COMMERCE DEPARTMENT

Environmental Report
Buffalo Ridge Wind Project

Docket No. IP-7006/CN-19-309

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ABSTRACT

Buffalo Ridge Wind, LLC (BRW, applicant) is proposing to build a 109 megawatt wind farm in Lincoln and Pipestone counties in southwest Minnesota (Buffalo Ridge Wind project). In order to the build and operate the project, the applicant must obtain two approvals from the Minnesota Public Utilities Commission (Commission): a certificate of need (CN) and a site permit.

An environmental report (ER) must be prepared as part of the CN review process. Minnesota Department of Commerce, Energy Environmental Review and Analysis staff has prepared this environmental report. The report analyzes the human and environment impacts of the project as well as alternatives to the project. It will be used by the Commission in making a decision on the applicant's certificate of need application.

A public hearing will be held in the project area and is anticipated to occur March 26, 2019. Notice of the hearing will be issued separately. An administrative law judge (ALJ) from the Minnesota Office of Administrative Hearings will preside over the hearings. The ALJ will make recommendations to the Commission regarding the project. Commission decisions on a certificate of need and site permit are expected in the third quarter of 2020.

Additional materials related to this project and its permitting proceedings are available on the Department's website: http://mn.gov/commerce/energyfacilities and on the State of Minnesota's eDockets system: https://www.edockets.state.mn.us/EFiling/search.jsp (enter the year "19" and the number "309" for the CN or year "19" and the number "394" for the site permit).

Persons interested in receiving future notices about this project can place their names on the project mailing list by contacting docketing.puc@state.mn.us or (651) 201-2246 and providing the docket number (19-309 or 19-394), their name, email address, and mailing address. Please indicate how you would like to receive notices – by email or U.S. mail.

This document can be made available in alternative formats (i.e., large print or audio) by calling (651) 539-1530 (voice).

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ACRONYM/TERM	DEFINITION
AADT	average annual daily traffic
ACS	American Community Survey
ADLS	aircraft detection lighting system
agl	above ground level
ALJ	administrative law judge
amsl	above mean sea level
ANSI	American National Standards Institute
BMP	best management practice
BRW or Applicant	Buffalo Ridge Wind, LLC
capacity	the capability of a system, circuit, or device for storing electronic charge
Commission or MPUC	Minnesota Public Utilities Commission
CN	certificate of need
CR	County Road
CSAH	County State Aid Highway
dBA	A-weighted decibels
distribution	relatively low-voltage lines that deliver electricity to a retail customer’s home or business
DOC	Minnesota Department of Commerce
ECS	Ecological Classification System
EERA	Energy Environmental Review and Analysis
EIA	electromagnetic interference analysis
EMF	electromagnetic field
EOR	element occurrence record

ACRONYM/TERM	DEFINITION
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	Floodplain Insurance Rate Map
GE	General Electric
generator	a machine by which mechanical energy is changed into electrical energy
geotechnical	a science that deals with the application of geology to engineering
GPS	global positioning system
GRE	Great River Energy
HAP	hazardous air pollutant
hub	the central component of the wind turbine that connects the rotors to the generator
interconnection	location of project connection to the power grid
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
LGU	local government unit
LNTE	low-noise trailing edge
LWECS	large wind energy conversion system
MBS	Minnesota Biological Survey
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MET	meteorological tower

ACRONYM/TERM	DEFINITION
micrositing	the process in which the wind resources, potential environmentally sensitive areas, soil conditions, and other site factors, as identified by local, state and federal agencies, are evaluated to locate wind turbines and associated facilities
Minn. R.	Minnesota Rule
MISO	Midcontinent Independent Transmission System Operator, Inc.
MNDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MW	megawatt
MWh	megawatt-hour
NEER	NextEra Energy Resources, LLC
NAC	noise area classification
NESC	National Electric Safety Code
NHD	National Hydrography Dataset
NHIS	Natural Heritage Information System
NLEB	northern long-eared bat
North Star	North Star Solar PV, LLC
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSP	Northern States Power Company
NTIA	National Telecommunications and Information Administration
NWI	National Wetlands Inventory
O&M	operation and maintenance

ACRONYM/TERM	DEFINITION
PM	particulate matter
POI	points of interconnection
PPA	power purchase agreement
ppm	parts per million
Project	BRW Project
PV	Photovoltaic
PWI	Public Waters Inventory
RD	rotor diameter; diameter of the rotor from the tip of a single blade to the tip of the opposite blade
REC	recognized environmental condition
RES	renewable energy standard
rotor	three blades mounted to a rotor hub
ROW	right-of-way
SCADA	supervisory control and data acquisition
SHPO	Minnesota State Historic Preservation Office
SWPPP	stormwater pollution prevention plan
step-up transformer	a transformer that increases voltage
TH	Trunk Highway
TV	Television
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WCA	Wetland Conservation Act

ACRONYM/TERM	DEFINITION
WCFZ	worst-case Fresnel zone
WMA	wildlife management area
WOUS	waters of the United States
WPA	waterfowl protection area

SUMMARY

This environmental report (ER) has been prepared for the Buffalo Ridge Wind Project, a proposed 109 megawatt (MW) wind farm in Lincoln and Pipestone County, Minnesota. It evaluates the potential human and environmental impacts of the project and three alternatives to the project – a no build alternative, a generic 109 MW wind farm sited elsewhere in Minnesota, and 109 MW solar farm. This ER will be used by the Minnesota Public Utilities Commission in deciding whether to issue a certificate of need for the project.

No Build Alternative

Impacts that would result from the no build alternative include: (1) a possible reduction in the state's ability to meet its renewable energy objectives; (2) the loss of economic benefits to the project area; and (3) the potential negative impacts resulting from replacing the renewably generated electrical energy with energy generated from a non-renewable source.

Economic benefits that would be lost include temporary and permanent jobs, an increase in the counties' tax base, and a loss of lease payments to project participants. Impacts associated with electrical generation using non-renewable resources include health impacts due to air emissions, impacts to water resources associated with heat rejection, and climate change impacts. The burning of carbon-based fuels results in greenhouse gas emissions that exacerbate climate change. Climate change impacts include significant impacts to public health, food production, and biodiversity.

Buffalo Ridge Wind Project, Generic 109 MW Wind Farm, and 109 MW Solar Farm

Because they are all renewable technologies, these three alternatives have similar potential human and environmental impacts. They have minimal impacts on air and water resources; they generate minimal wastes. Accordingly, they have minimal impacts on human health and the environment. With proper siting, impacts to vegetation and to threatened and endangered species can also be minimized.

However, there are differences in potential impacts among the alternatives. Wind farms have potentially greater impacts on human settlements due to aesthetic impacts, shadow flicker, and noise impacts. Due to their size, wind turbines can be seen from a distance. They change the viewshed and impact the aesthetics of the landscape. Because of their height, wind turbines must have safety beacons. These beacons can be seen from a distance and can impact a relatively dark night sky. In contrast, solar farms are relatively shorter and their aesthetic impacts are limited to a smaller viewshed. Additionally, solar farms do not require safety beacons.

Wind farms produce shadow flicker; solar farms do not. Shadow flicker can impact human settlements near wind farms. Both wind and solar farms must meet Minnesota state noise standards. However, of the two noise sources, wind farms produce relatively greater sound levels

and thus have a greater potential for noise impacts, even when these impacts are within state standards.

The project and a generic 109 MW wind farm will have relatively greater impacts on wildlife than a solar farm, particularly impacts to birds and bats. Bird fatalities for wind farms range from 3 to 6 fatalities per MW per year; bat fatalities range from 1 to 20 fatalities per MW per year. Solar farm impacts on birds and bats are minimal. Bird impacts for the project are anticipated to be similar to, or slightly less than, impacts for a 109 MW wind farm sited elsewhere in Minnesota. Bat impacts for the projects are anticipated to be less than those for a 109 MW wind farm sited elsewhere in Minnesota.

A solar farm will have relatively greater impacts on land use and agriculture than a wind farm. Solar farms require 7 to 10 acres of land per MW. Wind farms require about 0.75 acres per turbine; approximately 0.3 acres of land per MW. Accordingly, from a land use perspective wind farms projects are relatively more compatible with agricultural production. Wind farms can interfere with aerial application of agricultural products.

1.0 INTRODUCTION

On July 12, 2019, Buffalo Ridge Wind, LLC (BRW or Applicant) filed a certificate of need (CN) application with the Minnesota Public Utilities Commission (Commission) for the Buffalo Ridge Wind project (project). On July 17, 2019, the applicant filed a site permit application for the project. Revised CN and site permit applications were submitted on August 9, 2019. BRW is a wholly owned, indirect subsidiary of NextEra Energy Resources, LLC (NEER). BRW is proposing to construct a 109 megawatt (MW) large wind energy conversion system (LWECS) in Lincoln County and Pipestone County, Minnesota.

Project Overview

The Buffalo Ridge Wind project includes wind turbines, a project collector substation, collection lines, an operation and maintenance (O&M) building, one permanent meteorological tower, an aircraft detection lighting system, and gravel access roads. Approximately 17,460.6 acres of the project area and all project infrastructure are located in Lincoln County (Figure 1). Approximately 148.3 acres of the project area is located in Pipestone County. The portion of the project area located in Pipestone County is for wind turbine setback purposes only and no project infrastructure or construction activities will occur in Pipestone County.

The project will produce up to 109 MW and will use 36 General Electric (GE) 2.82 MW wind turbines and four GE 2.3 MW turbines. The project will interconnect to the electric transmission grid at the existing Buffalo Ridge substation owned by Northern States Power Company (NSP), a subsidiary of Xcel Energy. BRW's anticipated commercial operation date for the project is February 2, 2021.

There was previously a NEER wind facility operating in the general vicinity of the project area, called the Buffalo Ridge Wind Farm. The original Buffalo Ridge Wind Farm was constructed in 1994 and consisted of 73 Kenetech turbines. The original wind farm was permitted by Lincoln County. The site was decommissioned by NEER in 2017.

BRW has entered into a power purchase agreement (PPA) with Great River Energy (GRE). In the PPA, GRE has agreed to purchase the full output of the project for a 25-year term. The project, as a generator of wind energy, qualifies as an "eligible energy technology" for the purposes of the Minnesota Renewable Energy Standard (RES), as set forth in Minn. Stat. § 216B.1691. According to GRE, the project will assist GRE in meeting and exceeding its RES requirements, in addition to its own voluntary renewable energy goals.

State of Minnesota's Role

In order to build the project, BRW must obtain two approvals from the Commission – a CN and a site permit. In addition to these approvals from the Commission, the project also requires approvals (e.g., permits, licenses) from other state agencies and federal agencies with permitting authority for specific resources (e.g., the waters of Minnesota). Commission site and route permits supersede and preempt all zoning, building, and land-use regulations promulgated by local units of government.

BRW has applied to the Commission for a certificate of need and a site permit. With these applications, the Commission has before it two distinct considerations: (1) whether the proposed project is needed, or whether some other project would be more appropriate for the state of Minnesota, for example, a project of a different type or size, or a project that is not needed until further into the future, and (2) if the project is needed, where is it best located and what conditions are necessary to ensure environmental preservation, sustainable development, and the efficient use of resources.

To help the Commission with its decision-making and to ensure a fair and robust airing of the issues, the state of Minnesota has set out a process for the Commission to follow in making its decisions. This process includes: (1) development of a draft site permit, (2) development of an environmental report (ER), and (3) a public hearing before an administrative law judge.

The goal of the draft site permit is to describe the ways in which the potential impacts of the project will be mitigated. The goal of the ER is to describe the potential human and environmental impacts of the project and alternatives to the project. The goal of the hearing is to advocate, question, and debate what decisions the Commission should make about the project. The entire record developed in this process—the draft site permit, the ER, and the report from the administrative law judge, including all public input and testimony—is considered by the Commission when it makes its decisions on the applicant's CN and site permit applications.

Organization and Content of This Document

This ER is organized into eight sections:

Section 1: Introduction
Section 2: Regulatory Framework
Section 3: Description of the Proposed Project
Section 4: Description of Project Alternatives
Section 5: The No Build Alternative
Section 6: Human and Environmental Impacts
Section 7: Feasibility and Availability of Alternatives
Section 8: References

Sources of Information

Information for this report has been gathered from multiple sources that are cited throughout the report. The primary source documents are the CN and site permit applications submitted by

BRW. Applicable information from reports issued by the Minnesota Environmental Quality Board and Minnesota Department of Commerce has also been included in this report.

2.0 REGULATORY FRAMEWORK

The Buffalo Ridge Wind Project requires two approvals from the Minnesota Public Utilities Commission – a CN and a site permit. The project will also require approvals from other state and federal agencies with permitting authority for actions related to the project.

2.1 Certificate of Need

Construction of a large energy facility in Minnesota requires a CN from the Commission. BRW submitted a CN application to the Commission on July 12, 2019, and a revised application on August 9, 2019. On November 12, 2019, the Commission issued an order accepting the application as substantially complete and authorizing an informal review process (i.e., notice and comment).

Certificate of Need Criteria

The Commission must determine whether the proposed project is needed or if another project would be more appropriate for the state of Minnesota. Minnesota Rules, part 7849.0120 provides the criteria that the Commission must use in determining whether to grant a CN:

- The probable result of denial would be an adverse effect on the future adequacy, reliability, or efficiency of energy supply to the applicant, to the applicant’s customers, or to the people of Minnesota and neighboring states.
- A more reasonable and prudent alternative to the proposed facility has not been demonstrated by a preponderance of the evidence on the record.
- The proposed facility, or a suitable modification of the facility, will provide benefits to society in a manner compatible with protecting the natural and socioeconomic environments, including human health.
- The record does not demonstrate that the design, construction, or operation of the proposed facility, or a suitable modification of the facility, will fail to comply with relevant policies, rules, and regulations of other state and federal agencies and local governments.

If the Commission determines that the applicant has met these criteria, a CN is granted. The Commission’s CN decision determines the type of project, the size of the project, and its timing. The Commission could place conditions on the granting of a CN.

The CN decision does not determine the locations of wind turbines or conditions on their operation; these determinations are made in the site permit for the project.

2.2 Site Permit

A site permit from the Commission is required to construct a large wind energy conversion system (LWECS), which is any combination of wind turbines and associated facilities with the capacity to generate five MW or more of electricity. The Minnesota Wind Siting Act is found at Minnesota Statutes Chapter 216F. The rules to implement the permitting requirements are in Minnesota Rule 7854.

BRW submitted a site permit application to the Commission on July 17, 2019, and a revised site permit application on August 12, 2019.

