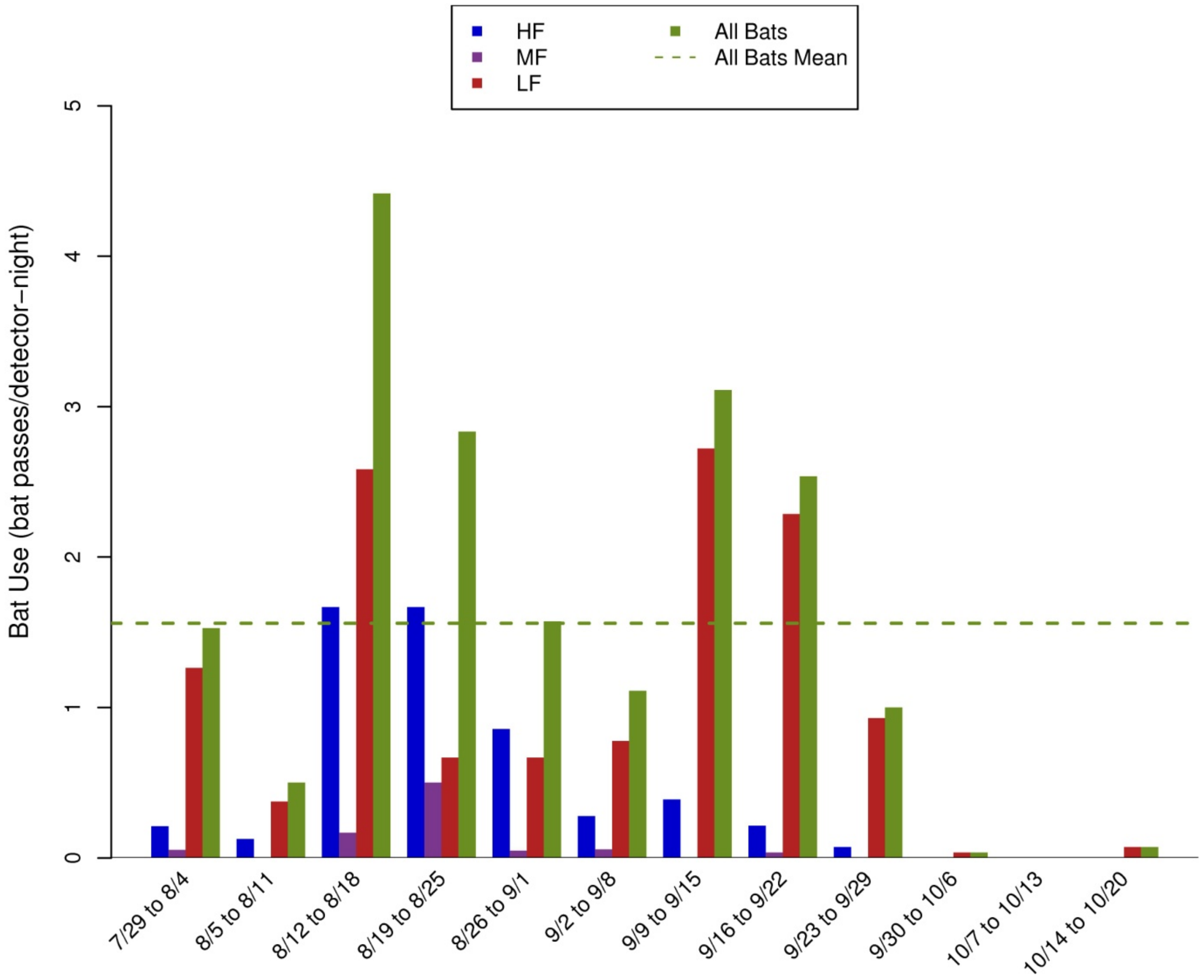


Figure 6. Weekly bat use by high-frequency (HF), mid-frequency (MF), and low-frequency (LF) bats at the Glacier Ridge Wind Project Area for the study period July 29 – October 20, 2009.

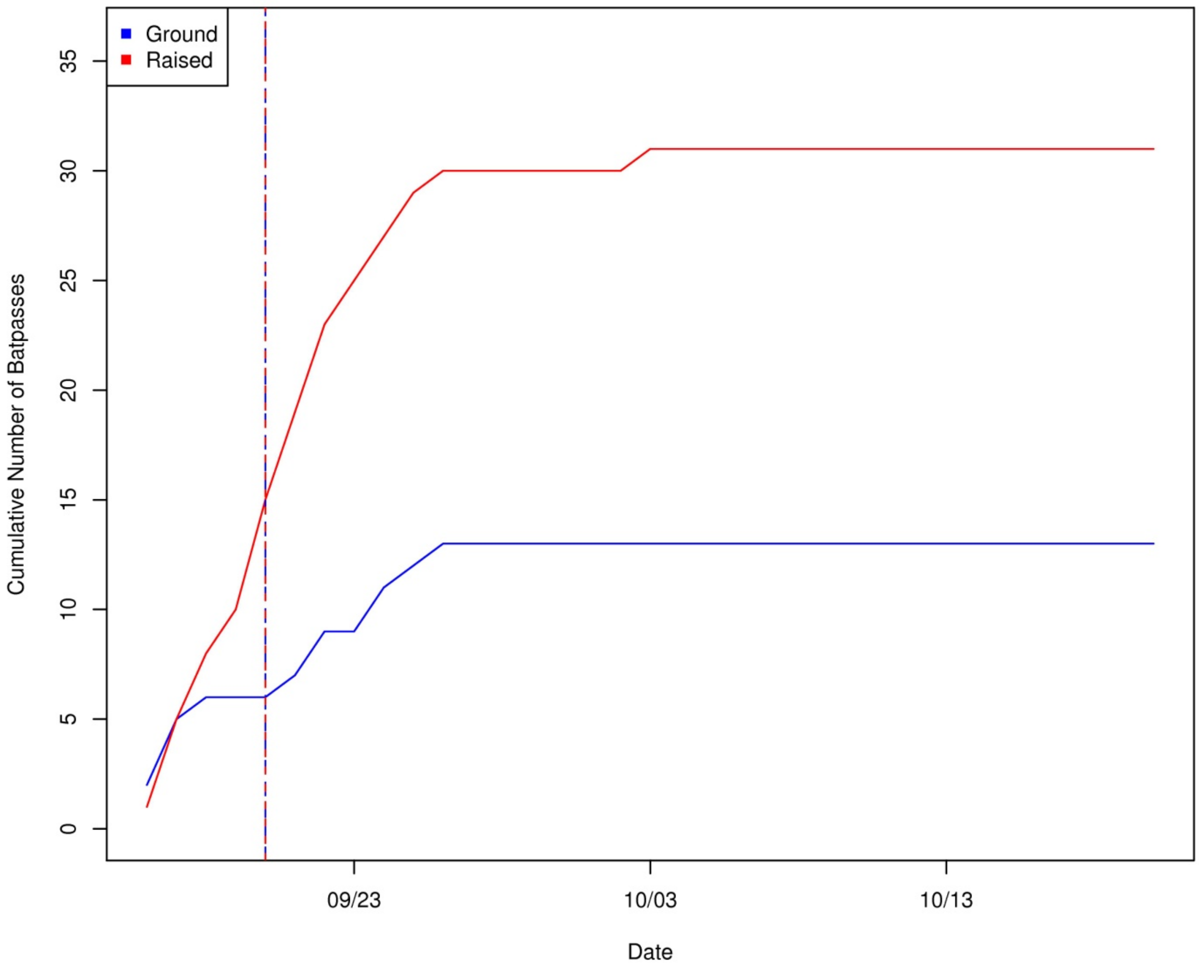


Figure 7. Empirical cumulative distribution of bat passes at paired ground and raised Anabat detectors at station GR1 within the Glacier Ridge Wind Project Area, September 16 – October 20, 2009. Dashed vertical line indicates the point at which 50% of the calls occurred for both ground and raised units, an indication of the median date of bat activity.