Site Permit Criteria

In making a siting decision for the wind farm, the Commission considers factors prescribed in statute and rule. Minnesota Statutes, section 216E.03, identifies considerations that the Commission must take into account when siting wind farms, including potential impacts on human and natural resources. The Commission also must determine that a project is compatible with environmental preservation, sustainable development, and the efficient use of resources.

2.3 Environmental Review

The Minnesota Environmental Policy Act requires that governmental units consider the human and environmental impacts of a project prior to approving the construction and operation of the project. For the Buffalo Ridge Wind Project, this consideration takes two forms – (1) a site permit application and comment period and (2) an environmental report (ER).

Site Permit Application

For the Commission's site permit decision, the site permit application constitutes environmental review of the project. The application discusses the potential human and environmental impacts of the project and mitigation measures. These impacts can occur during construction and operation of the project. Public comments on the application result in the Commission's development and issuance of a draft site permit for the project.

Department of Commerce, Energy Environmental Review and Analysis (EERA) staff solicited public comments on the site permit application through a public meeting and comment period (discussed further, below). Based on these comments and on EERA recommendations, the Commission has issued a draft site permit for the project.

Environmental Report

An ER is intended to facilitate informed decision-making by the Commission and other entities with regulatory authority over the project. An ER describes and analyzes the potential human and environmental impacts of a project and alternatives to the project. It does not advocate or state a preference for a specific alternative.

Scoping is the first step in the development of the ER for the project. The scoping process has two primary purposes: (1) to gather public input as to the impacts, mitigation measures, and alternatives to study in the ER, and (2) to focus the ER on those impacts, mitigation measures, and alternatives that will aid in the Commission's decisions on the project.

EERA staff gathered input on the scope of the ER through a public meeting and an associated comment period. Commission and EERA staff held a joint public information and ER scoping meeting on December 5, 2019, in Lake Benton, Minnesota. Approximately 35 to 40 persons attended the meeting; six members of the public commented during the meeting. A public comment period following the meeting closed on December 27, 2019. Comments were received from members of the public and state agencies, including the Minnesota Department of Natural Resources (DNR) and the Minnesota Department of Transportation (MnDOT).

Based on public comments and applicable rules, the Department of Commerce issued the scoping decision for the ER on January 10, 2020 (Appendix A). The scoping decision identifies the human and environmental impacts to be analyzed for the project and alternatives to the project. Based on the scoping decision, EERA staff has prepared this ER. The ER will be entered into the record for these proceedings so that it can be used by the Commission in making decisions about the CN for the project.

2.4 Public Hearing

After the Commission issues a draft site permit for the project and after issuance of the ER, a public hearing will be held in the project area. The hearing will be presided over by an administrative law judge (ALJ) from the Office of Administrative Hearings (OAH). At the hearing, citizens, agencies, and governmental bodies will have an opportunity to submit comments, present evidence, and ask questions. The ALJ will submit a report to the Commission with findings of facts, conclusions of law, and recommendations regarding the site permit for the project.

2.5 Commission Decision

After considering the entire record, the Commission will determine whether to grant a CN for the project. The Commission may place conditions on the granting of a CN.

If a CN is granted, the Commission will also determine the conditions appropriate for the project's site permit. Site permits include conditions specifying construction and operating standards; they also include mitigation plans and project-specific mitigation measures. Decisions by the Commission on the CN and site permit applications are anticipated in the third quarter of 2020.

2.6 Other Permits and Approvals

A site permit from the Commission is the only permit required for the siting of the project. Commission-issued site permits supersede local planning and zoning and bind state agencies; thus, state agencies are required to participate in the Commission's permitting process to aid the Commission's decision-making and to indicate sites that are not permittable.

However, various federal, tribal, state, and local approvals may be required for activities related to the construction and operation of the project. All permits subsequent to the Commission's issuance of a site permit and necessary for the project (commonly referred to as "downstream permits") must be obtained by a permittee. The information in this ER may be used by downstream permitting agencies in their evaluation of impacts to resources. Table 1 lists permits and approvals that could be required for the project, depending on the final design.

Table 1. Potential Permits and Approvals Required for Buffalo Ridge Wind Project

Regulatory Authority	Permit/Approval	Applicability to the Project
FEDERAL		
Federal Energy Regulatory Commission	Authorization to Sell Wholesale Power at Market Based Rates	An authorization for power sellers that can demonstrate that they lack or have adequately mitigated horizontal and vertical market power.
Federal Aviation Administration	Part 7460 Review	Review of structures taller than 200 feet and determination of no hazard; review of final turbine locations and heights.
Federal Communications Commission	Non-Federally Licensed Microwave Study	Study to avoid interference with point-to-point microwave communications.
	NTIA Communication Study	Study to avoid interference with telecommunications.
U.S. Army Corps of Engineers	Clean Water Act Section 404 Coordination	As required to protect water quality through authorized discharges of dredged and fill material to waters of the Unite States.
U.S. Fish and Wildlife Service	Informal Coordination under Section 7 of the Endangered Species Act	Coordination to establish conservation measures for endangered species.
Environmental Protection Agency Region 5 in coordination with the Minnesota Pollution Control Agency	Spill Prevention, Control, and Countermeasure Plan	Plan required if project oil storage exceeds regulatory limits.
U.S. Department of Agriculture	Informal Consultation for Affected Properties in Conservation, Easement, or Reserve Programs	As required where project impacts specific conservations or reserve land management programs.

Regulatory Authority	Permit/Approval	Applicability to the Project
Federal Emergency Management Agency	Coordination of Flood Plain Designation	As required if and where project impacts project area floodplains.
STATE		
Minnesota Public Utilities Commission	Certificate of Need	Required approval of the project.
	Site Permit for LWECS	Required for siting of the project consistent with state policies.
Minnesota Department of Labor and Industry	Electrical Plan Review, Permits, and Inspections	Review and inspections as required for project electrical infrastructure.
Minnesota State Historic Preservation Office (SHPO)	Informal Cultural Resources Consultation	Consultation with SHPO regarding archaeological, historic, and cultural resources that could be present in the project area. Development of any necessary cultural resource plans for the project.
Minnesota Pollution Control Agency	National Pollutant Discharge Elimination System/State Disposal System Permit (NPDES/SDS) – Construction Stormwater Permit	Required to minimize impacts to waters due to construction of the project. Required for construction disturbances of more than one acre or if project is part of a common plan of development.
	License for a Very Small Quantity Generator of Hazardous Waste	Required if hazardous waste handling exceeds regulatory limits.
	Spill Prevention Control and Countermeasure Plan	Plan required if project oil storage exceeds regulatory limits.
	Aboveground Storage Tank Notification Form	Required for storage tanks that meet size and content regulatory requirements.
	Clean Water Act Section 401 Water Quality Certification	As required, with Section 404 approval, to prevent impairment of waters in the project area.
Minnesota Department of Health	Environmental Bore Hole Approval	Required for boreholes where used for subsurface geotechnical studies.
	Plumbing Plan Review	As required for O&M building.
	Water Well Permit	As required for O&M building.
Minnesota Department of Natural Resources	Informal Coordination Regarding Endangered Species	Coordination to establish conservation measures for state species that are threatened, endangered, or of special concern.
	Coordination on Avian and Bat Protection Plan	Coordination to ensure measures that minimize impacts to avian and bat species.

Regulatory Authority	Permit/Approval	Applicability to the Project
	General Permit for Water Appropriations, Dewatering	As required for water use and dewatering.
	Public Waters Work Permit and/or License to Cross Public Lands and Waters	As required for crossings of public waters and lands by the project.
Minnesota Department of Transportation	Oversize/Overweight Permit for State Highways	Required for transport of oversize/overweight project components to project site.
	Access Driveway Permits for MnDOT Roads	Required when a change in access is necessary to a MnDOT right-of-way or property.
	Tall Structure Permit	As required for approval of tall structures.
	Utility Access Permit	Required for access to utilities in MnDOT rights-of-way or properties.
LOCAL		
Lincoln County and Pipestone County (O&M and laydown only)	Conditional Use Permit	As required by local regulation.
	Land Use Permit	As required by local regulation.
	Roadway Access Permit	As required by local regulation to ensure proper use of local roads.
	Drainage Permit	As required by local regulation.
	Working in Right-of-Way Permit	As required by local regulation.
	Overweight/Over-Dimension Permit	As required by local regulation to ensure proper transport of project components on local roads.
	Utility Permit	As required by local regulation.
Lincoln County and Pipestone County Soil and Water Conservation District	Wetland Conservation Act Approvals	As required to minimize impacts to wetlands in the project area.
Townships	Right-of-way permits, crossing permits, road access permits, and driveway permits for access roads and electrical collection system.	As require by local regulation.
OTHER		
Midcontinent Independent Transmission System Operator	Turbine Change Study	As required for interconnection approvals.
	Generator Interconnection Agreement	Required for interconnection approval.

3.0 DESCRIPTION OF THE PROPOSED PROJECT

The applicant, BRW, is proposing to build a 109 MW LWECS. BRW is responsible for the construction, operations, maintenance, oversight, and management of the project.

3.1 Project Description

The project is proposed to include 36 GE 2.82 MW wind turbines and four GE 2.3 MW wind turbines (Figure 2). The project will include a maximum of 40 turbines. Alternate turbine locations have been identified to provide for flexibility in the event development or constructability issues are encountered. It is anticipated that approximately 37.4 acres of land will be needed to accommodate the turbine pad, access roads, and ancillary facilities. The turbine characteristics for these turbine models are summarized in Table 2. All turbines utilize three-bladed rotors to capture wind energy. The rotors use blade pitch regulation and other technologies to achieve optimum power output under various site conditions and wind speeds. All of the turbines will utilize low-noise trailing edge (LNTE) serrations on the turbine blades to reduce sound impacts.

Table 2. Turbine Specifications

Design Features	GE 2.82 Wind Turbines	GE 2.3 Wind Turbine
Nameplate Capacity	2.82 MW	2.3MW
Hub Height	89 m (292 ft)	80 m (262.5 ft)
Rotor Swept Area	12,704 m^2 (136744.7ft^2)	10,660 m^2 (114,743 ft^2)
Total Height	152.072 m (499 ft)	138.3 m (453.74 ft)
Rotor Diameter	127.2 m (417 ft)	116.5 m (382 ft)
Cut in Wind Speed	3 m/s (6.8 mph)	3 m/s (6.8 mph)
IEC Wind Class	7.85 m/s (17.6 mph)	7.0 m/s (15.7 mph)
Cut Out Wind Speed	30 m/s (66.8 mph) in 600 sec time interval	32 m/s (71.6 mph) in 600 sec time interval
Rotor Speed	7.4–15.7 RPM	7.4–15.7 RPM
Tip Speed	85.1–89.1 m/s (190.4–199.3 mph)	81.7–85.4 m/s (182.8–191.0 mph)
Sound Power Level at Turbine	95.2–108.5 dBA	93.5–106 dBA

Design Features	GE 2.82 Wind Turbines	GE 2.3 Wind Turbine
Power Regulation	Blade pitch controls power. Controls included for zero voltage ride-through (ZVRT) and enhanced reactive power (0.9 power factor)	Blade pitch controls power. Controls included for ZVRT and enhanced reactive power (0.9 power factor)
Generation	2.82 MW per turbine	2.3 MW per turbine
Tower	Multicoated, conical tubular steel with safety ladder to the nacelle. Rest platforms each section.	Multicoated, conical tubular steel with safety ladder to the nacelle. Rest platforms each section.
Supervisory Control and Data Acquisition	Each turbine equipped with SCADA controller hardware, software and database storage capability	Each turbine equipped with SCADA controller hardware, software and database storage capability
FAA Lighting	Yes, per FAA permitting	Yes, per FAA permitting
Foundation	Per manufacturer specifications Spread foot or pier foundation.	Per manufacturer specifications Spread foot or pier foundation.

dBA = A-weighted decibels
SCADA = supervisory control and data acquisition
Source: GE manufacturer specifications
(GE Power and Water 2015; GE Renewable Energy 2017, 2018a, 2018b, 2018c:82–127)

Each turbine is comprised of a foundation, tower, nacelle, hub, and three blades (GE Renewable Energy 2018). The turbine towers are built of tapered steel cylinders consisting typically of three to four sections that are welded together. Wind turbine surfaces are coated for protection against corrosion in generally non-glare white, off white, or gray. Each turbine has a lockable steel door at the base of the tower, through which the nacelle and turbine blades can be accessed. Inside each tower, platforms are accessible via ladder or lifts that are equipped with fall-arresting safety systems.

Each turbine tower includes a control panel that houses electronic and communication equipment. Each nacelle includes a wind speed and direction sensor that supports signaling when winds are sufficient for turbine operation. Each turbine is equipped with variable-speed control and independent blade pitch to enhance efficiency. An automated supervisory control and data acquisition (SCADA) system provides local and remote supervision and control of turbine equipment and performance.

Energy from the turbines will be routed through a 34.5 kV underground electrical collection system (approximately 28 miles) to a proposed project collector substation. The electrical collection system will be buried approximately 36 to 48 inches underground. Figure 2 (Project Area and Facilities) shows the preliminary design of the underground electrical system.

The proposed project collector substation will include 34.5 kV and 115 kV busses, transformers, circuit breakers, reactive equipment, steel structures, a control building, metering units, and air break disconnect switches. The project collector substation will connect to the existing Buffalo Ridge Substation via a short transmission jumper that will cross existing transmission lines owned by Northern States Power Company (NSP) (Figure 3). Additional equipment, e.g., breakers, buses, will be added to the Buffalo Ridge Substation in order to facilitate the connection with the proposed project collector substation.

BRW proposes to construct the proposed project collector substation to the east of the city of Lake Benton, Minnesota within the project area (Figure 3). BRW will execute an option with a landowner to purchase up to 10 acres where it proposes to construct the proposed collector substation. The project collector substation graveled footprint is anticipated to be no larger than one acre; detailed design engineering will confirm the size based on equipment needs.

The project will include installation of one permanent meteorological tower (MET). The proposed location of the MET tower within the project area is shown in Figure 2. Consistent with Commission requirements, the MET tower will be no closer than 250 feet from the edge of road rights-of-way (ROWs). The permanent MET tower will remain for the duration of the project's operations.

The proposed location of the O&M facility within the project area is shown in Figure 2. The footprint of the facility is anticipated to be approximately two acres and will include an access road, parking lot and O&M building. If an O&M building is to be constructed, it will be approximately 2,250 square feet (209 square meters) and will house project equipment with a parking lot adjacent to the building. BRW will dig a new well and install a new septic system for sanitary needs. Alternatively, an existing O&M building outside of the project area may also be used.

Each turbine will have a low-profile gravel access road to connect the turbine with the public road network or private access roads. The roads will be all-weather gravel construction and approximately 16 feet wide once the wind project is operational. The approximate length of permanent access roads to be installed is 20.6 miles with final length determined by final layout. Temporary access roadways will be constructed to a width of up to 45 feet to facilitate crane movement during construction. Drainage culverts will be installed as appropriate.

The project will utilize an aircraft detection lighting system (ADLS). The ADLS controls turbine safety lighting. With ADLS, turbine safety beacons will only be illuminated when an aircraft is detected near the project.

The project will also require grading of a temporary laydown area of approximately 15 acres. The temporary laydown area will serve as a location for parking during construction, an area where office trailers will be situated, and as a storage and staging area for construction materials and equipment during construction. The temporary laydown area will be located in agricultural areas where land use rights have been acquired and environmental surveys have been conducted.

It is not anticipated that a concrete batch plant will need to be established for project use within the project area.

3.2 Project Location

The project is located in southwestern Minnesota, immediately southeast of the city of Lake Benton and southwest of the city of Tyler. Approximately 17,460.6 acres of the project area and all project infrastructure are in Lincoln County. Approximately 148.3 acres of the project area is in Pipestone County (Figure 1). Table 3 provides a list of the Township sections that the project is located within.

Table 3. Project Location

County Name	Township Name	Township	Range	Sections
Lincoln	Lake Benton	109	45	10, 11, 13–16, 20–23, 26–29, 32–36
Lincoln	Hope	109	44	31
Pipestone	Fountain Prairie	108	45	3

The project area consists of predominantly agricultural cropland, pasture, and wooded shelter belts surrounding residences and riparian areas. The project area contains approximately 13,462 acres of cultivated land or about 79.7 percent of the project area. The project area contains approximately 213.3 acres of pastures, or approximately 1.3 percent of the project area, and approximately 2,255.4 acres of grassland/herbaceous habitat, or approximately 13.4 percent of the project area.

The size of the project area allows some siting flexibility in the event that turbine locations currently identified prove to be unsuitable. It also provides sufficient room for the required setbacks and buffering of sensitive features. The siting of the turbines, collector substation, collector lines, and meteorological towers will be within the project area (Figure 4). An O&M facility is planned to be constructed within the project area; an existing O&M building outside of the project area may also be used.

The project layout adheres to the wind energy conversion facility siting criteria outlined in the Commission's Order Establishing General Wind Permit Standards (Docket No. E, G999/M-07-

1102) and EERA's Site Permit Application Guidance and has addressed applicable county regulations or agency guidance from Lincoln and Pipestone County. Turbines associated with the project are sited solely in Lincoln County, though the project area extends slightly into Pipestone County.

Lincoln County provided a letter on June 4, 2019, indicating that the county supports a finding that there is good cause not to apply the county's standards to the project. Although no project turbines are sited in Pipestone County, BRW provided information on Pipestone County in its site permit application for the purpose of completeness, given that setbacks associated with project turbines may partially extend into Pipestone County. Pipestone County has previously recognized the inapplicability of its wind siting ordinance (Section 5-10) to a wind project subject to the siting jurisdiction of the Commission (see Docket No. IP-6903/WS-18-179).

Table 4 summarizes the Commission's setback standards applicable to the project, based on the Commission's general wind permit standards as well as accounting for setbacks required in recent Commission site permits. The project is designed to meet the setback standards summarized in Table 4.

Table 4. Wind Turbine Setbacks for the Project

Wind Facility and Collector Lines Setback Categories	Setback Conditions as Represented in Recent Site Permits
Wind Access Buffer	Wind turbine towers shall not be placed less than five RD on prevailing wind directions and three RD on non-prevailing wind directions from the perimeter of the lands where the Permittee does not hold the wind rights, without the approval of the Commission. This section does not apply to public roads and trails.
Internal Spacing	The turbine towers shall be constructed within the site boundary as approved by the Commission. The turbine towers shall be spaced no closer than three RD in non-prevailing wind directions and five RD on prevailing wind directions. If required during final micrositing of the turbine towers to account for topographic conditions, up to 20 percent of the towers may be sited closer than the above spacing but the Permittee shall minimize the need to site the turbine towers closer.

Wind Facility and Collector Lines Setback Categories	Setback Conditions as Represented in Recent Site Permits
Noise	Greater of 1,000 feet (305 meters) for participating residents and for nonparticipating residents or Compliance with noise standards established as of the date of this permit by the Minnesota Pollution Control Agency (MPCA) at all times at all appropriate locations. The noise standards are found in Minnesota Rules chapter 7030. https://www.revisor.mn.gov/rules/?id=7030.0030 https://www.revisor.mn.gov/rules/?id=7030.0040 Turbine operation shall be modified or turbines shall be removed from service if necessary to comply with these noise standards. The Permittee or its contractor may install and operate turbines, as close as the minimum setback required in this permit, but in all cases shall comply with MPCA noise standards. The Permittee shall be required to comply with this condition with respect to all residences or other receptors in place as of the time of construction, but not with respect to such receptors built after construction of the towers.
Roads	Wind turbine and MET towers shall not be located closer than 250 feet (76 meters) from the edge of the nearest public road right-of-way (ROW).
Public Lands	Wind turbines and associated facilities including foundations, access roads, underground cable, and transformers, shall not be located in public lands, including Waterfowl Production Areas, Wildlife Management Areas, Scientific and Natural Areas, or in county parks, and wind turbine towers shall also comply with the setbacks of the wind access buffer.
Public Water Wetlands	Wind turbines and associated facilities including foundations, access roads, underground cable, and transformers, shall not be placed in public waters wetlands, as defined in Minnesota Statutes section 103G.005, subdivision 15a, except that electric collector or feeder lines may cross or be placed in public waters or public waters wetlands subject to permits and approvals by the Minnesota Department of Natural Resources (MNDNR), the U.S. Army Corps of Engineers (USACE), and local units of government as implementers of the Minnesota Wetland Conservation Act.

Wind Facility and Collector Lines Setback Categories	Setback Conditions as Represented in Recent Site Permits
Meteorological Towers	Permanent towers for meteorological equipment shall be free standing. Permanent meteorological towers shall not be placed less than 250 feet (76 meters) from the edge of the nearest public road ROW and from the boundary of the Permittee's site control, or in compliance with the county ordinance regulating meteorological towers in the county the tower is built, whichever is more restrictive. Meteorological towers shall be placed on property the Permittee holds the wind or other development rights. Meteorological towers shall be marked as required by the FAA. There shall be no lights on the meteorological towers other than what is required by the FAA. This restriction shall not apply to infrared heating devices used to protect the wind monitoring equipment.
Aviation	The Permittee shall not place wind turbines or associated facilities in a location that could create an obstruction to navigable airspace of public and licensed private airports (as defined in Minnesota Rule 8800.0100, subparts 24a and 24b) in Minnesota, adjacent states, or provinces. https://www.revisor.mn.gov/rules/?id=8800.0100 The Permittee shall apply the minimum obstruction clearance for licensed private airports pursuant to Minnesota Rule 8800.1900, subpart 5. Setbacks or other limitations shall be followed in accordance with the Minnesota Department of Transportation (MnDOT), Department of Aviation, and FAA. The Permittee shall notify owners of all known airports within six miles (10 kilometers) of the project prior to construction. https://www.revisor.mn.gov/rules/?id=8800.1900
Footprint Minimization	The Permittee shall design and construct the LWECS so as to minimize the amount of land that is impacted by the LWECS. Associated facilities in the vicinity of turbines such as electrical/electronic boxes, transformers, and monitoring systems shall, to the greatest extent feasible, be mounted on the foundations used for turbine towers or inside the towers unless otherwise negotiated with the affected landowner(s).
Communication Cables	The Permittee shall place all supervisory control and data acquisition (SCADA) communication cables underground and within or adjacent to the land necessary for turbine access roads unless otherwise negotiated with the affected landowner(s).

Wind Facility and Collector Lines Setback Categories	Setback Conditions as Represented in Recent Site Permits
Electrical Collector and Feeder Lines	Collector lines that carry electrical power from each individual transformer associated with a wind turbine to an internal project interconnection point shall be buried underground. Collector lines shall be placed within or adjacent to the land necessary for turbine access roads unless otherwise negotiated with the affected landowner(s). Feeder lines that carry power from an internal project interconnection point to the project substation or interconnection point on the electrical grid may be overhead or underground. Feeder line locations shall be negotiated with the affected landowner(s). Any feeder lines that parallel public roads shall be placed within the public ROW or on private land immediately adjacent to public roads. If feeder lines are located within public ROW, the Permittee shall obtain approval from the governmental unit responsible for the affected ROW. Collector and feeder line locations shall be located in such a manner to minimize interference with agricultural operations, including, but not limited to, existing drainage patterns, drain tile, future tiling plans, and ditches. Safety shields shall be placed on all guy wires associated with overhead feeder lines. The Permittee shall submit the engineering drawings of all collector and feeder lines in the site plan. The Permittee must fulfill, comply with, and satisfy all Institute of Electrical and Electronics Engineers, Inc. (IEEE) standards applicable to this project, including but not limited to, IEEE 776 [Recommended Practice for Inductive Coordination of Electric Supply and Communication Lines], IEEE 519 [Harmonic Specifications], IEEE 367 [Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault], and IEEE 820 [Standard Telephone Loop Performance Characteristics] provided the telephone service provider(s) have complied with any obligations imposed on it pursuant to these standards. Upon request by the Commission, the Permittee shall report to the Commission on compliance with these standards.

3.3 Project Cost and Schedule

The capital expenditure for the project is estimated to be approximately $170 million. This includes all costs of development, design, and construction. General costs associated with project operation, maintenance, initial spare parts, operating equipment and operating supplies will be $140,000 during the first year and average approximately $3.3 million per year over the following 24 years. BRW anticipates that the project will be in commercial operation by February 2, 2021. A draft decommissioning plan has been prepared for the project (Appendix B). The plan documents activities necessary to decommission and restore the project area in accordance with the requirements of Minn. R. 7854.0500, subp.13.

4.0 DESCRIPTION OF PROJECT ALTERNATIVES

In examining the need for the project, Minnesota Rule 7849.1200 requires that the Commission consider alternatives to the proposed project. A no build option must be evaluated in addition to evaluating alternatives and their associated impacts. This section provides a discussion of alternatives to the project. Alternatives to the project would generally consist of generation facilities of all types, including non-renewable sources such as coal, oil, or natural gas. However, as the proposed project would produce renewable energy for use in Minnesota, the alternatives considered for this ER are technologies that are eligible to be counted toward Minnesota's renewable energy objectives. These alternatives include: (1) a no build option, (2) a generic 109 MW LWECS sited in Minnesota, (3) a 109 MW solar farm, and (4) other renewable alternatives (Appendix A).

Other renewable alternatives include hydropower, biomass, and hydrogen derived from renewable sources. As these alternatives are not currently feasible and available (see Section 7), they are not discussed further here. The potential impacts of a no build option are discussed in Section 5. The potential impacts of the Buffalo Ridge Wind Project, a generic 109 MW LWECS, and a 109 MW solar farm are discussed in Section 6.

4.1 No Build Alternative

The no build alternative means that no project would be constructed. The potential benefits and drawbacks of not constructing the proposed project will be considered for the no build alternative.

4.2 109 MW LWECS

An alternative to the proposed Buffalo Ridge Wind Project that would utilize a renewable energy resource is a wind farm sited elsewhere in Minnesota. This alternative could be a single 109 MW project or a combination of smaller dispersed projects that, altogether, generate a total of 109 MW. This ER will attempt to describe differences in the impacts associated with a generic 109 MW wind project sited elsewhere in Minnesota and the proposed project. As the proposed project includes short transmission interconnection, it is assumed that the hypothetical LWECS also includes a short transmission interconnection.

4.3 109 MW Solar Farm

Another alternative renewable energy source to the proposed project is a solar farm that generates a similar amount of electricity as the proposed project. A photovoltaic power station, also known as a solar farm, is a large-scale photovoltaic (PV) system that can supply power to the electricity grid. Solar farms are different from most rooftop and other decentralized solar power applications as they supply power at the utility scale rather than supplying local users.

This solar farm alternative could be a single 109 MW project or a combination of smaller dispersed solar projects that, altogether, generate a total of 109 MW. This ER will attempt to describe differences in the impacts associated with a 109 MW solar farm and the proposed project.

Information for making comparisons between a solar farm and the proposed project has been drawn from the North Star solar farm. The North Star project is a 100 MW solar farm located in east central Minnesota that underwent environmental review and permitting in Minnesota in 2015.

5.0 THE NO BUILD ALTERNATIVE

This section analyzes the potential benefits and drawbacks of the no build alternative. The no build alternative assumes no wind project is constructed; thus, the no build alternative analyzes the impacts of the status quo. For example, with a proposed roadway project, the no build alternative assesses the impacts associated with not improving the roadway. This includes potential traffic increases on nearby roads and highways, increased maintenance costs, and longer travel times.

5.1 Human and Environmental Impacts

Impacts that would result from the no build alternative include: (1) a possible reduction in the state's ability to meet its renewable energy objectives; (2) the loss of economic benefits to the region; and (3) the potential negative impacts resulting from replacing the renewably generated electrical energy with energy generated from a non-renewable source.

Renewable Energy Objectives

Minnesota has committed to a renewable energy objective of generating 25 percent of its electricity from eligible renewable sources by the year 2025 (Minnesota Statute 216B.1691). Additionally, Minnesota has seen significant wind development, in part due the strength of the wind regime in the southwestern portion of the state (Figure 5A). Minnesota utilities forecast the need for 5,841 MW of renewable generation by the year 2025 to meet this objective (Minnesota DOC 2013). If the Buffalo Ridge Wind Project, or an alternative renewable energy project is not built, it could reduce the state's ability to meet its renewable energy objectives.

Loss of Economic Benefits

The no build option would result in foregoing the following economic benefits: an addition of temporary and permanent jobs, an increase in the counties' tax base, and a loss of lease payments to project participants.

Communities near the project would potentially be deprived of the expected positive economic benefits associated with construction, including temporary and full-time positions. Approximately 200 construction and 7 to 12 full-time O&M jobs are expected as part of the project. BRW plans to use local contractors and suppliers, where feasible, for portions of construction, which would contribute to the overall economy of the region. Purchase of products to construct and operate the facilities such as fuel, equipment, services, and supplies would benefit businesses in the counties as well as the state. These employment and economic opportunities would be lost if the project is not built.

The project will pay a Wind Energy Production Tax to the local units of government of $0.0012 per kilowatt-hour (kWh) of electricity produced. BRW estimates that this would result in estimated annual Wind Energy Production Tax revenues of between $500,000 and $600,000 in Lincoln County (CN Application Section 4.2.3).