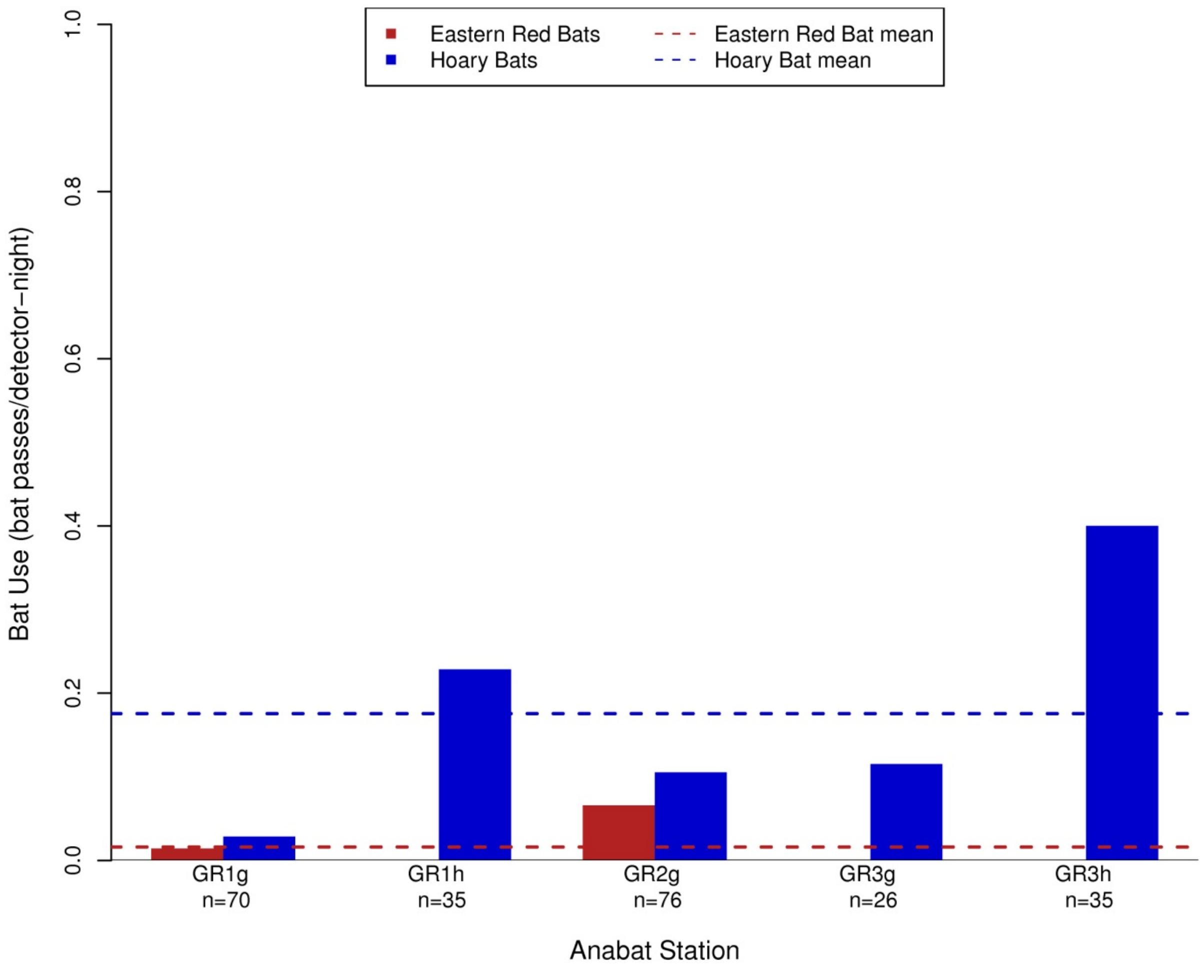


Figure 8. Number of passes per detector–night (bat use) by hoary bats and eastern red bats, by Anabat station at the Glacier Ridge Wind Project Area, for the study period July 29 – October 20, 2009.

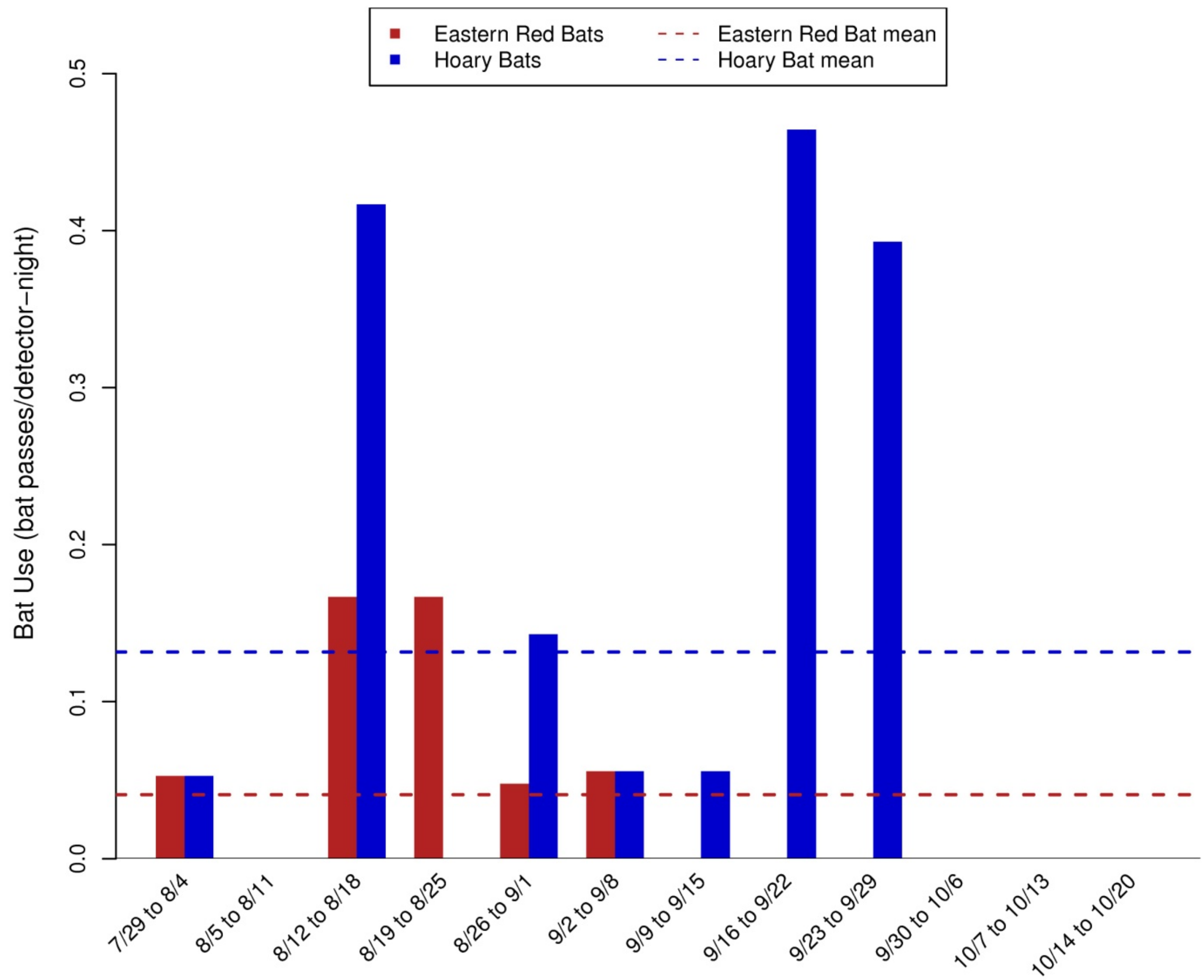


Figure 9. Number of passes per detector–night (bat use) by hoary bats and eastern red bats at the Glacier Ridge Wind Project Area for the study period July 29 – October 20, 2009, presented by week.

BAT ACOUSTIC STUDY PLAN

Glacier Ridge Wind Project
Barnes County, South Dakota

Prepared for:

Glacier Ridge Wind Farm, LLC
330 2nd Avenue South, Suite 820
Minneapolis, Minnesota 55401 USA

Prepared by:

Western EcoSystems Technology, Inc.

4007 State Street, Suite 109
Bismarck, North Dakota

June 29, 2016

WEST Inc.

Table of Contents

INTRODUCTION

Glacier Ridge Wind Farm, LLC, is considering the development of the Glacier Ridge Wind Project (Project or Glacier Ridge), located in Barnes County, North Dakota (Figure 1). The purpose of the bat acoustic study is to determine presence or probable absence of the federally threatened northern long-eared bat (*Myotis septentrionalis*; NLEB). These surveys are anticipated even though the species is currently not prohibited from take by wind energy development as part of the 4(d) rule published (http://www.fws.gov/Midwest/endangered/mammals/nleb/index.html).

To better understand use of the Project area by the NLEB, WEST will follow the U.S. Fish and Wildlife Service's (USFWS) 2016 Range-Wide Indiana Bat Summer Survey Guidelines. Because the Project location is well west of the known range of the Indiana bat, these tasks will focus on the NLEB. Although an initial review of the Project location suggests this site has limited continuous tracts of high-quality habitat for the NLEB (lacks continuous, larger tracts of woodland), the Project is located within the range of the NLEB. As such, it is possible NLEB habitat and potential presence will be identified through this assessment. Based on the habitat mapping, acoustic sampling at multiple sites throughout the Project area will be conducted to detect the presence or probable absence of the federally threatened northern long-eared bat. Per the guidelines, if NLEB are detected with the acoustics, additional surveys may be required, including:

1) Mist-net surveys at sites where acoustic surveys identified and verified NLEB calls. The proposed methods were developed in accordance with current USFWS guidance for these species: the USFWS Range-Wide Indiana Bat Summer Survey Guidelines (USFWS 2016) will follow the National White-Nose Syndrome Decontamination Protocol (USFWS 2012).

2) Radio tracking of any female or juvenile NLEB will be performed for up to seven days after capture to determine if bats are utilizing areas in or near the Project as roost sites or maternity colonies.

Given the Project's location and results of surveys in the immediate vicinity, it is unlikely that NLEB will be detected and no mist netting is planned.