Replacement with a Nonrenewable Resource

The no build alternative may result in the need for electricity that would have been supplied from a renewable resource (wind) to come from a non-renewable resource such as natural gas or coal. The project would produce approximately 478,600 megawatt-hours annually (MW/year).

The impacts associated with electrical generation using non-renewable resources vary. These impacts generally include health impacts due to air emissions, impacts to water resources associated with heat rejection, and climate change impacts. The burning of carbon-based fuels results in greenhouse gas emissions that exacerbate climate change. Climate change impacts include significant impacts to public health, food production, and biodiversity.

5.2 Human and Environmental Benefits

The benefits of not building the project include the avoidance of potential human and environmental impacts associated with the project. These impacts are discussed in Section 6 of this ER.

6.0 HUMAN AND ENVIRONMENTAL IMPACTS

The project and its alternatives have the potential for human and environmental impacts. This section discusses these impacts in addition to potential mitigation strategies. The alternatives to the project analyzed here include (1) a generic 109 MW LWECS sited elsewhere in Minnesota and (2) a 109 MW solar farm. The potential impacts of the no build option are discussed in Section 5.

Summary of Human and Environmental Impacts

Because they are all renewable technologies, the alternatives discussed here have similar potential human and environmental impacts. They have minimal impacts on air and water resources; they generate minimal wastes. Accordingly, they have minimal impacts on human health and the environment. With proper siting, impacts to vegetation and to threatened and endangered species can also be minimized.

However, there are differences in potential impacts among the alternatives. LWECS projects have potentially greater impacts on human settlements due to aesthetic impacts, shadow flicker, and noise impacts. Due to their size, wind turbines can be seen from a distance. They change the viewshed and impact the aesthetics of the landscape. Because of their height, wind turbines must have safety beacons. These beacons can be seen from a distance and can impact a relatively dark night sky. In contrast, solar farms are relatively shorter and their aesthetic impacts are limited to a smaller viewshed. Additionally, solar farms do not require safety beacons. LWECS lighting impacts can be mitigated by using systems that automatically minimize lighting impacts – e.g., the ADLS system proposed for the project.

LWECS projects produce shadow flicker; solar farms do not. Shadow flicker can impact human settlements near LWECS projects. Both LWECS and solar farms must meet Minnesota state noise standards. However, of the two noise sources, LWECS projects produce relatively greater sound levels and thus have a greater potential for noise impacts, even when these impacts are within state standards.

The project and a generic 109 MW LWECS will have relatively greater impacts on wildlife than a solar farm, particularly impacts to birds and bats. Bird fatalities for LWECS projects range from 3 to 6 fatalities per MW per year; bat fatalities range from 1 to 20 fatalities per MW per year. Solar farm impacts on birds and bats are minimal. Bird impacts for the project are anticipated to be similar to, or slightly less than, impacts for a 109 MW LWECS sited elsewhere in Minnesota. Bat impacts for the projects are anticipated to be less than those for a 109 MW LWECS sited elsewhere in Minnesota.

A solar farm will have relatively greater impacts on land use and agriculture than LWECS projects. Solar farms require 7 to 10 acres of land per MW. LWECS projects required about

0.75 acres per turbine; thus approximately 0.3 acres of land per MW. Accordingly, from a land use perspective LWECS projects are relatively more compatible with agricultural production. LWECS projects can interfere with aerial application of agricultural products.

6.1 Air Quality

Electric generation facilities may emit air pollutants during their construction and operation. This ER analyzes those potential air pollutants as required by Minn. R. 7849.1500, subp. 2.

6.1.1 Criteria Pollutants

Minn. R. 7849.1500 requires this ER to examine emissions of the following pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), mercury (Hg), and particulate matter (PM). These pollutants are known as criteria pollutants (USEPA 2019).

Buffalo Ridge Wind Project

The project would not emit criteria pollutants during its operation. As a zero-emission energy resource, the project has significant positive impacts on the natural environment when compared to fossil fuel generating plants. During operation, the project will not discharge air pollutants that can negatively impact the environment, e.g., PM, Hg, or CO_2.

Emissions of criteria pollutants will occur during the construction of the project but will be minimal and localized. The emissions associated with the project's construction would be similar to other large scale outdoor construction activities such as road work or commercial developments.

Emissions would likely include dust from earth-moving activities and exhaust from diesel or fuel-powered construction equipment. Development of the project would include multiple, dispersed construction sites within the project area including the proposed turbine pad sites and proposed access roads. Dust emissions can be controlled at each construction site using standard construction practices. This dust would be considered fine PM (less than 2.5 microns, or PM2.5). PM2.5 is generally 3 percent to 10 percent of total PM (U.S. Environmental Protection Agency's AP-42, Sections 13.2 and 11.9 2017). PM2.5 is of greater concern than larger PM as it has the potential to travel further into the lungs. Standard construction practices could include a reduction of speed limits, covering of disturbed areas, and watering of exposed surfaces. Dust emissions related to vehicle traffic would be reduced once the project is constructed. Maintenance and repairs would generate limited emissions.

Generic 109 MW LWECS

A generic 109 MW LWECS would not emit criteria pollutants during operation, though it would have ancillary emissions (from construction activities) similar to those from the project.

109 MW Solar Farm

As with the project, a solar farm would not emit criteria pollutants during operation. Temporary air quality impacts would occur during the construction phase of the solar farm project. Once operational, the project would not generate criteria pollutants or carbon dioxide. Thus, impacts due to criteria pollutants would be similar to those from the project.

Mitigation

Emissions from construction vehicles can be minimized by ensuring that construction equipment is in good functioning condition. Standard construction practices (e.g., watering exposed surfaces and covering disturbed areas) can be used to control dust (fine PM) resulting from construction activities.

6.1.2 Hazardous Air Pollutants and Volatile Organic Compounds

Electrical generation facilities have the potential to emit air pollutants during their construction and operation. Minn. R. 7849.1500 requires this ER to examine emissions of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). These types of pollutants are known or suspected of being carcinogenic and causing other serious health effects (USEPA 2017).

For all of the alternatives, HAP and VOC emissions are anticipated to be negligible.

Mitigation

No additional mitigation measures are required other than standard best management practices (BMPs) for the handling and storage of the minor quantities of hazardous materials needed for the project, a generic LWECS, or a 109 MW solar farm.

6.1.3 Ozone

Large electric power generating facilities, such as coal, natural gas, and biomass facilities, have the potential to produce reactive gases, which can lead to ground-level ozone formation. Ozone and nitrous oxide are reactive compounds that contribute to smog and can have adverse impacts on human respiratory systems. Accordingly, these compounds are regulated and have permissible concentration limits. Minnesota has an ozone limit of 0.08 parts per million (ppm). The federal ozone limit is 0.07 ppm. Minnesota Rule 7849.1500, subpart 2 requires that anticipated ozone formation be addressed. Ozone can cause human health risks and can also damage crops, trees and other vegetation (USEPA 2019).

For all of the alternatives, ozone emissions are anticipated to be negligible.

Mitigation

Since neither wind farms nor solar farms produce ozone or ozone precursors no mitigation measures are required.

6.2 Water Resources

Energy generation facilities have the potential to impact water resources. These resources are discussed here. Additionally, per Minnesota Rule 7849.1500, this section specifically discusses water appropriations and wastewaters.

6.2.1 Water Appropriations

Water may need to be appropriated to large electric power generation facilities for operations. This section discusses the potential impacts of those appropriations.

Buffalo Ridge Wind Project

Water appropriations for potable and sanitary water would likely be needed for the project's O&M building. A well would be installed to fulfill these requirements. The applicant will obtain the required permits and approvals for this appropriation.

Well depths within the project area vary widely from approximately 25 to 350 feet deep, with most being less than 100 feet deep (MDH 2019). Turbine tower foundations for the project will be installed to a depth of up to approximately 12 feet. If tower foundation excavation occurs below the water table, dewatering may be required for construction. If this occurs, a groundwater appropriations permit would be required from the MNDNR. The permit would identify drawdown capacities and impact mitigation measures.

Water needed for other construction activities, such as dust abatement, would either come from a local well or may be trucked in from a suitable local resource. The source of water will be determined closer to construction.

Generic 109 MW LWECS

A generic 109 MW LWECS would have water appropriations and regulatory requirements similar to those associated with the project.

109 MW Solar Farm

A 109 MW solar farm would have water appropriations and regulatory requirements similar to those associated with the project. Solar panels are typically installed on metal structures anchored into the ground. Solar farms also typically include an O&M building with potable and sanitary water requirements.

Mitigation

Minimal or no human or environmental impacts would result from water appropriations associated with each alternative. No mitigation measures are required.

6.2.2 Wastewater

Some large electric generation facilities have the potential to generate significant amounts of wastewater. This section discusses potential impacts from wastewater generation.

Buffalo Ridge Wind Project

No wastewater discharges will occur as a result of the construction or operation of the project except for domestic-type sewage discharges. Temporary sanitary facilities will be provided during construction, and the O&M building may require a septic system, which will be installed in accordance with applicable regulations.

Generic 109 MW LWECS

A generic 109 MW LWECS would have wastewater impacts that are similar to the project.

109 MW Solar Farm

A generic solar farm would have wastewater impacts that are similar to the project

Mitigation

Minimal or no human or environmental impacts would result from waste water associated with each alternative. No mitigation measures are required.

6.2.3 Groundwater

Groundwater in Minnesota is largely a function of local geologic conditions that determine the type and properties of aquifers. The Minnesota DNR divides the state into six groundwater provinces based on bedrock and glacial geology. Most groundwater originates from rain and melting snow and ice that infiltrate into the ground; it is the source of water for springs and wells. It is relied on as a source for drinking water, irrigation, and industrial use. Groundwater can be sourced from shallow surficial aquifers or from deeper confined aquifers. Activities that reduce the quantity of available water or introduce contaminants into these aquifers can affect groundwater resources and the people and industries that rely on them.

Buffalo Ridge Wind Project

Groundwater resources are not abundant or widely distributed within this portion of the state because of lower precipitation rates and the quaternary and bedrock geology present in this region (Adolphson et al. 1982). The limited groundwater resources in this region have prompted the establishment of an extensive network of water pipelines which transport groundwater from a few select areas with productive groundwater wells to the majority of the region (Patterson 1997).

Impacts to groundwater resources and wells are not expected from the project. A well may be installed to fulfill the O&M building water requirements. Construction dewatering may occur depending on the respective site, weather, and soil conditions. Dewatering consists of the removal of surface water and/or groundwater by diverting and/or removing construction areas within water features or wet areas, as needed for construction.

Generic 109 MW LWECS

Impacts to groundwater from a 109 MW LWECS would be comparable to the project, depending on site location and the geological material underlying the project site. The potential for groundwater contamination may be higher in areas with karst topography.

109 MW Solar Farm

Impacts to groundwater for 109 MW solar farm would be comparable to the project, depending on site location and the geological material underlying the project site. Because groundwater resources are not abundant in BRW project area, a solar farm would have similar impacts if built in the project area.

Mitigation

Well locations will be taken into account and turbines will be set back from wells following state and county standards for the project. Construction and operation of the project is not expected to impact groundwater resources, so no mitigation is proposed.

Groundwater use is anticipated to be minimal for both LWECS and solar farms. Supply and drawdown impacts will be further addressed in appropriations permits, if applicable.

6.2.4 Surface Water

Potential impacts to surface waters from renewable electric generation projects are largely related to construction activities. In addition, hazardous materials need to be properly stored to prevent impacts to surface waters.

Buffalo Ridge Wind Project

Buffalo Ridge (a glacial moraine) divides the project area into two primary drainage basins:

1. The southwestern portion of the project area generally drains south and west. This area is located within the Lower Big Sioux River Watershed (HUC-8 10170203), which is part of the Big Sioux River Watershed, which is part of the Missouri River Basin.

2. The central and northeastern portions of the project area generally drain north and east. This area is located within the Redwood River Watershed (HUC-8 07020006), which is part of the Minnesota River Watershed, which is part of the Mississippi River Basin.

Within these drainage basins, numerous intermittent and ephemeral watercourses and a few perennial watercourses are scattered across the project area.

According to the USGS National Hydrography Dataset (NHD), the project area contains approximately 54.9 miles of NHD watercourses and 24.7 acres of NHD waterbodies (0.14 percent of the project area) (USGS 2018). Nine of the watercourses within the project area are MN Public Waters Inventory (PWI) public watercourses with designated 50-foot buffer requirements according to the MN Buffer Law (MNDNR 2018a). Six PWI “public ditches” within the project area have a 16.5-foot designated buffer requirement. Based on aerial photograph interpretation, a moderate number of the aforementioned watercourses would likely be considered jurisdictional waters of the United States due to their proximity to the Red or Minnesota rivers.

Figure 6 displays waters that are designated as public waters under MNDNR’s Public Waters Permit Program.

Section 303(d) of the Clean Water Act requires each state to list streams and lakes that are not meeting their designated uses because of excess pollutants. According to the Minnesota Pollution Control Agency (MPCA), there are no records of impaired waterbodies within the project area (MPCA 2019).

The MNDNR commissioner may formally designate lakes for wildlife management under the authority of Minn. Stat. § 97A.101 subdivision 2 (a). There are no MNDNR designated wildlife lakes within the project area. There are also no identified outstanding resource value waters or trout streams within the project area (MNDNR 2015).

Federal Emergency Management Agency (FEMA) floodplain maps have been created and are available for most of the project area, but the majority of base flood elevations have not been determined. There are no 100-year flood plains (Zone A) located within the project area (FEMA 2019). A large expanse of the project area that has “public ditches” has been determined to be an area with minimal flood hazards (Zone C). Figure 7 depicts the FEMA FIRMs in the project area.

Potential impacts to surface waters could occur during construction of the project. The ground will be disturbed by excavation, grading, trenching, and vehicular traffic. This may increase erosion from surface water runoff, sedimentation, dewatering discharge, and watercourse diversion. These impacts are expected to be negligible and temporary. Design of the project will minimize these impacts to the extent possible.

Generic 109 MW LWECS

The primary source of impacts to surface water from a generic 109 MW LWECS would be similar to those for the project. Mitigation strategies would also be similar to those for the project, but they would depend on the site-specific features of the generic LWECS.

109 MW Solar Farm

Potential impacts to surface waters from a solar farm would likely occur during construction and would be similar to those for the project. Soil and sediment could potentially reach surface waters and wetlands as a result of excavation, grading, and construction traffic.

Mitigation

Mitigation for the project would be similar to that for a generic 109 MW LWECS and a 109 MW solar farm. Erosion prevention and maintenance of current hydrology are examples of mitigation measures. Other soil erosion measures include reclamation seeding, structured construction scheduling, surface roughening, erosion control blankets, straw wattles/bales, rolls, tackifiers (i.e., chemical compounds that increase the stickiness of adhesives so as to help seed or soil stay in place), mulch, vegetative buffers, hydro mulch, sediment fencing, and water bars.