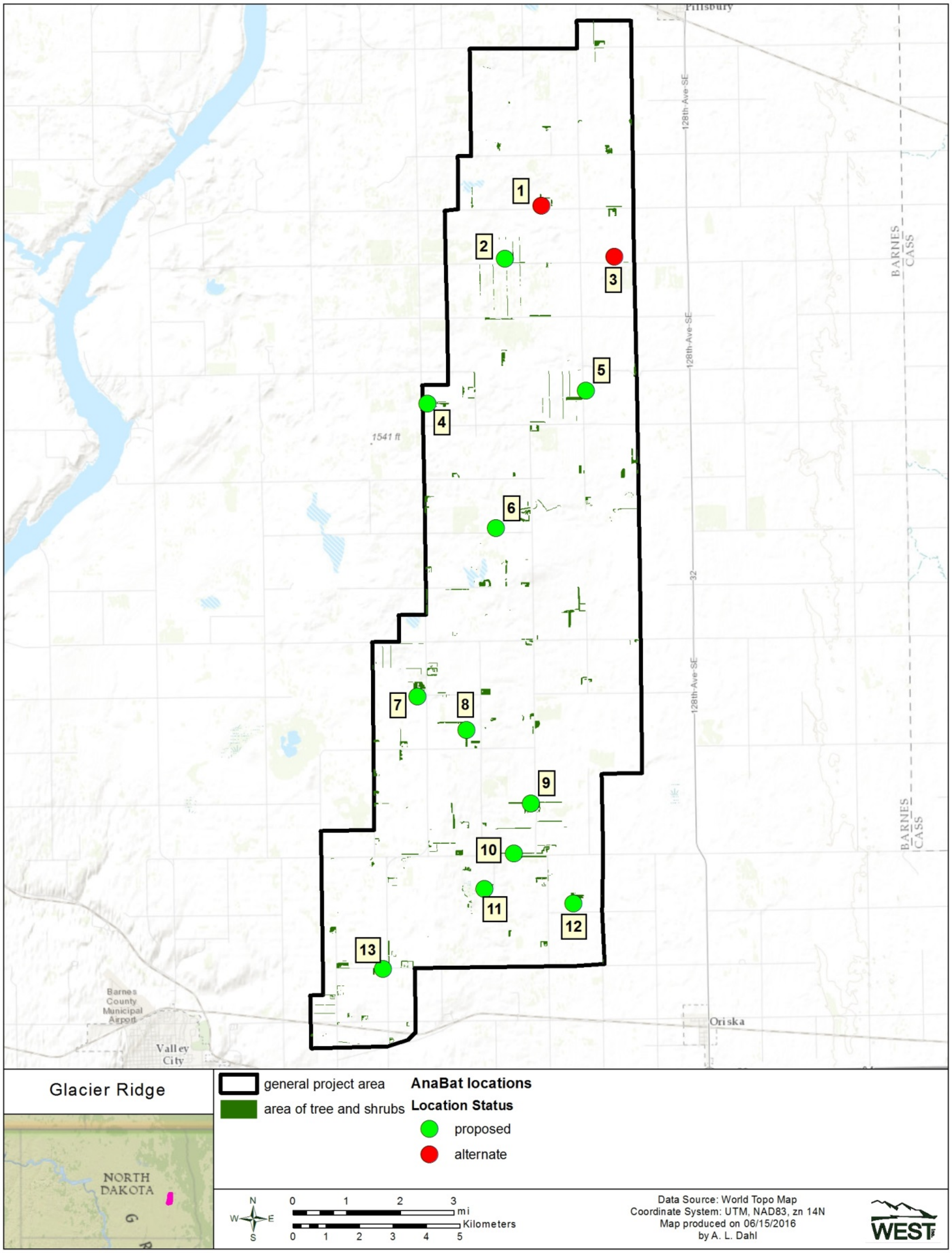


Figure 1. Location of the proposed Glacier Ridge Wind Project and project boundary.

SCOPE OF WORK

The following study plan is intended to provide written documentation of the methods that will be used to conduct presence/absence surveys of the threatened northern long-eared bat at the Project.

Presence/Absence Acoustic Bat Surveys

The objective of the presence/absence acoustic surveys is to assess the presence or probable absence of northern long-eared bats in the Project area; species with adequate quality call signatures will be identified. Acoustic surveys will be conducted between May 15 and August 15, 2016 consistent with USFWS Guidance. Bats will be surveyed using SM2 detectors and Anabat SDII or equivalent detectors. The presence/absence survey will focus on areas within and near forested habitat that is within the Project boundary. According to the USFWS guidelines for non-linear projects, two detector locations will be placed per acoustic survey site for “4 detector nights” (2 detectors for 2 nights; USFWS 2016) for each 123 acres of wooded habitat. The Project area contains approximately 700 acres of wooded habitat, with most being tree rows and shelterbelts around farm homes. Based on the amount of wooded habitat, the Project will therefore require that 11 locations be surveyed for two nights each, for a total of 22 detector-nights. Detectors will be placed in the larger wooded areas, near ponds/wetlands, and other bat features. Detector locations will be at least 656 feet (200 meters) apart. Detectors will be set out for a minimum of two consecutive nights at each location. Only nights in which favorable weather conditions occurred will be used for the analysis, per USFWS Guidance. If unfavorable weather conditions occur during sampling then the sites will be resampled.

All acoustic survey sites will be selected following current USFWS guidelines. Specifically, suitable sites may include: 1) forest-canopy openings, 2) areas near water, 3) wooded fence lines, 4) blocks of recently cleared forest with remnant potential roost trees, 5) road and stream corridors with open canopy or closed canopy greater than 10 m high, and 6) woodland edges. Features that reduce recorded call quality (e.g., vegetation, turbines, or microwave towers) will be avoided or set back from so as call quality is not compromised. Northern long-eared bats are most commonly encountered in riparian areas, near forested ponds, and in forested corridors; these locations will be given higher priority as survey sites, however, the preferred bat features may not always be available or accessible. In these cases, survey sites will be located along forest edges or in forested clearings, which are also recommended acoustic survey locations for these species. The proposed survey site locations may be changed based on field conditions.

Acoustic monitoring will begin 30 minutes prior to sunset and continue for the entire night and each site will be surveyed for two consecutive nights. For each acoustic survey night, the date, start and end time, site description, site coordinates, detector specifics, and weather data (e.g. temperature, cloud cover, moon phase, and wind speed) will be recorded. If no Myotis bats are detected during surveys in which weather conditions were unfavorable throughout all or most of the survey period, then another survey night will be added. Per the 2016 guidelines, unfavorable weather conditions include (a) temperatures that fall below 50°F (10°C); (b) precipitation, including rain and/or heavy fog, that exceeds 30 minutes or continues intermittently during the survey period; and (c) sustained wind speeds greater than 9 miles/hour (4 meters/seconds; 3 on Beaufort scale) for 30 or more minutes SM recorders are fully weatherproof with a custom die-cast aluminum enclosure, and the microphone used is extremely resistant to water, so no additional weatherproof housing is necessary (Britzke et al. 2010; USFWS 2016; Wildlife Acoustics, Inc., Maynard, MA). If Anabat detectors are used, a plastic case and PVC tube will be used for weatherproofing (Britzke et al., 2010) In either case the detector will be placed such that the microphone will be positioned approximately 3 m (10 ft) off of the ground.

Bat calls will be identified using quantitative identification methods, (Kaleidoscope version 3.1.7; www.wildlifeacoustics.com). All calls identified as northern long-eared bat by automated ID software will be examined and verified by a qualified biologist with extensive acoustic identification experience (Dr. Kevin Murray or Mr. Jeff Gruver). In addition, if the automated ID software indicates probable presence of northern long-eared bat at a station on a night (i.e., MLE p-value ≤ 0.05), all calls from that station and night will also be qualitatively reviewed. During qualitative review, call sequences will be reclassified as appropriate if they are not characteristic of northern long-eared bat, or that contain distinct calls produced by another species, or are of insufficient quality.

Following completion of the presence/absence survey, a report will be produced that describes the methods, results, and a discussion of the results. The report will summarize the results of both quantitative (automated acoustic ID) and qualitative analyses, with particular focus on the process used to identify or potentially rule out any federally-listed bat species (USFWS 2016).

LITERATURE CITED

Britzke, E. R., B. A. Slack, M. P. Armstrong, and S. C. Loeb. 2010. Effects of Orientation and Weatherproofing on the Detection of Bat Echolocation Calls. Journal of Fish and Wildlife Management 1(2): 136-141.

US Fish and Wildlife Service (USFWS). 2012. White-Nose Decontamination Protocol – Version 04.12.2016. Available online at: https://www.whitenosesyndrome.org/resource/national-white-nose-syndrome-decontamination-protocol-april-2016

US Fish and Wildlife Service (USFWS). 2016. Range-wide Indiana Bat Summer Survey Guidelines (April 2016). Available: https://www.fws.gov/midwest/endangered/mammals/inba/inbasummersurveyguidance.html

APPENDIX C - AGENCY CORRESPONDENCE

Correspondence with U.S. Fish and Wildlife Service

Holven, Adam

To: Gorman, Kim; Jennrich, Apryl; McNamara, Britt
Subject: RE: Wetland Easement Data for Proposed Project in Barnes County, ND

From: Sue Kvas [mailto:sue_kvas@fws.gov]
Sent: Tuesday, May 03, 2016 11:01 AM
To: Gorman, Kim <Kim.Gorman@tetratech.com>
Subject: RE: Wetland Easement Data for Proposed Project in Barnes County, ND

Hey Kim,

Attached is a map depicting the area of interest. If you have any questions concerning USFWS land interests, please contact the Valley City Wetland Management District, Kurt Tompkins at 701-845-3466.

Thanks,

Sue

Susan Kvas
Supervisory Fish and Wildlife Biologist
US Fish & Wildlife Service
Habitat and Population Evaluation Team – HAPET
3425 Miriam Ave.
Bismarck, ND 58503
Office : 701-355-8541

From: Gorman, Kim [mailto:Kim.Gorman@tetratech.com]
Sent: Tuesday, May 03, 2016 10:07 AM
To: sue_kvas@fws.gov
Cc: McNamara, Britt; Gorman, Kim; Holven, Adam
Subject: RE: Wetland Easement Data for Proposed Project in Barnes County, ND

Sue,

Attached please find the shapefile of the project boundary for consideration. Please let me know if you have difficulties with the files.