The type of control measure will vary depending upon slope gradients and the susceptibility of soil to wind and water erosion. The aforementioned BMPs can not only be employed to protect topsoil and minimize soil erosion but can also protect surface water quality and floodplain resources from direct and indirect impacts. A stormwater pollution prevention plan (SWPPP) would need to be developed and a National Pollutant Discharge Elimination System (NPDES) permit would be obtained prior to construction. BMPs can be employed to ensure that excavated material is contained, exposed soil is protected, restored material is stabilized and disturbed areas are re-vegetated with non-invasive species. Use of BMPs will also ensure that access roads and drainage ways will be designed in a manner that allows water to flow unrestricted from upper portions of the watershed to lower portions of the watershed.

A utility crossing license would be required for any crossings of PWI by roads, or electric feeder and collector lines. That license would specify methods and mitigation requirements.

6.2.5 Wetlands

Wetlands are an important feature of the Minnesota landscape; they provide ecological, economic, and social benefits. Wetlands support habitat for many different types of organisms, recharge groundwater, naturally filter pollutants, reduce flooding, and support cultural and recreational activities.

In the State of Minnesota, agencies representing three levels of government (federal, state, and local) regulate certain activities that affect wetlands, lakes, and watercourses. Any wetland listed in the PWI is protected by the Minnesota Public Waters Work Permit. A public waters work permit must be obtained from the DNR for work affecting the course, current or cross-section of public waters, including public waters wetlands. Wetlands not listed in the PWI are regulated under the Minnesota Wetland Conservation Act of 1991. The Wetland Conservation Act (WCA) is administered by the Minnesota Board of Water and Soil Resources and is implemented by local government units (LGUs). The LGU administering the WCA within the project area is the Soil & Water Conservation District of Lincoln County.

Wetlands are also federally protected under Section 404 of the Clean Water Act. A wetland permit from the U.S. Army Corps of Engineers (USACE) is required when discharging dredged or fill material into jurisdictional wetland and/or non-wetland WOUS. A permit and/or pre-construction notification may also be required by the local watershed district depending upon the location, size and type of impact. The U.S. Fish and Wildlife Service (USFWS) regulates and monitors wetlands through the National Wetlands Inventory, which is a publicly available resource that provides information on the abundance, characteristics, and distribution of US wetlands.

Buffalo Ridge Wind Project

The project area contains both isolated wetlands and wetlands associated with watercourses scattered across the project area. The project area is dominated by freshwater emergent wetlands with some mapped, shrub/scrub, and forested wetlands (Figure 8). Some wetlands within agricultural settings appear to exhibit anthropological disturbance. Based on aerial photograph interpretation, a moderate number of the aforementioned wetlands would likely fall under federal jurisdictional due to their proximity to the Red or Minnesota rivers.

Calcareous fens are a rare (e.g., approximately 200 known locations within Minnesota) and distinctive wetland type characterized by non-acidic peat with a constant supply of calcium and magnesium bicarbonate rich groundwater. This specialized environment is dominated by a calcium-loving plant community (MNDNR 2017). Calcareous fens have been identified in the vicinity of the project area (approximately 0.8 miles east of the project area). No calcareous fen has been identified within the project area. Calcareous fens are protected under both federal (Section 404 of the Clean Water Act) and state law (Minnesota Wetland Conservation Act) (MNDNR 2017). According to the MNDNR update to the USFWS National Wetlands Inventory (NWI) database, the project area contains approximately 848.2 acres of mapped NWI wetlands and open waterbodies (4.9 percent of the project area) (MNDNR 2017 and USFWS 2016).

Construction activities may directly or indirectly impact wetlands. These include impacts that occur within the wetland or outside the wetland in areas up-stream from the wetland. Siting structures such as access roads, turbine sites, substation sites, and collection lines close to these areas may pose an impact. Turbines and meteorological towers will be sited in upland, higher elevation areas to maximize the wind resource and, as such, are likely to avoid wetlands and surface waters that are typically found at lower elevations. Access roads and project-related infrastructure will be designed and sited to avoid or minimize permanent impacts to wetlands to the greatest extent possible. Temporary impacts to wetlands may occur based on construction easement extents. Field work to delineate wetlands is ongoing so that wetland areas can be avoided. In the event that permanent or temporary wetland impacts cannot be avoided during the siting of project infrastructure, BRW will coordinate with the appropriate agencies including USACE, WCA, and the Soil and Water Conservation District of Lincoln County.

Generic 109 MW LWECS

The primary source of impacts to wetlands from a generic 109 MW LWECS would be similar to those for the project. Mitigation strategies would also be similar to those for the project, but the extent of these strategies would be dependent on site specific features of the generic project.

109 MW Solar Farm

Impacts to wetlands from a 109 MW solar farm would be similar to those for the project. Potential impacts include sedimentation of wetlands from excavation, grading and construction traffic, potential to introduce invasive species, and changing wetland types and functions. Mitigation strategies would be similar to those for the project.

Solar panels decrease the amount of light that reaches the soil surface. This has the potential to change the plant community by decreasing plant productivity and reducing carbon sequestration. If wetland communities are located within the areas where solar panels occur, damage to vegetation could impact wetland viability.

Mitigation

Mitigation strategies would be similar for the project, the generic LWECS, and the solar farm, but the extent and degree would depend on site specific features. During the design phase, measures could be taken to avoid impacts to wetland areas, where possible, and to minimize impacts to wetlands in cases where the impacts cannot be avoided. Results of a wetland desktop analysis and micrositing field event could be used to avoid siting components in wetlands to the maximum extent practicable.

Directional drilling of collector and communication lines may be used to avoid or reduce the amount of impacts to wetlands. If adverse impacts to wetlands are unavoidable, the impacts will be minimized to the maximum extent practicable. BMPs will be used to protect topsoil, minimize soil erosion, and protect wetland resources from direct and indirect impacts. Minimizing soil erosion near wetlands helps to protect wetland functions and water quality, while also reducing potential fill. Wetland soils and moderately to steeply sloped ground can also be subject to sheet and rill erosion or slumping. Depending on site specific needs, seasonal construction scheduling, cutting trees where the stumps remain, temporary timber matting, erosion control blankets, mulch, straw bales, rolls, tackifiers (i.e., chemical compounds that increase the stickiness of adhesives so as to help seed or soil stay in place), temporary seeding, hydro mulch, and sediment fencing may be used to manage soil erosion. In some cases, a narrower construction corridor may be considered to minimize impacts.

A SWPPP would need to be developed and a NPDES permit would need to be obtained prior to construction. BMPs should be employed to ensure that excavated material is contained, exposed soil is protected, restored material is stabilized, and disturbed areas are revegetated with noninvasive species. Compensatory mitigation may be required if certain state and/or federal impact thresholds are surpassed.

6.3 Solid and Hazardous Wastes

Solid and hazardous wastes require proper handling at large electric generation facilities. They have the potential to contaminate surface and ground waters if not properly handled. Contamination of these types of wastes has been linked to adverse health effects in humans.

Buffalo Ridge Wind Project

During the construction of the project, hazardous materials would be temporarily stored and utilized within the project area. These hazardous materials may consist of fuel, lubricating oil, hydraulic oil, propylene glycol, and other materials required for the construction of a wind farm. Additionally, during operation of the wind farm, hazardous materials, such as hydraulic oil, lube oil, grease, and cleaning solvents would be necessary to maintain wind turbines and other equipment. Also, pad-mounted and grounding transformers required for the operation of the project contain large quantities of cooling fluids, likely consisting of mineral oil.

Prior to construction, the applicant will conduct Phase I environmental site assessment to identify and avoid existing recognized environmental conditions (RECs) within the project area, particularly associated with facilities identified by the MPCA database.

Generic 109 MW LWECS

The primary source of impacts due to solid and hazardous wastes from a generic 109 MW LWECS would be similar to those for the project.

109 MW Solar Farm

Solar farms generate solid and hazardous wastes during construction much like the LWECS projects. Impacts due to solid and hazardous wastes from a 109 MW solar farm would be similar to those for the project.

Mitigation

Solid and hazardous wastes are required to be stored, handled, and disposed of in accordance with Minn. R. Chapter 7045, local rules and regulations, and the site-specific spill, prevention, countermeasure, and control plans. Any monitoring, transportation, or handling of materials must be conducted by trained and qualified personnel utilizing established procedures and proper equipment. A list of all potentially hazardous materials, along with their safety data sheets, must be maintained at the O&M facility for each specific project.

The Phase I environmental site assessment would be used to identify and avoid, if necessary, any identified RECs. If RECs cannot be avoided, appropriate remediation, if required, could be conducted to avoid potential concerns associated with RECs.

6.4 Natural Resources

Flora, fauna, ecology, soils, and water can be affected by the development and operation of large electricity generation facilities. The following section discusses the potential impacts to these natural resources.

6.4.1 Environmental Setting

The Ecological Classification System (ECS), developed by the MNDNR and the U.S. Forest Service, uses the National Hierarchical Framework of Ecological Units to identify, describe, and map areas of land in Minnesota (Figure 9). This system informs management practices for large and small areas with similar ecological features.

Buffalo Ridge Wind Project

According to the MNDNR ECS (2019a), the project area is located partly within the Inner Coteau Subsection (251Bc) and the Coteau Moraines Subsection (251Bb) of the North Central Glaciated Plains Section of the Prairie Parkland Province. This section is important for wetland, lake, and prairie habitats. The Inner Coteau and Coteau Moraines Subsections are generally characterized by rolling topography consisting of Late Wisconsin highly dissected moraines with loess caps. The highest elevation within these subsections includes Buffalo Ridge, a ridgetop that traverses southwest Minnesota in a northwest to southeast orientation. The highest elevation of this ridge occurs within northern Lincoln County and reaches approximately 1995 feet (608 meters) above mean sea level (amsl) (Figure 13). Buffalo Ridge creates the undulating landscape within the project area (MNDNR 2018c).

Land use within the project area is primarily cultivated cropland, accounting for approximately 13,462 acres of cultivated land or about 79.7 percent of the project area, as shown in Figure 10. An additional 2,255.4 acres, or approximately 13.4 percent of the project area, is grassland/herbaceous habitat. According to the 2012 USDA Agricultural Census Report, more than 80 percent of the land in Lincoln County (roughly 290,940 acres) was used for agriculture on approximately 699 farms. Corn, soybeans, and forage crops are the primary crops grown in Lincoln County, while swine and cattle are the predominant livestock raised in the county. Market value of agricultural products sold in the county for 2012 was approximately $198.6 million, with crop markets at approximately $135.2 million and livestock markets at approximately $63.4 million (USDA 2012).

Approximately 59.1 percent of the project area is classified as prime farmland, while 26.3 percent is classified as prime farmland, if drained. Additionally, 8.0 percent is considered farmland of statewide importance and 5.9 percent of land within the project area is not prime farmland and (NRCS 2018).

The use of feedlots is a common practice in raising livestock in the state of Minnesota. The MPCA administers rules regulating livestock feedlots in Minnesota. According to MPCA's "What's in My Neighborhood" map search tool, there are 409 registered feedlots in Lincoln County, 32 of which are in the project area (MPCA 2016).

An average 0.75 acres of land per turbine is expected to be taken out of agricultural production for the life of the project to accommodate the turbine pad, access roads, and ancillary facilities. Landowners may continue to plant crops near, and graze livestock up to the gravel roadway and around each turbine pad. The placement of turbines in agricultural fields is suggested in the *U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines* (USFWS 2012). The primary impact to active agricultural land will be the reduction of crop production on a total of approximately 30 acres of farmland in the project area.

During construction, agricultural practices may be interrupted in areas that are typically farmed and construction activities may result in the temporary reduction in access to those areas and damage to drain tiles. Large-scale environmental impacts to agriculture or agricultural lands are not anticipated with the placement of turbines, access roads, and ancillary facilities in agricultural fields.

The project area is largely comprised of five soil complexes: Barnes-Buse complexes; Kranzburg-Brookings complexes; Singsaas-Oak Lake complexes; Parnell consociations; and Lakepark consociations. These soils are generally composed of silt loam to clay loam soils that are moderately dark in color and occur on level to steep slopes (Figure 11). These soils are generally deep, poorly drained to well drained, and are formed from loess, glacial till, and lacustrine deposits on glacial till (NRCS 2019).

The surficial geology of the project area is primarily comprised of till from the Bemis phase of the Des Moines Lobe (late Wisconsin-age glacial sediment) to the west, till from Verdi phase of the Des Moines Lobe phase (Wisconsin-age glacial sediment) to the central and east, and associated glacial-stream meltwater sediment deposits throughout (Patterson 1997) (Figure 12).

Generic 109 MW LWECS

A generic 109 MW LWECS located in a different part of Minnesota would have its own site specific environmental setting, as it would feature different ecological and environmental features. However, wind farms are often sited in areas of the state that provide the greatest wind resources, which also tend to be in agricultural areas of the state with similar ecological features (Figure 5A).

109 MW Solar Farm

While the site selection criteria for wind farms and solar farms share some common prerequisites (i.e., point of interconnect, adequate roadways and stakeholder concerns), there are sufficient contrasts to expect different siting outcomes (environmental setting).

Site identification analysis for solar farms takes into account the suitability of the specific sites and may include such factors as:

- Local regulations and ownership
- Zoning of the local area and agreements with landowners to avoid conflicts over land use
- Quality of terrain (land must include a low degree of forest clearing and tree removal as well as provide smooth terrain and even land features)
- Localized weather (conditions may make sites nonviable)
- Transmission capacity (studies on the local capacity to handle the solar farm's output)
- Distance to transportation corridors (transportation costs effect overall project costs and benefits)
- Flood risk assessment (avoiding low-lying sites subject to flooding concerns)
- Conservation and environmental impact issues (protected lands or species may alter development plans).

Mitigation

The applicant would need to minimize the impacts to the environmental setting to the maximum extent practicable for all proposed alternatives. All areas of temporary disturbance would be restored to the previous conditions following construction of the project. Additionally, following the life of the project, all land required for infrastructure would be returned back to pre-project conditions, as feasible. Land taken out of agricultural use due to project infrastructure and the associated economic loss would offset by lease payments agreed to by landowners. Additionally, lands adjacent to project infrastructure can remain to be used for agricultural production and/or cattle grazing.

6.4.2 Wildlife

Large electric generation projects have the potential to impact various types of wildlife. Habitats in a project's environmental setting provide forage and shelter for various mammals, fish, reptiles, amphibians, birds and insects, both resident and migratory.