Best,
Kimberely

Kimberely Gorman, GISP | **Operations Manager / Senior Program Manager**
Direct: 612.643.2224 | Main: 612.643.2200 | Fax: 612.643.2201
kim.gorman@tetratech.com

Tetra Tech
2001 Killebrew Drive, Suite 141 | Bloomington, Minnesota 55425 | www.tetratech.com

From: Sue Kvas <sue_kvas@fws.gov>
Sent: Tuesday, May 3, 2016 7:14:07 AM
To: Holven, Adam
Subject: RE: Wetland Easement Data for Proposed Project in Barnes County, ND

Hey Adam,

Yes, a shapefile of your project area would be great. I will provide you with a map showing USFWS land interests within the area once I know where the project is.

Thanks,

Sue

Susan Kvas
Supervisory Fish and Wildlife Biologist
US Fish & Wildlife Service
Habitat and Population Evaluation Team – HAPET
3425 Miriam Ave.
Bismarck, ND 58503
Office : 701-355-8541

From: Holven, Adam [mailto:adam.holven@tetratech.com]
Sent: Wednesday, April 27, 2016 9:16 AM
To: sue_kvas@fws.gov
Cc: Bellrichard, Kathy; Jennrich, Apryl
Subject: Wetland Easement Data for Proposed Project in Barnes County, ND

Hi Sue,

We are working on a proposed energy project in Barnes County, ND, east of Valley City, and we would like to get FWS wetland easement data for the project area. I'm working with Anne Marie Griger on this project and she has indicated that you've been able to provide this information for past projects.

What information would you need from me? Would a shapefile of the proposed project area work?

Thanks for your time,
Adam

Adam C. Holven | Senior Archaeologist/Project Manager
Direct: 612.643.2237 | Main: 612.643.2200 | Fax: 612.643.2201
adam.holven@tetratech.com

Tetra Tech
2001 Killebrew Drive, Suite 141 | Bloomington, Minnesota 55425 | www.tetratech.com

Holven, Adam

From: Anne-Marie Griger <Anne-Marie.Griger@res-americas.com>
Sent: Friday, June 10, 2016 10:50 AM
To: Bellrichard, Kathy; Holven, Adam
Cc: Sean Flannery
Subject: FW: Glacier Ridge - Barnes County easment confirmation
Attachments: Barnes 14C Contract and Maps.pdf; Barnes 193X Map 1 of 3.pdf; Barnes 193X Map 2 of 3.pdf

Kathy and Adam,

Please see below and attached. We had some additional information from the USFWS wetland management district that the parcels that were designated as conservation easements in the Glacier Ridge project area are actually covered by two easements: FmHA and wetland easement. According to USFWS, we can site project facilities on these parcels, but we can't impact the mapped wetlands and grassland blocks; however, the only mapping we have is in the attached contracts.

Can you please digitize these and add to the easement shapefiles/KMZ you previously sent on 5/17/16? The grassland blocks should be designated as must avoid.
I believe the wetland basins on the two Barnes 193X maps should have already been digitized, but we need to confirm.

Thanks,

Anne-Marie
Anne-Marie Griger, AICP
Permitting Specialist, Americas

O 512 617 2894 | C 512 213 8501

From: Tompkins, Kurt [mailto:kurt_tompkins@fws.gov]
Sent: Friday, June 10, 2016 8:53 AM
To: Anne-Marie Griger
Subject: Re: Barnes County easment confirmation

Hi, Anne-Marie.

Thanks for calling. I enjoyed our conversation as well.

As it turns out, the purple polygons depict FmHA easements. They are different than wetland easements. We don't have many of them. Some of them have grass blocks much like a grassland easement. I've attached a copy of the easement that covers both of the parcels depicted in purple. We refer to it as Barnes County FmHA Easement 14C. I'll let you read it. If you have any questions, please give me a call or send me an email.

I talked to Chris Kringstad and he said Jamie Middel contacted him and asked about a wind farm in portions of Sections 9 and 10, 141-57. These parcels are also covered by a wetland easement. So, there are two easements "stacked" on these parcels. This is quite rare. So, I've also attached a copy of the maps for the wetland easement that covers these parcels, which is Barnes County Easement 193X.

The bottom line is, as far as the easements are concerned, you can develop a wind farm on these parcels provided you avoid impacts to mapped wetlands and grass blocks.

Hopefully, this makes sense. Again, call or write if you have questions.

Kurt

On Thu, Jun 9, 2016 at 10:46 AM, Anne-Marie Griger <Anne-Marie.Griger@res-americas.com> wrote:

Hello Kurt,

Nice talking with you today. Please see attached map showing conservation easements in purple. The landowner has an existing wind turbine on a similar parcel, and spoke with Chris Kringstad in your office, who stated that he should be allowed to have turbines on these parcels. I would like to confirm if that is the case, and if these parcels were possibly categorized incorrectly and should be wetland easements. We understand that wetlands on wetland easements cannot be drained or filled.

Thank you very much for your assistance,

Anne-Marie

Anne-Marie Griger, AICP

Permitting Specialist, Americas

O 512 617 2894 | C 512 213 8501

Anne-Marie.Griger@res-group.com | www.res-group.com

--

Kurt Tompkins
District Manager
US Fish and Wildlife Service
Valley City Wetland Management District
11515 River Road
Valley City, ND 58072
O - 701-845-3466
C - 701-840-3128
F - 701-845-3482
http://www.fws.gov/refuge/valley_city_wmd/

From:	Clayton Derby <cderby@west-inc.com>
Sent:	Tuesday, April 26, 2016 2:37 PM
To:	Johnson, Sandra K.
Cc:	Sean Flannery; Anne-Marie Griger
Subject:	Glacier Ridge Data Request
Attachments:	temp_project_boundary.cpg; temp_project_boundary.dbf; temp_project_boundary.prj; temp_project_boundary.sbn; temp_project_boundary.sbx; temp_project_boundary.shp; temp_project_boundary.shx

Hello Sandy

Attached please find a generalized project boundary shapefile for the proposed Glacier Ridge project near Valley City. Can you please provide known eagle/raptor nests within 10 miles as well as any data you have on known lek locations and other species info in your database?

Thanks

Clayton Derby
CSO / Wildlife Biologist

Environmental & Statistical Consultants
4007 State Street, Suite 109
Bismarck, ND 58503
(701) 250-1756
(701) 426-5072 Cell
(701) 250-1761 Fax
cderby@west-inc.com
www.west-inc.com

From:	Clayton Derby <cderby@west-inc.com>
Sent:	Friday, May 06, 2016 11:45 AM
To:	Anne-Marie Griger; Sean Flannery
Subject:	Fwd: Glacier Ridge Data Request
Attachments:	baldeagle_May2016.shx; baldeagle_May2016.dbf; baldeagle_May2016.prj; baldeagle_May2016.sbn; baldeagle_May2016.sbx; baldeagle_May2016.shp

FYI

Clayton Derby
CSO / Wildlife Biologist

Environmental & Statistical Consultants
4007 State Street, Suite 109
Bismarck, ND 58503
(701) 250-1756
(701) 426-5072 Cell
(701) 250-1761 Fax
cderby@west-inc.com
www.west-inc.com

---------- Forwarded message ----------
From: **Johnson, Sandra K.** <sajohnson@nd.gov>
Date: Thu, May 5, 2016 at 10:35 AM
Subject: RE: Glacier Ridge Data Request
To: Clayton Derby <cderby@west-inc.com>

Here ya' go, thanks Clayton.

Correspondence with State Historical Society of North Dakota

STATE HISTORICAL SOCIETY OF NORTH DAKOTA

June 8, 2016

Mr. Adam Holven
Senior Archaeologist/Project Manager
Tetra Tech Inc.
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

ND SHPO REF: 16-1190 ND PSC – Proposed Glacier Ridge Wind Farm in Barnes County, North Dakota

Dear Mr. Holven,

Thank you for your preliminary information on ND SHPO REF: 16-1190 ND PSC – Proposed Glacier Ridge Wind Farm in Barnes County, North Dakota.

We recommend a Class I (file search), and a Class III (pedestrian) survey by a permitted architectural historian for standing buildings and structures (including cemeteries) over 50 years old in the visual Area of Potential Effect (APE). This is within a 2 mile radius of individual turbine locations. The purpose is to evaluate any architectural or structural features that may be eligible for nomination to the National Register of Historic Places. At least three out of the seven aspects of integrity used to evaluate historic properties could be impacted by the proposed project: the setting, feeling, and association of historic sites.

Class III archeological (pedestrian) surveys will be warranted for all areas directly impacted by the project, including crane paths, met towers, access roads, staging areas, transmissions lines and turbine pads. As part of the Class III Inventory, NDCRS site updates should be submitted on all sites resurveyed. If the project APE changes, we will request additional inventories, surveys and consultation.

Thank you for the opportunity to review this project to date. We look forward to further review of cultural resource surveys and site forms, and updates as the project siting occurs. 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,

Claudia J. Berg, State Historic Preservation Officer (North Dakota) and
Director State Historical Society of North Dakota

Tetra Tech Inc.