Buffalo Ridge Wind Project

Field and desktop studies indicate that wildlife usage in the project area is comparable to that documented at other wind projects in agricultural areas of the Midwest. Impacts to wildlife and wildlife habitat are expected to be minimal because grasslands, wooded areas, shrub lands and other areas identified as important to wildlife will be avoided whenever possible. Additionally, these important wildlife features occur in relatively small amounts within the project area. Minor impacts to grasslands, shrub lands and wetlands may occur during project construction. Construction and operation of the project is not expected to significantly change land use within, or adjacent to the project.

The Minnesota Biological Survey (MBS) has identified 21 sites of biodiversity significance that are located completely within and/or overlap the project area. The MBS uses four classifications denoting the level of biological diversity to rank sites. These rankings are “outstanding,” “high,” “moderate,” and “below.” Sites ranked “outstanding” have the highest likelihood of containing rare species (including rare native plant communities or intact native ecosystems); sites ranked “below” have a low likelihood of containing rare species, intact ecological communities, or are highly disturbed. The “high” and “moderate” rankings fall in between these classifications (MNDNR 2018b). Based on coordination with MNDNR, sites of “high” and “outstanding” biodiversity significance are considered avoidance areas. Two MBS sites within the project area have been ranked as “outstanding;” two sites are ranked as “high.” All project infrastructure has been sited to avoid any temporary or permanent impacts to these “high” and “outstanding” sites of biodiversity significance.

Given the absence of MNDNR Waterfowl Feeding and Resting Areas within or in close proximity to the project area, potential impacts to waterfowl as a result of the project are anticipated to be minimal. Approximately 19.6 percent of the project area is within one of the six segments of the Prairie Coteau Important Bird Areas. By siting the turbines in cultivated fields and designing the associated infrastructure to avoid or minimize impacts on the native plant communities, grasslands, wetlands, and streams, BRW has designed the project facilities to avoid and minimize impacts on avian grassland species of concern, including direct (mortality) and indirect (displacement, habitat loss and fragmentation) impacts.

Impacts to wildlife would primarily occur to avian and bat populations. There is a likelihood that bird and bat fatalities will occur at the project, but these fatalities are unlikely to affect populations of most species (Erickson et al. 2014), including species of concern.

Birds

The layout of the Buffalo Ridge Wind Project attempts to minimize impacts to avian species and their habitats by concentrating activity in agricultural lands and avoiding placing project infrastructure in native prairie, native plant communities, and sites of biodiversity significance. Adverse effects on avian species of concern and their habitats are not anticipated to occur due to construction or operation of the project.

No federal listed species, threatened or endangered, were observed during fixed-point avian use surveys in the project area; however, one state-listed endangered species, Henslow’s sparrow *(Ammodramus henslowii),* was observed. Three special status species were documented including: American white pelican (*Pelecanus erythrorhynchos*) (Minnesota special concern), Franklin's gull (*Leucophaeus pipixcan*) (Minnesota special concern), and bald eagle (*Haliaeetus leucocephalus*) (Bald and Golden Eagle Protection Act).

The site poses a relatively low risk to bald eagles, due to lack of eagle use and suitable nesting or foraging habitat in the project area. In addition, abundant prey for eagles is not expected to be present within the project area. Limited foraging opportunities may be present in the form of carrion, livestock carcasses, small game within grasslands/croplands, and waterfowl that may stop in project area crop fields or in adjacent wildlife management areas (WMAs). Most eagle activity is associated with eagle observations and nest activity on Lake Benton.

Aerial raptor nest surveys were conducted during 2017–2019 within and near the project area (Appendix I of the Site Permit application). Two occupied, active bald eagle nests were located 1.5 and 8.0 miles outside the proposed project area and within the surveyed 10-mile buffer. No unoccupied, inactive nests were consistent in size and shape with an eagle nest. The 2019 survey found one occupied, active bald eagle nest 1.5 miles north of the proposed project area across Lake Benton, with the eagle nest at the same location as in the 2017 and 2018 surveys.

As the previously operating Buffalo Ridge Wind Energy Project, Phase I-III (1994–2017) was constructed prior to Commission survey requirements, pre-construction surveys for that project were not conducted. Post-construction studies of Buffalo Ridge Phase I occurred in 1998, 1999, 2001, and 2002. Based on these studies, 31 species of birds were detected in post-construction fatality surveys, with a minimum 13 species documented during Buffalo Ridge Phase I from 1996 to 1999 (Johnson et al. 2000). The majority (76.4 percent) of fatalities in the area were smaller birds, passerine species, such as warblers, sparrows, swallows, flycatchers, and blackbirds. The total adjusted fatality rate for birds (based on scavenger removal and searcher efficiency) at Buffalo Ridge Phase I was estimated to be 4.14 birds/turbine in 1996, 2.51 birds/MW in 1997, and 3.14 birds/MW in 1998. Raptor fatalities were only documented at Buffalo Ridge Phase I in 1996 (0.43 raptors/MW/year), and raptor fatality estimates for wind farms in the region are minimal when compared to other regions. It is anticipated that the fatality rate per MW would remain similar to the previous project and other wind projects in southwestern Minnesota (Table 5).

Table 5. Annual Bird Carcass Rate Results from Post-Construction Monitoring Studies in Southern Minnesota

Wind Energy Facility	Bird Fatality Estimate[a]	No. of Turbines	Total MW
Buffalo Ridge, MN (Phase I; 1996)	4.14 (Johnson et al. 2000)	73	25.00
Moraine II, MN	5.59 (Derby et al. 2010b)	33	49.50
Buffalo Ridge, MN (Phase I; 1997)	2.51 (Johnson et al. 2000)	73	25.00
Buffalo Ridge, MN (Phase I; 1998)	3.14 (Johnson et al. 2000)	73	25.00
Buffalo Ridge, MN (Phase I; 1999)	1.43 (Johnson et al. 2000)	73	25.00
Elm Creek, MN	1.55 (Derby et al. 2010a)	67	100
Buffalo Ridge, MN (Phase III; 1999)	5.93 (Johnson et al. 2000)	138	103.50
Buffalo Ridge, MN (Phase II; 1998)	2.47 (Johnson et al. 2000)	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	3.57 (Johnson et al. 2000)	143	107.25
Elm Creek II, MN	3.64 (Derby et al. 2010a)	62	148.80
Black Oak, MN (2017)[b]	8.74 (Pickle et al. 2018)	39	78.00

a = number of fatalities/MW/year
b = Huso estimator
Source: Stucker and Moratz (2019).

Bats

As the previously operating Buffalo Ridge Wind Energy Project (1994–2017) was constructed prior to Commission survey requirements, pre-construction bat surveys were not conducted for that project. Post-construction studies of the Buffalo Ridge Project occurred in 1998, 1999, 2001, and 2002. During post-construction fatality surveys, a total of 184 bat fatalities were detected from 1996 through 1999 (Appendix L of Johnson et al. 2004). The majority of identifiable fatalities were tree bats, most of which (66 percent) were hoary bats *(Lasiurus cinereus).* No northern long-eared bats (NLEB) (*Myotis septentrionalis*), currently federally listed as threatened and Minnesota special concern, or tri-colored bats *(Perimyotis subflavus)* (Minnesota special concern), were documented in any of the post-construction studies. Two additional bat species that are now Minnesota species of special concern were observed during post construction monitoring, the big brown bat *(Eptesicus fuscus)* and little brown bat *(Myotis lucifugus*) (Johnson et al. 2000, 2004).

Bat fatality rates across wind energy facilities of the Buffalo Ridge area are relatively low compared to rates elsewhere in the Midwest (Johnson et al. 2004). Previously, bat fatalities at the Buffalo Ridge Phase I was estimated to be 0.74 bats/MW/year in 1999 (Johnson et al. 2000), with similar estimates during subsequent years (3.71 bats/MW/year in 2001; 1.81 bats/MW/year in 2002) (Johnson et al. 2004). Results of post-construction studies will be compared to these rates, but it is expected that the per-megawatt bat fatality rate will remain similar to facilities elsewhere in southwestern Minnesota which is generally low compared to other areas of the United States (Table 6; MNDNR USFWS 2018).

Table 6. Annual Bat Carcass Rate Results from Post-Construction Monitoring Studies in Southern Minnesota

Wind Energy Facility	Fatality Estimate[a]	No. of Turbines	Total MW
Black Oak, MN (2017)[b]	26.05 (Pickle et al. 2018)	39	78.00
Lakefield, MN (2014)[b]	20.19 (Westwood 2013)	137	205.50
Lakefield, MN (2012)[b]	19.87 (Westwood 2013)	137	205.50
Big Blue, MN (2013)	6.33 (Fagen Engineering 2014)	18	36.00
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35 (Johnson et al. 2004)	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71 (Johnson et al. 2004)	138	103.50
Grand Meadows, MN (2013)	3.11 (Chodachek et al. 2014)	67	100.50
Oak Glen, MN (2013)	3.09 (Chodachek et al. 2014)	24	44.00
Elm Creek II, MN (2011-2012)	2.81 (Derby et al. 2012)	62	148.80
Buffalo Ridge, MN (Phase III; 1999)	2.72 (Johnson et al. 2000)	138	103.50
Buffalo Ridge, MN (Phase II; 1999)	2.59 (Johnson et al. 2000)	143	107.25
Moraine II, MN (2009)	2.42 (Derby et al. 2010b)	33	49.50
Buffalo Ridge, MN (Phase II; 1998)	2.16 (Johnson et al. 2000)	143	107.25
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81 (Johnson et al. 2004)	138	103.50
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64 (Johnson et al. 2004)	143	107.25
Elm Creek, MN (2009-2010)	1.49 (Derby et al. 2010a)	67	100
Buffalo Ridge, MN (Phase I; 1999)	0.74 (Johnson et al. 2000)	73	25.00

a = number of fatalities/MW/year

b = Huso estimator
Source: Stucker and Moratz (2019)

Based on the results of the studies in Table 6, the project is not expected to result in bat fatalities at rates higher than similar facilities in areas dominated by agriculture with minimal forested habitat. As with other facilities in Minnesota, tree bats (e.g., hoary bats and eastern red bats) are anticipated to be at greatest risk of fatality.

As part of the development of the project, a desktop assessment for NLEB was conducted. Based on the desktop habitat review of woodland habitat for NLEB, the project has 1,348.2 acres of suitable habitat within the project area and within a 2.5-mile survey buffer. Less than 8.0 percent of that bat habitat, 105 acres, falls within the survey buffer, which accounts for 0.6 percent of the total project area. Risk to the federally listed NLEB is expected to be relatively low, due to the lack of suitable summer habitat and the fact that no fatalities have been found at the previously operating turbines.

Insects

The project area has the potential to harbor a number of federally and state-listed insect species such as the Dakota skipper (*Hesperia dacotae;* federally listed threatened and state-listed endangered), Poweshiek skipperling (*Oarisma poweshiek;* federally listed threatened and state listed endangered), and Ottoe skipper (*Hesperia ottoe;* state-listed endangered) (Site Permit Appendix H – Wildlife Conservation Strategy). Habitat requirements for these species are very specific and consist exclusively of native prairie with limited cattle grazing. The habitat preferences of these insects largely overlap, and grassland habitats dominated by nonnative grasses are generally not suitable for these species.

There are 26 MNDNR mapped native prairies within the project area that may provide some level of native grassland habitat, which may be suitable for these listed insect species. Furthermore, two federally designated critical habitat units for the Dakota skipper and one federally designated critical habitat unit for the Poweshiek skipperling occur within the project area; these areas are coincident with the Hole-In-The-Mountain Preserve and Hole-In-The-Mountain WMA.

A desktop analysis and supportive field surveys to identify suitable habitat for the Dakota skipper and Poweshiek skipperling was conducted within the project area in June 2019 during the flight season. Approximately 103 acres of suitable habitat for the Dakota skipper was found in the project area. Potential impacts to these species may occur during the construction and operational phases if the project infrastructure is located within suitable habitat.

Reptiles and Amphibians

A variety of reptiles and amphibians may be present within the project area and may be impacted by the construction and operation of the project, such as the American toad *(Anaxyrus americanus),* Great plains toad *(Anaxyrus cognatus),* northern leopard frog *(Lithobates pipiens),* western chorus frog *(Pseudacris triseriata),* painted turtle *(Chrysemys picta),* snapping turtle

(Chelydra serpentine), Blanding's turtle *(Emydoidea blandingii),* prairie skink *(Plestiodon septentrionalis),* red-bellied snake *(Storeria occipitomaculata),* and the common and plains garter snake (*Thamnophis sirtalis* and *Thamnophis radix*). Most of the species listed here live in habitats associated with wetlands, streams and ditches. A few of the aforementioned species may be found in open areas, such as grasslands or fallow agricultural fields.

Mammals

Many common mammal species are likely to utilize the project area and may be impacted by the construction and operation of the project, including white-tailed deer *(Odocoileus virginianus),* raccoon *(Procyon lotor),* coyote *(Canis latrans),* red and gray fox (*Vulpes fulva* and *Vulpes urocyon),* Virginia opossum *(Didelphis virginiana),* gray squirrel *(Sciurus carolinensis),* fox squirrel *(Sciurus niger),* thirteen-lined ground squirrel *(Spermophilus tridecemlineatus),* striped skunk *(Mephitis mephitis),* short-tailed weasel *(Mustela erminea),* and badger *(Taxidea taxis).* These larger mammal species are most likely to utilize the wooded areas and uncultivated grassland areas that are present within the project area, while the smaller mammal species are likely to use those areas as well as the cultivated areas within the project area.

Generic 109 MW LWECS

Comparing impacts to wildlife with a generic 109 MW wind farm located elsewhere in Minnesota is difficult as impacts would depend on site specific characteristics. However, similar to other wind projects within Minnesota, birds and bats would generally be the primary wildlife species of concern.

109 MW Solar Farm

Impacts to wildlife for solar farms depend on site specific characteristics much like a LWECS. Therefore, an effective comparison is difficult to draw. With this in mind, when solar farms are not sited in desert environments, they are often sited in cultivated agricultural lands or pasturelands. Animals within this environment are used to disturbed or non-native cover types of environment. These species are often generalists and fare well in these types of habitats.

The effects from construction displacement would be similar to other construction projects, including LWECS. However, the primary impact to wildlife results from the large contiguous footprint and the resulting site restoration. Solar farms are surrounded by a perimeter fence, which inhibits movement across the landscape. Small animals may be able to move through or around the perimeter, but access for larger animals will be limited. Inhibiting movements could affect habitat structure and utilization of the land. Various behaviors, such as preying or foraging strategies, could be impacted.