2001 Killebrew Dr., Suite 141 ♦ Bloomington, MN 55425 ♦ (612) 643-2200 ♦ FAX (612) 643-2201

RECORD OF COMMUNICATION

☒ TELEPHONE CONVERSATION
- ☐ Incoming
- ☒ Outgoing

☐ MEETING

DATE: 6/17/2016
TIME: 10:30 pm
RECORDED BY: Adam Holven
PROJECT NO.:

SUBJECT: Architectural Studies for Glacier Ridge Wind Energy Project

PARTICIPANTS (*Denotes part-time attendance)	ORGANIZATION	TELEPHONE/ext.
Susan Quinnell, Review and Compliance Coordinator	ND State Historic Preservation Office	701-328-3576
Adam Holven	Tetra Tech	612-643-2237

SUMMARY:

Mr. Holven called Ms. Quinnell to discuss the recommendation for a Class III Cultural Resource Inventory for architectural resources for the Glacier Ridge Wind Energy Project. Mr. Holven confirmed that the ND SHPO was not aware of any unique architectural resources within the ND SHPO proposed 2-mile study area or of any resources located beyond the 2-mile study area that the ND SHPO would like to see assessed. Ms. Quinnell indicated that she was not aware of any unique resources in the area nor did she indicate that she had special concerns for resources located beyond the 2-mile study area. She indicated that the assessment of resources within the 2-mile study area should be sufficient.

ACTION ITEMS	*DUE DATE*

DISTRIBUTION: ☒ PARTICIPANTS ☐ OTHER ☐ FILE

Correspondence with North Dakota Geological Survey

North Dakota Geological Survey

Edward C. Murphy - State Geologist
Department of Mineral Resources
Lynn D. Helms - Director
North Dakota Industrial Commission
www.state.nd.us/ndgs

June 21, 2016

Mr. Adam Holven
Tetra Tech, Inc.
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

Re: Proposed Glacier Ridge Wind Farm – Barnes County, North Dakota

Dear Mr. Holven,

The North Dakota Geological Survey (NDGS) appreciates the notification and opportunity to review and provide comment on your proposed energy development project. The May 31, 2016 information request letter received by our office was reviewed on June 10th and 20th, 2016. Regarding the construction of a new wind farm at the proposed location, our agency would not have any properties in the described project areas under ownership nor of current property interest.

As you may be aware, the proposed project area is located in the Glaciated Plains physiographic region of the state, bordered on the west by the Missouri Coteau and the Red River Valley to the east. The majority of the project area is underlain by as much as 200 feet of unconsolidated glacial "till" sediments derived from Pleistocene glacial processes associated with the Kensal-Oakes Moraine. These unconsolidated glacial sediments are underlain by bedrock of the Cretaceous Pierre and Niobrara Formations in the western and eastern subsurface project areas, respectively. Shales of the Pierre Formation have been found to exhibit slope stability problems along natural and engineered slopes throughout the Sheyenne River Valley, and in particular throughout the Sheyenne River Valley in Valley City. Glaciolacustrine silts and clays from glacial Lake Lanona, whose engineering properties at this time are not well understood, are also found to occur in the southwestern project area.

Our Paleontological Resources Program staff also reviewed this request and while not likely, if any excavations do encounter paleontological resources, this should be communicated to our paleontology program staff as soon as possible.

Recently completed geologic mapping work in the Valley City area and additional geologic information for the proposed project area can be found on our website at: www.dmr.nd.gov/ndgs/ Please feel free to contact our offices at (701) 328-8000 or via email at fjanderson@nd.gov at any time if there are any additional questions or comments.

Sincerely,

North Dakota Geological Survey:

Fred J. Anderson,
Geologist

FJA\

Correspondence with North Dakota Department of Health

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

June 13, 2016

Mr. Adam Holven
Tetra Tech, Inc.
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

Re: Glacier Ridge Wind Farm, Barnes County, North Dakota

Dear Mr. Holven:

This department has reviewed the information concerning the above-referenced project submitted under date of May 31, 2016, 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. Aggregate to be used for road construction should not contain any erionite. Aggregate sources should be tested for erionite following guidelines found at www.ndhealth.gov/EHS/Erionite. For questions regarding erionite testing, please call Scott Radig at 701-328-5166.

3. 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.

4. 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.

5. 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.

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.
c: Scott Radig, Director, Division of Waste Management

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.

Correspondence with North Dakota State Water Commission

North Dakota State Water Commission

900 EAST BOULEVARD AVENUE, DEPT 770 • BISMARCK, NORTH DAKOTA 58505-0850
(701) 328-2750 • TTY 1-800-366-6888 or 711 • FAX (701) 328-3696 • http://swc.nd.gov

June 24, 2016

Adam Holven
Tetra Tech Inc.
2001 Killebrew Drive, STE 141
Bloomington, MN 55425

Dear Mr. Holven:

This is in response to your request for review of environmental impacts associated with the Glacier Ridge Wind Farm project in Barnes 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. No floodplain permits are necessary relative to the National Flood Insurance Program.

- The ND State Water Commission (Commission) maintains a network of observation/monitor water wells and the location of gaging stations throughout the state, and many are located close to public right-of-ways. The location information can be obtained from the Commission's website at: http://swc.nd.gov.; then click on "Information and Education"; then click on "Maps/GIS and Data," then click on "Map Services;" then click on the "Ground and Surface Water Information" map. Please inform the Water Appropriations Division of the Commission at 701-328-2754, if gaging stations or water wells may be affected by the project or accidently damaged.

- The project may require a Surface Drain permit from the Office of the State Engineer, if there are any wetlands to be filled. An "Application for Surface Drain" is enclosed. Please contact Dwight Comfort at 701-328-4960, if you have questions concerning the permit.

- 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.

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:dm/1570

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:

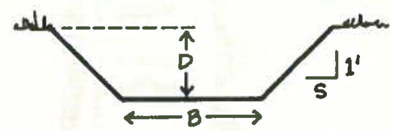
(2) LEGAL DESCRIPTION - DRAIN CENTERLINE: [use separate sheet(s) if necessary]	1/4	SECTION	TOWNSHIP	RANGE
	1/4	SECTION	TOWNSHIP	RANGE
	1/4	SECTION	TOWNSHIP	RANGE
(3) LEGAL DESCRIPTION - DRAIN OUTLET:	1/4 1/4	SECTION	TOWNSHIP	RANGE

(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):	

FOR USE BY WATER RESOURCE DISTRICT AND STATE ENGINEER

❒ The Water Resource District Board has investigated according to NDAC Section 89-02-01-09.2.

❒The proposed drainage (❒ will ❒ will not) flood or adversely affect lands of downstream landowners.

This application is hereby:

❒ Denied Signature: ______________________________
Chairman or Secretary of Water Resource District Board

❒ Approved Date: ______________________________

(1) The State Engineer or Water Resource District Board may revoke or modify the project and the rights granted under the permit to protect the public health, safety, and welfare; to protect property; or to ensure the orderly control of water resources.

(2) Construction must be completed within two years from the date of final approval.

This application:

❒ does Involve drainage of state-wide or Interdistrict significance

❒ does not involve drainage of state-wide or interdistrict significance

If the State Engineer has determined that this application does not involve drainage of state-wide or Interdistrict significance, approval by the Water Resource District Board constitutes a permit to drain.

If the State Engineer has determined that this application involves drainage of state-wide or interdistrict significance, approval by both the Water Resource District Board and the State Engineer must be given to constitute a permit to drain.

This application involving drainage of state-wide or interdistrict significance is:

❒ Denied Signature: ______________________________
State Engineer

❒ Approved Date: ______________________________

CONDITIONS:
(1) The State Engineer may revoke or modify the project and the rights granted under the permit to protect the public health, safety, and welfare; to protect property; or to ensure the orderly control of water resources.
(2) Construction must be completed within two years from the date of final approval.

Mail to:

Office of the State Engineer
900 East Boulevard Avenue, Dept 770
Bismarck, ND 58505

Correspondence with North Dakota Game and Fish Department

Glacier Ridge - Agency Meeting Summary

MEETING Invitees/Attendees:
John Schumacher, NDGFD
Sean Flannery, RES (phone)
Anne-Marie Griger, RES (phone)
Clayton Derby, WEST
Kevin Shelley, USFWS, unable to attend

PREPARED BY: Clayton Derby, WEST

DATE: April 28, 2016

On April 28, 2016, RES America Developments Inc. (RES) met with the North Dakota Game and Fish Department (NDGFD) to provide information on past wildlife studies as well as the planned wildlife survey efforts associated with the Glacier Ridge Wind Project (Project) in Barnes County, North Dakota. The U.S. Fish and Wildlife Service was invited but unable to attend. The meeting was held at the NDGFD office, Bismarck.

The following is a summary of the topics discussed at the meeting regarding the Project.

I. Wildlife Studies

Clayton Derby of WEST provided an overview of the studies previously conducted as well as those planned for 2016/2017:

- Surveys completed prior to 2016
  - Critical Issues Analysis and agency consultation - 2009
  - Avian point counts – 2009/2010
  - Raptor nest surveys – 2010 and again in 2012
  - Acoustic bat surveys - 2010
- RES met with the NDGFD (John Schumacher) and the USFWS (Heidi Riddle) in October 2011
  - That meeting included an overview of the biology of the Glacier Ridge site
  - a review of the methods for Tier 3 wildlife surveys conducted in 2009-2010
  - a review of the results from the Tier 3 wildlife surveys from 2009-2010
- Surveys conducted or planned for 2016-2017
  - Avian use surveys – increased number of locations, 60 min surveys
  - Raptor nest surveys – aerial surveys, 10 mile buffer
  - Habitat mapping – to assist in other survey efforts (NLEB, Dakota skipper) as well as to address request from USFWS in 2011.
  - Stage 1 Eagle Risk Assessment
  - Northern long-eared bat presence/absence surveys – pending habitat mapping and need, currently addressed via 4(d) Rule.