A solar farm would have significantly less impact on bird and bat species than a LWECS because of the low-lying structures and static to minimal movement of the panels. However, recent studies based on limited data have indicated avian mortality may occur as a result of landing on the panels. Some birds when they come into contact with the panels may either experience initial impact or a loss of flying ability. These preliminary findings based on limited data suggest that birds may interpret the appearance of solar panels to be similar to an open body of water (USFWS Forensics Lab, 2014).

Mitigation

Generally, the following measures should be implemented for LWECS projects to avoid potential impacts to wildlife:

- Avoid and minimize siting turbines in mapped native prairie, native plant communities, and MBS sites of biodiversity significance ranked moderate, high, or outstanding.
- Maintain MNDNR recommended setback distances from WMAs, WPAs, and conservation areas to reduce risk to waterfowl and grassland-associated birds and butterflies when siting turbines in the project.
- Avoid or minimize placement of turbines in high quality grassland or pasture areas that may act as native grasslands for breeding grassland bird and butterfly species.
- Avoid or minimize placement of turbines in previously undisturbed shrub/scrub vegetation types that may provide additional habitat for breeding birds.
- Protect existing trees and shrubs by avoiding or minimizing tree removal for turbines, access roads and underground collector lines.
- Avoid or minimize disturbance of individual wetlands or drainage systems during construction.
- Prepare a prairie protection and management plan in consultation with the MNDNR.
- Maintain appropriate water and soil conservation practices during construction through the implementation of construction BMPs. These practices include silt fencing, temporary reseeding, permanent seeding, mulching, filter strips, erosion blankets, grassed waterways and sod stabilization.
- Construct wind turbines using tubular monopole towers.
- Minimize turbine lighting while remaining in compliance with FAA requirements.
- Coordinate with local NRCS staff to revegetate non-cropland and pasture areas disturbed during construction or operation of the wind facility with native seed mixes appropriate to the region.
- Inspect and control noxious weeds in areas disturbed by the construction and operation of the project.
- Prepare and implement a Wildlife Conservation Strategy (WCS)/Avian Bat Protection Plan (ABPP) during construction of the project.

Additionally, feathering turbine blades up to the manufacturer set cut-in speed from one-half hour before sunset to one-half hour after sunrise, from April 1 to October 31, has been shown to reduce potential impacts to bat species.

Solar facilities are sited to avoid and minimize impacts to wildlife. Specifically, this includes adverse effects due to fragmentation, habitat loss, and displacement. Biological and natural resource inventories are utilized to identify wildlife corridors and necessary avoidance measures during construction and operation of the facility. Further, restoration of grassland type habitat within the site can attract insects, bees, and butterflies, providing food and nesting habitat for birds. Additionally, utilizing biodegradable materials for soil and erosion BMPs rather than photodegradable materials can help minimize impacts to wildlife.

6.4.3 Vegetation

Large energy projects can have short and long-term impacts on vegetation. During construction, temporary impacts to vegetation occur as a result of ground disturbance activities. If the land is restored, ground disturbance is considered a short-term impact. Long term impacts are due to the permanent placement facilities that do not allow the area to be restored (e.g., turbine locations, O&M, substation, permanent access roads, etc.).

Disturbance due to construction activities can lead to the introduction of invasive species or noxious weeds. Vehicles can transfer seed from contaminated sites to exposed soils in uncontaminated sites, resulting in the transfer of the noxious weeds or invasive species. Additionally, noxious weeds can alter the landscape by displacing native vegetation, specifically the conversion from forested to open settings when woody vegetation is outcompeted. Also, during project operations, routine maintenance or emergency repairs can result in temporary impacts to vegetation as ground disturbance, vegetation trampling, and the spread of weeds may occur.

Buffalo Ridge Wind Project

The 2011 National Landcover Database (Homer et al. 2015) indicates that the project area contains approximately 13,462 acres of cultivated land or about 79.7 percent of the project area. In addition, the database indicates that the project area contains approximately 213.3 acres of pastures, or approximately 1.3 percent of the project area, and approximately 2,255.4 acres of grassland/herbaceous habitat, or approximately 13.4 percent of the project area (Figure 10). Areas used as pastures, filter strips (i.e., buffer strips), or areas that are not actively farmed, can have the ecological functions of grasslands. These grassy areas can serve the same purpose as native prairie, providing valuable habitat for grassland nesting or foraging birds. The remaining land cover type within the project area consists primarily of developed/disturbed space (Table 7).

Table 7. Land Cover Types and Their Relative Abundance in the Project Area

Land Cover	Sum of Area (Acres)	Percent of Project Area
Cultivated Crops	13,462 (5,447.9 hectares)	79.7%
Grassland	2,255.4 (912.7 hectares)	13.4%
Hay/Pasture	213.3 (86.3 hectares)	1.3%
Disturbed/Developed	811.5 (328.4 hectares)	4.8%
Open Water	4.6 (1.9 hectares)	0.03%
Wetlands	78.8 (31.9 hectares)	0.5%
Deciduous Forest	66.1 (26.7 hectares)	0.4%
Barren Land	1.1 (0.4 hectares)	0.01%
TOTAL	**16,892.8 (6,836.3 hectares)**	**100%**

Four native plant communities are located within the project area (Figure 14). MNDNR has assigned a biodiversity rank to these communities. Two of the native plant community types, Ups13d, Dry Hill Prairie (Southern), and Ups23a, Mesic Prairie (Southern), are ranked as Imperiled (S2). MHs38b, Basswood – Bur Oak – (Green Ash) Forest and WMs83a1, Seepage Meadow/Carr, Tussock Sedge Subtype, are ranked as Vulnerable to Extirpation (S3) within the project area. Table 8 provides a breakdown of approximate acreage and ecological classification for these feature types.

Table 8. Native Prairie and Native Plant Community Types within the Project Area

	Acreage within Project Area by Biodiversity Rank		
Native Plant Community Type	**Outstanding**	**High**	**Moderate**
MHs38b – Basswood – Bur Oak – (Green Ash) Forest	N/A	24.8 (10 hectares)	N/A
UPs13d – Dry Hill Prairie (Southern)	1.8 (0.7 hectares)	131.6 (53.3 hectares)	89.7 (36.3 hectares)
UPs23a – Mesic Prairie (Southern)	N/A	N/A	4.4 acres (1.8 hectares)
WMs83a1 – Seepage Meadow/Carr, Tussock Sedge Subtype	N/A	1.9 (0.8 hectares)	N/A

Vegetation will be removed during construction of turbine pads, access roads, substation, and O&M facilities. BRW is proposing to place the majority of project infrastructure in agricultural fields. Less than 0.21 percent of the total project area will be permanently converted to sites for wind turbines or other permanent project infrastructure. Table 9 details anticipated permanent impacts to vegetation and unique vegetation types within the project area. Project infrastructure will be sited to avoid sites of biodiversity significance that are ranked high or outstanding. Mapped native plant communities will be avoided to the extent practical. Should infrastructure be planned in areas mapped as native plant communities, coordination with the MNDNR is necessary.

Table 9. Summary of Estimated Permanent Impacts to Vegetation (Acres)

Land Cover Type	Turbines (acres)	Access Roads (acres)	O&M Facility (acres/)	Substation (acres)	Total (acres)
Cultivated Crops	4.3	20.1	0	5.2	29.6
Hay/Pasture	0	0.1	0	0	0.1
Developed, Open Space	0	0.4	0	0	0.4
Developed, Medium Intensity	0	0	0	0	0
Herbaceous	0.3	1.7	4.9	0.3	7.3
Native Plant Community	0	0	0	0	0
Total	4.6	22.3	4.9	5.6	37.4

Temporary vegetation impacts will occur during construction activities associated with the installation of underground collection lines, crane walks, and the laydown and staging areas. As ground will be disturbed by equipment from different geographic areas, introduction of noxious weeds and invasive species may occur. It is important to work with all project construction parties to minimize and prevent the introduction of invasive species and noxious weeds.

Generic 109 MW LWECS

Similar impacts are expected for a generic 109 MW LWECS. However, site specific effects are difficult to assess for vegetation, including native prairie, native plant communities, and sites of biodiversity significance.

109 MW Solar Farm

The degree and level of impact is difficult to assess for solar farms without site specific knowledge. Developers of solar farms often grade land and remove vegetation to minimize installation and operational costs. This prevents shading of the panels and reduces the risk of spreading fires. Ground-mounted PV solar farms require approximately 7 to 10 acres per MW. To construct the North Star facility, 170 acres were graded and cleared of vegetation. The entire solar farm occupies 800 acres; because of this relatively larger footprint, impacts to vegetation would be greater than for a comparable LWECS.

Mitigation

Direct permanent and temporary impacts to vegetation within the project area can be mitigated by micro-siting infrastructure to avoid sensitive plants and plant communities. Using BMPs and standard construction practices can minimize soil erosion. Coordination with the local NRCS office is advised to ensure the reseeding of disturbed areas with locally sourced native mixes should impacts occur during construction activities.

Preparation of a prairie protection plan is advised in consultation with the MNDNR. Prairie protection plans detail efforts to avoid impacts to prairies through site design. Additionally, any impacts expected to occur to MBS sites of biodiversity significance will be coordinated with MNDNR as appropriate. BMPs should be implemented by all project construction entities entering the project area to control and prevent the introduction of invasive species. BMPs include limiting invasive species spread by cleaning mowers and bladed equipment, minimizing disturbance to native areas, limiting traffic through weed-infested areas, early detection and elimination if invasive species, and frequently inspecting equipment storage areas for weeds. In the event that invasive weeds are detected, control via properly timed cutting and targeted herbicide use should be conducted in keeping with the herbicide BMPs published by the Minnesota Department of Transportation (MnDOT) and MDA (MDA 2018).

Impacts arising from site preparation practices of removing vegetation from solar farm sites can be minimized in certain circumstances by co-locating solar farms with agricultural operations such as harvestable crops, grazing, and apiary. There are successful examples of co-locating solar facilities with these types of agricultural operations.

6.4.4 Rare and Unique Natural Resources

The USFWS, MBS, and the Minnesota Natural Heritage Information System (NHIS) provide distribution lists of federal and state listed threatened, endangered, and candidate species, as well as potential occurrence of any significant natural features and native plant communities within the project area. The NHIS database is continually updated and provides the most accurate and complete list of Minnesota's rare and special status species, native plant communities, and significant natural features. This section addresses occurrences of rare and unique natural resources and sites that harbor critical habitat or have the potential to harbor critical habitat.

Large electric generation facilities have the potential to impact individuals and/or their habitat. Impacts to bald eagles are of additional concern in Minnesota. Consideration of their observed range and of site specific variables must be taken into account to avoid adverse impacts. Wind energy facilities have the option to apply for an Incidental Take Permit and Nest Removal Permits for the species. They must make a determination of the respective risk or the project's potential to take the species and obtain approval from the USFWS.

Buffalo Ridge Wind Project

The majority of rare and unique natural features identified during the MNDNR's NHIS data review for the project area are grassland-associated invertebrates (butterflies) and vascular plants which are primarily concentrated in the western edge of the project area in association with existing state-owned WMA properties, the Nature Conservancy's Hole-In-The-Mountain Prairie, and grassland dominated areas (Figure 10). Proactive avoidance of native grassland habitat and public lands within the project area has been suggested by the MNDNR to the greatest extent practicable.

The USFWS county list of federal and state listed threatened, endangered, and candidate species indicates that Lincoln and Pipestone counties are within the range (i.e., has documented records, harbors critical habitat, and/or has the potential to harbor critical habitat for the designated species) of the federally listed threatened northern long-eared bat, western prairie fringed orchid *(Platanthera praeclara),* Poweshiek's skipperling, and Dakota skipper, and the federally listed endangered Topeka shiner (USFWS 2014). In the state of Minnesota, the western prairie fringed orchid and the Dakota skipper are designated by the state as endangered.

The federally threatened northern long-eared bat roosts under bark, cavities, or crevices of dead and living trees during summer (Carter and Feldhamer 2005; USFWS 2014). Foraging habitat is generally located within forests interiors beneath the forest canopy, but above the shrub strata; however, northern long-eared bats have been known to forage over tallgrass prairie habitat where insects are gleaned from vegetation (Boyles et al. 2009). The bat may occur as a migrant within the project area, but the absence of high quality woodlands or floodplain forests within the project area limit the bat's likelihood to occur as a summering or wintering species within the project area.

The Topeka shiner is a federally listed endangered species that occurs in small prairie streams in pools containing clear, clean water (Berg et al. 2004). The Topeka shiner critical habitat final rule was designated by USFWS on July 27, 2004 and encompasses streams within the entirety of the project area and approximately 196 miles (315 kilometers) of five stream segments in southern Lincoln County, Minnesota (USFWS 2004). The closest NHIS Topeka shiner occurrences to the project area are: (1) along the southern and western margins of the project area at tributaries of the Pipestem and East Branch of Flandreau Creek, and (2) 1.3 miles to the west of the southwest corner of the project area. The USFWS Twin Cities Field Office has prepared specific recommendations for projects that may impair waters containing Topeka shiners in Minnesota (USFWS Twin Cities Field Office 2016). These recommendations are restricted to the Big Sioux River and Rock River watersheds within Lincoln County. These two watersheds make up less than 30 percent of the project area, with waters flowing to the north and east in the Redwood River watershed. Impacts to Topeka Shiner or their habitats are not anticipated.

The Dakota skipper is a federally listed threatened species and state-listed endangered species in Minnesota. The Dakota skipper prefers native drier prairie, where medium grasses are a major element of the vegetation. Final critical habitat was designated by USFWS for the Dakota skipper on October 1, 2015, including about 19,900 acres in Minnesota, North Dakota, and South Dakota (USFWS 2014). One federally designated critical habitat unit for the Dakota skipper occurs within the project area, and it is associated with Hole-in-the-Mountain area to the western boundary of the project area. Surveys in recent years by MNDNR indicate that the Dakota skipper, in particular, has disappeared from dozens of known sites in Minnesota. As part of a reintroduction effort, in June 2017, The Nature Conservancy, Minnesota Zoo, USFWS, and MNDNR reintroduced 200 adult Dakota skippers on the Hole-in-the-Mountain Prairie Preserve (Ahlering 2018), with a second reintroduction completed at the same site in 2018 (Runquist et al. 2018). The Hole-in-the Mountain Prairie Preserve is within the project area and adjacent to the project area's western boundary. The preserve is buffered from the project by standard Commission setbacks. The prior Buffalo Ridge Wind Energy Project was located in similar proximity to the site.

A desktop analysis aimed at identifying potential suitable habitat for the Dakota skipper and Poweshiek skipperling was conducted. The desktop analysis, based off aerial imagery, identified a patchwork of potentially suitable habitat (remnant native prairie and wetlands) for both the Dakota skipper and Poweshiek skipperling scattered in limited areas within the project area, but primarily on the western edge of the project area.