See the attached presentation for details on the topics covered. There was general agreement that the studies and methods described in the presentation were the appropriate level of study for the Project. Mr. Schumacher indicated that the NDGFD primary concern is to avoid or minimize impacts to native grasslands, which the Project does overall by being sited in this portion of North Dakota.

One bald eagle nest was identified in the 2016 nest survey near the western boundary of the Glacier Ridge Project. RES is working to site turbines 1.5 miles away from this nest at a minimum, and WEST is collecting additional data in the vicinity of this nest to better understand use.

RES will provide updates as additional information becomes available through surveys.

"VARIETY IN HUNTING AND FISHING"

NORTH DAKOTA GAME AND FISH DEPARTMENT

100 NORTH BISMARCK EXPRESSWAY BISMARCK, NORTH DAKOTA 58501-5095 PHONE 701-328-6300 FAX 701-328-6352

July 1, 2016

Adam Holven
Tetra Tech, Inc.
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

Dear Mr. Holven:

RE: Proposed Glacier Ridge Wind Farm
Barnes County, North Dakota

The North Dakota Game and Fish Department has reviewed this project for wildlife concerns.

A primary concern with wind power development is the disturbance of native prairie associated with construction of turbines, access roads, and other associated facilities. We ask that work within native prairie be avoided to the extent possible. This could include micro-siting turbines onto adjacent previously disturbed land, locating access roads on existing section line trails rather than across undisturbed native prairie, etc. Avoidance of native prairie areas reduces impacts to a variety of grassland species including Sprague's pipit and Dakota skipper. We also suggest the US Fish and Wildlife Service Land-Based Wind Energy Guidelines be implemented as appropriate during the development of this project.

The National Wetland Inventory indicates various wetlands located within the proposed project area. We recommend that any unavoidable wetland impacts be replaced in kind, above-ground appurtenances not be placed in wetland areas, and no alterations be made to existing drainage patterns.

We ask that collection lines be buried whenever possible, and any necessary overhead lines be marked when placed over perennial streams or sited in close proximity to wetland complexes to minimize possible avian impacts. The publication "Reducing Avian Collisions with Power Lines: the State of the Art in 2012" provides a range of management options which can be used to reduce avian losses.

Aerial surveys should be conducted for raptor nests before construction begins. A ½-mile construction buffer should be implemented around active eagle nest sites (known occupied within the past 5 years). Ms. Sandra Johnson, Conservation Biologist, can be contacted at 701-328-6327 for additional information on eagle nest sites in the state.

We also recommend that routine monitoring for avian and bat mortality be included as part of the facility maintenance plan for the life of the project. We would appreciate being kept informed as this project progresses, and if possible, we would like the GPS coordinates for each turbine after the site has been established.

Sincerely,

Greg Link
Chief
Conservation & Communication Division

js

Correspondence with North Dakota Department of Transportation

North Dakota Department of Transportation

Grant Levi, P.E.
Director

Jack Dalrymple
Governor

June 8, 2016

Adam Holven
Tetra Tech
2001 Killebrew Dr, Suite 141
Bloomington, MN 55425

APPLICATION FOR A CERTIFICATE OF SITE COMPATABILITY FOR PROPOSED GLACIER RIDGE WIND FARM, BARNES COUNTY, NORTH DAKOTA

We have reviewed your May 31, 2016, letter.

This project should have no adverse effect on the North Dakota Department of Transportation highways.

However, if because of this project any work needs to be done on highway right-of-way, appropriate permits and risk management documents will need to be obtained from the Department of Transportation District Engineer, John Thompson at 701-845-8800.

Robert Fode

ROBERT A. FODE, P.E., DIRECTOR – OFFICE OF PROJECT DEVELOPMENT

57/raf/js
c: John Thompson, Valley City District Engineer

608 East Boulevard Avenue • Bismarck, North Dakota 58505-0700
Information: 1-855-NDROADS (1-855-637-6237) • FAX: (701) 328-0310 • TTY: 711 • www.dot.nd.gov

Correspondence with Department of the Army Corps of Engineers

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
NORTH DAKOTA REGULATORY OFFICE
1513 SOUTH 12TH STREET
BISMARCK ND 58504-6640

REPLY TO
ATTENTION OF

July 6, 2016

North Dakota Regulatory Office

Mr. Adam Holven
Tetra Tech, Inc.
2001 Killebrew Drive, Suite 141
Bloomington, Minnesota 55425

Dear Mr. Holven:

This is in response to your letter dated May 31, 2016, requesting comments on the proposed **Glacier Ridge Wind Farm Project** proposed to be located northeast of Valley City in Barnes County, North Dakota.

U. S. Army Corps of Engineers Regulatory Offices administer Section 10 of the Rivers and Harbors Act (Section 10) and Section 404 of the Clean Water Act (Section 404). A Section 10 permit would be required for work impacting navigable waters, this includes work over, through, or under Section 10 waters. Section 10 waters in North Dakota are the Missouri River (including Lake Sakakawea and Lake Oahe), Yellowstone River, James River (south of the railroad tracks in Jamestown, North Dakota), Bois de Sioux River, Red River of the North, and Upper Des Lacs Lake. A Section 404 permit would be required for the discharge of dredge or fill material (temporarily or permanently) in waters of the United States. Waters of the United States may include, but are not limited to, rivers, streams, ditches, coulees, lakes, ponds, and their adjacent wetlands. Fill material includes, but is not limited to, rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mines or other excavation activities and materials used to create any structure or infrastructure in waters of the United States.

Complete the enclosed application and mail it to the letterhead address if the project requires a Section 10/404 permit.

If we can be of further assistance or should you have any questions regarding our program, please do not hesitate to contact this office by letter or phone at (701) 255-0015, extension 2003.

Sincerely,

Toni R. Erhardt
Project Manager
North Dakota Regulatory Office

Enclosure

Instructions for Preparing a Department of the Army Permit Application

Blocks 1 through 4. To be completed by Corps of Engineers.

Block 5. Applicant's Name. Enter the name and the E-mail address of the responsible party or parties. If the responsible party is an agency, company, corporation, or other organization, indicate the name of the organization and responsible officer and title. If more than one party is associated with the application, please attach a sheet with the necessary information marked Block 5.

Block 6. Address of Applicant. Please provide the full address of the party or parties responsible for the application. If more space is needed, attach an extra sheet of paper marked Block 6.

Block 7. Applicant Telephone Number(s). Please provide the number where you can usually be reached during normal business hours.

Blocks 8 through 11. To be completed, if you choose to have an agent.

Block 8. Authorized Agent's Name and Title. Indicate name of individual or agency, designated by you, to represent you in this process. An agent can be an attorney, builder, contractor, engineer, or any other person or organization. Note: An agent is not required.

Blocks 9 and 10. Agent's Address and Telephone Number. Please provide the complete mailing address of the agent, along with the telephone number where he / she can be reached during normal business hours.

Block 11. Statement of Authorization. To be completed by applicant, if an agent is to be employed.

Block 12. Proposed Project Name or Title. Please provide name identifying the proposed project, e.g., Landmark Plaza, Burned Hills Subdivision, or Edsall Commercial Center.

Block 13. Name of Waterbody. Please provide the name of any stream, lake, marsh, or other waterway to be directly impacted by the activity. If it is a minor (no name) stream, identify the waterbody the minor stream enters.

Block 14. Proposed Project Street Address. If the proposed project is located at a site having a street address (not a box number), please enter it here.

Block 15. Location of Proposed Project. Enter the latitude and longitude of where the proposed project is located. If more space is required, please attach a sheet with the necessary information marked Block 15.

Block 16. Other Location Descriptions. If available, provide the Tax Parcel Identification number of the site, Section, Township, and Range of the site (if known), and / or local Municipality that the site is located in.

Block 17. Directions to the Site. Provide directions to the site from a known location or landmark. Include highway and street numbers as well as names. Also provide distances from known locations and any other information that would assist in locating the site. You may also provide description of the proposed project location, such as lot numbers, tract numbers, or you may choose to locate the proposed project site from a known point (such as the right descending bank of Smith Creek, one mile downstream from the Highway 14 bridge). If a large river or stream, include the river mile of the proposed project site if known

Block 18. Nature of Activity. Describe the overall activity or project. Give appropriate dimensions of structures such as wing walls, dikes (identify the materials to be used in construction, as well as the methods by which the work is to be done), or excavations (length, width, and height). Indicate whether discharge of dredged or fill material is involved. Also, identify any structure to be constructed on a fill, piles, or float-supported platforms.

The written descriptions and illustrations are an important part of the application. Please describe, in detail, what you wish to do. If more space is needed, attach an extra sheet of paper marked Block 18.

Block 19. Proposed Project Purpose. Describe the purpose and need for the proposed project. What will it be used for and why? Also include a brief description of any related activities to be developed as the result of the proposed project. Give the approximate dates you plan to both begin and complete all work.

Block 20. Reasons for Discharge. If the activity involves the discharge of dredged and/or fill material into a wetland or other waterbody, including the temporary placement of material, explain the specific purpose of the placement of the material (such as erosion control).

Block 21. Types of Material Being Discharged and the Amount of Each Type in Cubic Yards. Describe the material to be discharged and amount of each material to be discharged within Corps jurisdiction. Please be sure this description will agree with your illustrations. Discharge material includes: rock, sand, clay, concrete, etc.

Block 22. Surface Areas of Wetlands or Other Waters Filled. Describe the area to be filled at each location. Specifically identify the surface areas, or part thereof, to be filled. Also include the means by which the discharge is to be done (backhoe, dragline, etc.). If dredged material is to be discharged on an upland site, identify the site and the steps to be taken (if necessary) to prevent runoff from the dredged material back into a waterbody. If more space is needed, attach an extra sheet of paper marked Block 22.

Block 23. Description of Avoidance, Minimization, and Compensation. Provide a brief explanation describing how impacts to waters of the United States are being avoided and minimized on the project site. Also provide a brief description of how impacts to waters of the United States will be compensated for, or a brief statement explaining why compensatory mitigation should not be required for those impacts.

Block 24. Is Any Portion of the Work Already Complete? Provide any background on any part of the proposed project already completed. Describe the area already developed, structures completed, any dredged or fill material already discharged, the type of material, volume in cubic yards, acres filled, if a wetland or other waterbody (in acres or square feet). If the work was done under an existing Corps permit, identity the authorization, if possible.

Block 25. Names and Addresses of Adjoining Property Owners, Lessees, etc., Whose Property Adjoins the Project Site. List complete names and full mailing addresses of the adjacent property owners (public and private) lessees, etc., whose property adjoins the waterbody or aquatic site where the work is being proposed so that they may be notified of the proposed activity (usually by public notice). If more space is needed, attach an extra sheet of paper marked Block 24.

Information regarding adjacent landowners is usually available through the office of the tax assessor in the county or counties where the project is to be developed.

Block 26. Information about Approvals or Denials by Other Agencies. You may need the approval of other federal, state, or local agencies for your project. Identify any applications you have submitted and the status, if any (approved or denied) of each application. You need not have obtained all other permits before applying for a Corps permit.

Block 27. Signature of Applicant or Agent. The application must be signed by the owner or other authorized party (agent). This signature shall be an affirmation that the party applying for the permit possesses the requisite property rights to undertake the activity applied for (including compliance with special conditions, mitigation, etc.).

DRAWINGS AND ILLUSTRATIONS

General Information.

Three types of illustrations are needed to properly depict the work to be undertaken. These illustrations or drawings are identified as a Vicinity Map, a Plan View or a Typical Cross-Section Map. Identify each illustration with a figure or attachment number.

Please submit one original, or good quality copy, of all drawings on 8½ x11 inch plain white paper (electronic media may be substituted). Use the fewest number of sheets necessary for your drawings or illustrations.

Each illustration should identify the project, the applicant, and the type of illustration (vicinity map, plan view, or cross-section). **While illustrations need not be professional (many small, private project illustrations are prepared by hand), they should be clear, accurate, and contain all necessary information.**

Vicinity Map

The vicinity map you provide will be printed in any public notice that is issued and used by the Corps of Engineers and other reviewing agencies to locate the site of the proposed activity. You may use an existing road map or US Geological Survey topographic (scale 1:24,000) as the vicinity map. Please include sufficient details to simplify locating the site from both the waterbody and from land. Identify the source of the map or chart from which the vicinity map was taken and, if not already shown, add the following:

- location of activity site (draw an arrow showing the exact location of the site on the map).
- latitude, longitude, river mile, if known, and/or other information that coincides with Block 6 on the application form.
- name of waterbody and the name of the larger creek, river, by, etc., that the waterbody is immediately tributary to.
- names, descriptions and location of landmarks.
- name of all applicable political (county, parish, borough, town, city, etc.) jurisdictions
- name of and distance to nearest town, community, or other identifying locations
- names or numbers of all roads in the vicinity of the site.
- north arrow.
- scale.

Plan View

The plan view shows the proposed activity as if you were looking straight down on it from above. your plan view should clearly show the following:

- Name of waterbody (river, creek, lake, wetland, etc.) and river mile (if known) at location of activity.
- Existing shorelines.
- Mean high and mean low water lines and maximum (spring) high tide line in tidal areas.
- Ordinary high water line and ordinary low water line if the proposed activity is located on a non-tidal waterbody.
- Average water depths around the activity.
- Dimensions of the activity and distance it extends from the high water line into the water.
- Distances to nearby Federal projects, if applicable.
- Distance between proposed activity and navigation channel, where applicable.
- Location of structures, if any, in navigable waters immediately adjacent to the proposed activity.
- Location of any wetlands (marshes, swamps, tidal flats, etc.)
- North arrow.
- Scale.
- If dredged material is involved, you must describe the type of material, number of cubic yards, method of handling, and the location of fill and spoil disposal area. The drawing should show proposed retention levees, weirs, and/or other means for retaining hydraulically placed materials.
- Mark the drawing to indicate previously completed portions of the activity.

Cross Section View and/or Elevation

The elevation and/or cross section view is a scale drawing that shows the side, front, or rear of the proposed activity. If a section view is shown, it represents the proposed structure as it would appear if cut internally for display. Your elevation should clearly show the following:

- Water elevations as shown in the plan view.

- Water depth at water-ward face of proposed activity or, if dredging is proposed, dredging and estimated disposal grades.
- Dimensions from mean high water line (in tidal waters) of proposed fill or float, or high tide line for pile supported platform. Describe any structures to be built on the platform.
- Cross section of excavation or fill, including approximate side slopes.
- Graphic or numerical scale.
- Principal dimensions of the activity

Notes on Drawings*

- Names of adjacent property owners who may be affected. Complete names and addresses should be shown in Block 5 on ENG Form 4345.
- Legal property description: Number, name of subdivision, block, and lot number. Section, Township, and Range (if applicable) from plot, deed, or tax assessment.
- Photographs of the site of the proposed activity are not required; however, pictures are helpful and may be submitted as part of any application.
- **While illustrations need not be professional (many small, private project illustrations are prepared by hand), they should be clear, accurate, and contain all necessary information.**

* Drawings should be as clear and simple as possible (ie, not too "busy").

U.S. ARMY CORPS OF ENGINEERS **APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT** 33 CFR 325. The proponent agency is CECW-CO-R.	***Form Approved -*** ***OMB No. 0710-0003*** ***Expires: 31-AUGUST-2013***

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETE

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME First - Middle - Last - Company - E-mail Address -	8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required) First - Middle - Last - Company - E-mail Address -
6. APPLICANT'S ADDRESS: Address- City - State - Zip - Country -	9. AGENT'S ADDRESS: Address- City - State - Zip - Country -
7. APPLICANT'S PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax	10. AGENTS PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax

STATEMENT OF AUTHORIZATION

11. I hereby authorize, ________________________ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

______________________________ ____________
SIGNATURE OF APPLICANT DATE

NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)

13. NAME OF WATERBODY, IF KNOWN (if applicable)	14. PROJECT STREET ADDRESS (if applicable) Address City - State- Zip-
15. LOCATION OF PROJECT Latitude: °N Longitude: °W	

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions)

State Tax Parcel ID Municipality

Section - Township - Range -

17. DIRECTIONS TO THE SITE

18. Nature of Activity (Description of project, include all features)

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres

or

Linear Feet

23. Description of Avoidance, Minimization, and Compensation (see instructions)

24. Is Any Portion of the Work Already Complete? ☐ Yes ☐ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address-

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT DATE SIGNATURE OF AGENT DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

Copy of Form Letter and List of Agencies Contacted

May 31, 2016

NAME
TITLE
AGENCY
ADDRESS
CITY, North Dakota ZIP

Subject: Information Request for the Proposed Glacier Ridge Wind Farm in Barnes County, North Dakota

Dear NAME:

Tetra Tech has been contracted by Glacier Ridge Wind, LLC (Glacier Ridge) to prepare an application for a Certificate of Site Compatibility for the proposed Glacier Ridge Wind Farm (the Project), in accordance with North Dakota Century Code (NDCC) Section 49-22-07. This proposed Project located in Barnes County would consist of approximately 300 megawatts (MW). As part of that application, Tetra Tech is conducting an investigation of property in Barnes County located northeast of Valley City; this area is referred to as the Study Area. The Project Study Area shown in the attached figure is the primary focus of Tetra Tech's investigation.

The Project Study Area would include portions of the following tracts:

County	Township	Range	Sections
Barnes	140 N	57 W	1 – 11, 17 – 20
Barnes	140 N	58 W	1, 12 – 13, 24
Barnes	141 N	56 W	5 – 8, 17 – 20, 29 – 31
Barnes	141 N	57 W	1 – 18, 20 – 36
Barnes	141 N	58 W	1, 12 – 13
Barnes	142 N	56 W	5 – 8, 17 – 19, 30 – 31
Barnes	142 N	57 W	1 – 3, 10 – 15, 22 – 27, 34 – 36
Barnes	143N	56 W	6 – 7, 17 – 20, 29 – 32
Barnes	143 N	57 W	1, 11 – 15, 22 – 27, 34 – 36

Per Section 69-06-01-05 of the North Dakota Public Service Commission (PSC)'s administrative rules, we are consulting your agency for assistance in identifying concerns or issues within the boundaries of the tracts listed above that would influence a decision regarding the use of the land, as well as applicable permits that may be required from your office.

Tetra Tech Inc.
2001 Killebrew Drive, Suite 141, Bloomington, MN 55425
Tel 612-643-2200 Fax 612-643-2201 tetratech.com

A list of previously conducted, ongoing, and planned biological studies and surveys is included below:

Study/Survey	Status	Year
Bat use survey	Completed	2009
Baseline wildlife studies	Completed	2010
Spring raptor nest survey	Completed	2012
Avian and eagle use studies	Underway	2016
Aerial raptor nest survey	Completed	2016
Bat habitat and acoustic study	Underway	2016
Desktop and field-based habitat mapping	Planned for summer	2016
BBCS	Planned	2016
Eagle Nest Data from NDGF	Received	May 2016

On April 28, 2016, Glacier Ridge held a meeting with North Dakota Game and Fish (NDGF) introducing the Project. Representatives from the U.S. Fish and Wildlife Service (USFWS) were also invited to this meeting; however, no USFWS representatives were present. The aforementioned biological studies were presented in this meeting. The NDGF generally agreed that these studies were an appropriate level of study for the Project. The NDGF indicated that their primary concern with regard to wind energy is avoidance or minimizing impacts to native grasslands. A summary of the meeting was sent to representatives of NDGF and USFWS in May 2016.

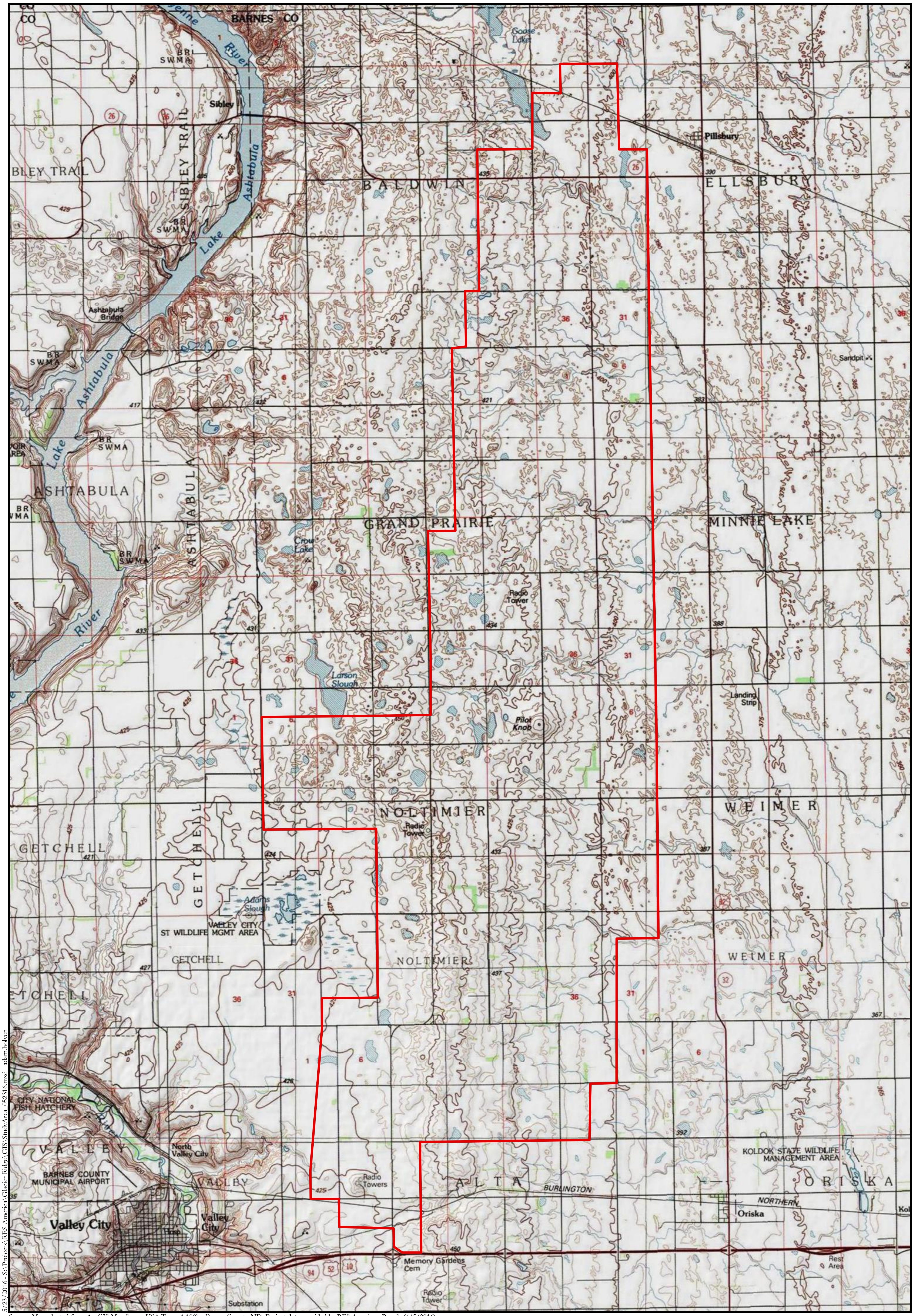
Information provided by your agency will be used to help guide Project development in a manner that identifies and avoids impacts to sensitive resources where practicable. We have sent similar query letters to other agencies including, but not limited to, the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, North Dakota Department of Health, and State Historical Society of North Dakota.

We would appreciate a response by June 30, 2016. Please contact me at (612) 643-2237 if you have any questions. Thank you for your assistance.

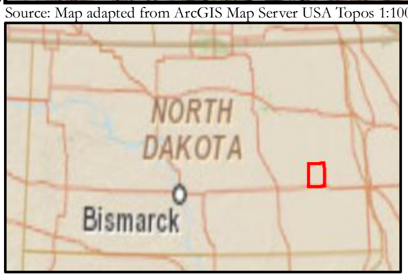
Respectfully submitted,

Adam Holven
Tetra Tech, Inc
2001 Killebrew Drive, Suite 141
Bloomington, MN 55425

Attachments (1) – Study Area Map



Source: Map adapted from ArcGIS Map Server USA Topos 1:100k - Barnes County, ND; Project data provided by RES America - Parcels (4/5/2016).



Study Area

0 1 2 3 Miles

Figure 1
Project Study Area
Glacier Ridge Wind, LLC
Barnes County, North Dakota

TETRA TECH

Agency	Contact	Address
U.S. Fish and Wildlife Service	Kevin Shelley, Acting ND Supervisor	U.S. Fish and Wildlife Service North Dakota Field Office 3425 Miriam Avenue Bismarck, ND 58501-7926
North Dakota Game and Fish Department	John Schumacher, Resource Biologist	North Dakota Game and Fish Department 100 N. Bismarck Expressway Bismarck, ND 58501-5095
U.S. Army Corps of Engineers	Dr. Daniel Cimarosti, Regulatory Program Manager	U.S. Army Corps of Engineers Omaha District North Dakota Regulatory Office 1513 South 12th Street Bismarck, ND 58504
State Historical Society of North Dakota	Claudia J. Berg, Director	State Historical Society of North Dakota North Dakota Heritage Center 612 East Boulevard Avenue Bismarck, ND 58505-0830
North Dakota Parks and Recreation Department	Kathy Duttenhefner, Coordinator	North Dakota Parks and Recreation Department 1600 East Century Avenue, Suite 3 Bismarck, ND 58503-0649
North Dakota Department of Health	David Glatt, Chief	North Dakota Department of Health Environmental Health Section Gold Seal Center 918 E. Divide Avenue Bismarck, ND 58501-1947
North Dakota State Water Comission	Linda Weispfenning, Water Resource Planner	North Dakota State Water Commission 900 East Boulevard Avenue, Dept. 770 Bismarck, ND 58505-0850
Valley City	David C. Schelkoph, City Administrator	254 2nd Avenue NE P.O. Box 390 Valley City, ND 58072
North Dakota Indian Affairs Commission	Mr. Scott Davis, Executive Director	North Dakota Indian Affairs Commission 600 East Boulevard Avenue 1st Floor - Judicial Wing, Room # 117 Bismarck, ND 58505
North Dakota Geological Survey	Mr. Edward C. Murphy, State Geologist	North Dakota Geological Survey 600 East Boulevard Avenue Bismarck, ND 58505-0840
North Dakota Department of Transportation	Mr. John Thompson, District Engineer	North Dakota Department of Transportation, Valley City District 1524 Eighth Avenue SW Valley City, ND 58072-4200
North Dakota Department of Trust Lands	Mr. Lance D. Gaebe, Commissioner	North Dakota Department of Trust Lands P.O. Box 5523 Bismarck, ND 58506-5523
North Dakota Department of Agriculture	Mr. Doug Goehring, Agriculture Commissioner	North Dakota Department of Agriculture 600 East Boulevard Avenue, Department 602 Bismarck, ND 58505-0020

North Dakota Aeronautics Commission	Mr. Larry Taborsky, Director	North Dakota Aeronautics Commission P.O. Box 5020 Bismarck, ND 58502-5020
Barnes County Soil Conservation District	Mr. Bill Bertram, Chair	Barnes County Soil Conservation District 110 Winter Show Road SW Valley City, ND 58072
Barnes County Municipal Airport Authority	Shawn Anderson, Chairman	Barnes County Municipal Airport Authority P.O. Box 2 Valley City, ND 58072
Barnes County	Cindy Schwehr, Commissioner - District 1	Barnes County Board of Commissioners 11442 23rd Street SE Rogers, ND 58479
North Dakota Department of Commerce	Al Anderson, Commissioner	North Dakota Department of Commerce 1600 E. Century Ave., Suite 2 Bismarck, ND 58503