Despite recent targeted survey effort for this species, recent confirmed records of this species in western Minnesota have become very rare (MNDNR 2019c). However, these survey results provide a limited picture of the species, as this species' survey window is extremely limited each summer (a three-week period from late June to mid-July during calm periods in the morning only). Furthermore, there are a very small number of qualified surveyors who can identify this inconspicuous species in the field. As a result, this species does have the potential to occur in appropriate grassland habitats within the project area. As such, three rounds of adult Dakota skipper and Poweshiek skipperling occupancy surveys were completed within the project area in July 2019.No Dakota skippers or Poweshiek skipperlings were observed during any of the three rounds of adult occupancy surveys.

The western prairie fringed orchid is a federally listed threatened and state-listed endangered species in Minnesota. Western prairie fringed orchids are very local in their distribution and are largely restricted to remnant native prairies or sedge meadows. These sites typically occur in full sunlight on moist till or sandy soils. There are very few remaining suitable sites for this orchid within its range as this species is excluded by cattle grazing and limited by mowing for wild hay (MNDNR 2017). Remnant native prairie and wetlands occur in the project area; however, there are no NHIS records of this species within the project area or within one mile of the project area. As such, this species is expected to have a low chance of occurring within the project area.

The applicant received a formal Natural Heritage Review letter from the MNDNR for the project on April 5, 2019. In addition to the formal Natural Heritage Review letter from MNDNR, the applicant queried the electronic database for rare species occurrences within one mile of the project area.

Results from the MNDNR NHIS database review for the project area indicated 129 element occurrence records (EORs) of 28 different types of rare plants or animals within 1 mile of the project area boundary. Of the EORs, five are state-listed endangered, two are state-listed threatened, and 21 are state special concern species. Seventy-four percent of EORs were outside the 2.5-mile project boundary. The mapped occurrences include 11 records of nine vertebrate species, with only two species, Blanding's turtle and Richardson's ground squirrel, within the project area. Among invertebrates, 49 records from among eight invertebrate species, with 69 percent of EORs outside the project area. Among the 10 plant species, there are 40 EORs, with 78 percent outside the project area. (Table 10). The NHIS maintains that it is not an exhaustive inventory, and, thus, does not represent all occurrences of rare features within the state. In addition, ecologically significant features for which the NHIS has no records may exist within the project area.

It is important to note that some of the species listed are restricted to aquatic and wetland environments and are not expected to be impacted by development of the project (e.g., hair-like beak rush). Furthermore, several species identified are typically found in open, native prairies.

Native prairie and open grasslands functioning as prairie are not anticipated to be impacted by development of the project.

Table 10. NHIS Species Recorded within 1 Mile of the Project

Type, Common Name	Scientific Name	Status	Number of NHIS Records within the Project Area	Number of NHIS Records within 1 Mile of the Project Area	Year of Most Current Observation
Vertebrate Animals					
Loggerhead Shrike	*Lanius ludovicianus*	SE	0	1	2006
Henslow's Sparrow	*Ammodramus henslowii*	SE	0	2	2006
Purple Martin	*Progne subis*	SPC	0	1	2006
Prairie Vole	*Microtus ochrogaster*	SPC	0	1	2006
Richardson's Ground Squirrel	*Urocitellus richardsonii*	SPC	1	1	1982
Western Harvest Mouse	*Reithrodontomys megalotis*	SPC	0	1	2006
Blanding's Turtle	*Emydoidea blandingii*	ST	0	2	2006
Invertebrate Animals					
Dakota Skipper	*Hesperia dacotae*	SE	2	1	2009
Ottoe Skipper	*Hesperia ottoe*	SE	1	0	2006
Poweshiek Skipperling	*Oarisma poweshiek*	SE	5	4	2006
Pawnee Skipper	*Hesperia leonardus pawnee*	SPC	1	1	2006
Iowa Skipper	*Atrytone arogos iowa*	SPC	0	1	1996
Regal Fritillary	*Speyeria idalia*	SPC	4	1	2017
Abbreviated Underwing	*Catocala abbreviatella*	SPC	1	0	1983
Whitney's Underwing	*Catocala whitneyi*	SPC	1	0	1981

Type, Common Name	Scientific Name	Status	Number of NHIS Records within the Project Area	Number of NHIS Records within 1 Mile of the Project Area	Year of Most Current Observation
Leadplant Flower Moth	*Schinia lucens*	SPC	1	0	2007
A Jumping Spider	*Habronattus texanus*	SPC	1	0	1978
A Jumping Spider	*Phidippus pius*	SPC	1	0	1975
Plants					
Hair-like Beak Rush	*Rhynchospora capillacea*	ST	0	1	2007
Small-leaved Pussytoes	*Antennaria parvifolia*	SPC	1	1	2009
Soft Goldenrod	*Solidago mollis*	SPC	0	2	1983
Few-flowered Spikerush	*Eleocharis quinqueflora*	SPC	0	1	2007
Plains Reedgrass	*Calamagrostis montanensis*	SPC	0	1	1944
Red Three-awn	*Aristida purpurea var. longiseta*	SPC	2	0	2007
Missouri Milk-vetch	*Astragalus missouriensis* var. *missouriensis*	SPC	1	0	2006
Western White Prairie-clover	*Dalea candida* var. *oligophylla*	SPC	2	1	2008
Prairie Moonwort	*Botrychium campestre*	SPC	1	0	2007
Small White Lady's-slipper	*Cypripedium candidum*	SPC	0	1	2012

SE = state-listed endangered, ST = state-listed threatened; SPC= state special concern; FE = federally listed endangered; FT = federally listed threatened

The MNDNR has mapped rare and unique native plant communities as part of its NHIS database. These native plant communities have the potential to provide habitat for rare species of flora and fauna. The native prairie type habitats and calcareous fens native plant communities are both identified as constraints by the MNDNR in the July 18, 2017, and Natural Heritage Review letter of April 5, 2019. Most of the native plant communities are found on the western edge of the project area, with limited inclusions within the project, which have been identified as areas for avoidance (Figure 14; Table 11).

Negligible impacts to rare and unique natural resources are expected from the proposed project, due to the scarcity of such resources in the project area. In addition, limited potential natural habitat for these resources have been identified as areas of avoidance for project construction and operations activities.

Table 11. NHIS Records of Native Plant Communities Recorded within 1 Mile of the Project

Native Plant Community Type	Number of NHIS Records within the Project Area	Number of NHIS Records within One Mile of the Project Area
Basin Meadow/Carr – S2 Imperiled	0	1
Basswood – Bur Oak – (Green Ash) Forest – S3: Vulnerable to Extirpation	2	23
Calcareous Fen (Southwestern) – S2: Imperiled	0	3
Cattail – Sedge Marsh (Prairie) – S1: Critically Imperiled	0	3
Dry Hill Prairie (Southern) – S2: Imperiled	35	73
Dry Sand – Gravel Prairie (Southern) – S2: Imperiled	0	15
Mesic Prairie (Southern) – S2: Imperiled	2	2
Prairie Meadow/Carr – S3: Vulnerable to Extirpation	0	18
Seepage Meadow/Carr, Aquatic Sedge Subtype – S3: Vulnerable to Extirpation	0	1
Seepage Meadow/Carr, Tussock Sedge Subtype – S3: Vulnerable to Extirpation	1	5
Spikerush – Bur Reed Marsh (Prairie) – S1: Critically Imperiled	0	1
Wet Prairie (Southern) – S2: Imperiled	0	8
Wet Seepage Prairie (Southern) – S1: Critically Imperiled	0	1
TOTAL	40	154

Generic 109 MW LWECS

Without site specific information on rare and unique resources, a comparison of the potential impacts of a generic 109 MW LWECS cannot be drawn.

109 MW Solar Farm

Site specific information on rare and unique resources is needed to draw a comparison. As stated in Section 6.4.2, solar farms are generally fenced off areas and can have a higher potential to affect rare and unique wildlife attempting to move through the project area.

Mitigation

Compiling a pre-construction inventory of sensitive biological features within the project area can help to better tailor micro-siting activities to avoid or minimize potential impacts to sensitive biological features for both an LWECS and a solar farm project. Avoiding siting project infrastructure within wetlands, drainage systems, or MBS sites can also help to reduce potential biological impacts for an LWECS or solar farm project. Additionally, limiting impacts to native grassland and wetland areas during the construction and siting process will reduce the potential impacts for rare and unique natural features (e.g., Dakota skipper and any other listed plants and animals).

The following practices along with the measures outlined in Section 6.4.2 would help prevent potential impacts to rare and unique natural resources for the project, a generic LWECS, or a solar farm:

- Limit impacts to wooded habitat that has potential roosting habitat for northern long-eared bats. If impacts cannot be avoided, additional activity and cutting restrictions may be warranted per USFWS 4(d) rule and should be conducted in consultation with USFWS.
- Topeka shiner–related management minimization recommendations (USFWS Twin Cities Field Office 2016) for the Big Sioux and Rock River watersheds include (but are not limited to) the following:
    - Avoid dewatering or temporarily diverting streams for construction when practical.
    - Avoid conducting in-stream work before August 15 to avoid disrupting spawning.
    - Follow all applicable requirements and best management practices for stormwater permits from the MPCA.
    - Minimize removal of riparian vegetation when applicable.
    - Mulch areas of disturbed soil and reseed promptly when applicable.
    - Implement appropriate erosion and sediment prevention measures.
    - Ensure that erosion control features are in place.

- Design and install instream structures (e.g., box culverts) in a manner that will not impair passage of Topeka shiners after construction is completed when applicable.
- Do not operate motorized vehicles instream.
- Backfill placed in the stream should consist of rock or granular material free of fines, silts, and mud.
- Prevent materials and debris from falling into the water during construction.

Specific to the Buffalo Ridge Wind project, the applicant has agreed to prepare a Native Prairie Protection Plan and will continue to coordinate with USFWS and MNDNR accordingly.

6.5 Human and Social Environment

Large electric generation facilities have the potential to impact human, community, and social environments. The following sections discuss these potential impacts.

6.5.1 Demographics

Buffalo Ridge Wind Project

The project is located in southwestern Minnesota in an agricultural/rural region within Lincoln and Pipestone Counties. The 2010 census population for Lincoln County was 5,896 (U.S. Census Bureau 2019a) while the U.S. Census 2017 American Community Survey (ACS) population estimate for Lincoln County was 5,724, representing a population decrease of approximately 3.7 percent (U.S. Census Bureau 2019b). The 2010 census population for Pipestone County was 9,596 (U.S. Census Bureau 2019a) while the 2018 census population for Pipestone County was 9,047, representing a population decrease of approximately 5.7 percent (U.S. Census Bureau 2019a). The county seat of Lincoln County is the city of Ivanhoe, Minnesota, located approximately 11 miles (17 kilometers) north of the project area, and the county seat of Pipestone County is the city of Pipestone, Minnesota, located approximately 12.5 miles (20 kilometers) southwest of the project area.

Table 12 shows the U.S. Census Bureau 2013–2017 ACS demographic profile data for the State of Minnesota, Lincoln County, Pipestone County and townships within the project area including: Lake Benton, Hope, and Fountain Prairie (U.S. Census Bureau 2019b). The demographic profile summarizes some of the population and economic characteristics of Minnesota, Lincoln County, Pipestone County, and the townships in which the project is located.

Table 12. Population and Economic Characteristics

Location	Population	Housing Units (Occupied)	Per Capita Income	Families Below Poverty Line (%)	Minority Population (%)
Minnesota	5,490,726	2,404,624	$34,712	6.6%	24.4%
Lincoln County	5,724	3,136	$28,382	7%	5%
Pipestone County	9,229	4,488	$28,706	8.4%	16.4%
Lake Benton Township	207	171	$55,588	0.0%	0.5%
Hope Township	313	112	$49,057	4.3%	1.3%
Fountain Prairie Township	180	66	$31,443	6.1%	0.0%

Source: U.S. Census Bureau (2019b)

According to ACS estimates, educational services, and health care and social assistance accounted for 23 percent of jobs for Lincoln County; agriculture, forestry, fishing and hunting at 13.9 percent; manufacturing accounted for 10.6 percent; followed by retail trade at 8.9 percent (U.S. Census Bureau 2019b). According to ACS estimates, educational services, and health care and social assistance accounted for 22 percent of jobs for Pipestone County; agriculture, forestry, fishing and hunting at 12.3 percent; manufacturing accounted for 13 percent; followed by retail trade at 10.8 percent (U.S. Census Bureau 2019b).

Approximately 200 construction and 7 to 12 full-time O&M jobs are expected as part of the project. Development of the project will strengthen the local economy through annual payments to landowners with project infrastructure on their property, the use of local contractors and suppliers, potential temporary jobs for local workers, and tax benefits to local governments. Lincoln and Pipestone counties are expected to experience short-term positive economic impacts associated with tax payments during the construction phase of the project through the use of the hotels, restaurants, and other consumer goods and services by the various workers, as well as the purchase of materials such as fuel, concrete, and gravel from local vendors. It is anticipated that the economic impact would also expand into towns and cities within adjacent Lyon, Yellow Medicine, and Murray counties.

Wind energy infrastructure in the project area will provide significant long-term positive economic benefits to local landowners, the state, and the local economy of southwestern Minnesota. Landowners in the project area will benefit from annual lease payments and, in accordance with state and county law, payments are expected from property tax and production taxes on the land and energy production to local governments.

The project is not anticipated to significantly change the demographics of the project area or of Lincoln and Pipestone Counties.

Generic 109 MW LWECS

A similar amount of construction jobs and full-time operational jobs would be expected for a generic 109 MW LWECS. Tax revenue and purchasing of local goods would generate an overall positive impact for the specific location. These impacts would be dependent on the location's specific social and economic characteristics that make up the population of the area. A generic 109 MW LWECS would require a similar amount of land as the project. Land and setback requirements are usually satisfied by siting LWECS projects on contiguous agricultural land. As is true for the project, a generic 109 MW LWECS is not anticipated to significantly change the demographics of its host community.

109 MW Solar Farm

A 109 MW solar farm would likely require a greater amount of land than the project or a generic 109 MW LWECS. Given the land requirements of a 109 MW solar farm, it is also anticipated that such a solar farm would be sited on agricultural land and would subsequently remove more land from production. An influx of jobs for initial construction would be expected for the solar farm. For the North Star facility, approximately 250–300 workers were used to develop the project and 12 were permanently employed to operate the facility. Solar farms are also required to pay property taxes and production taxes to local governments in accordance with state and county law. Approximately $240,000 was generated annually by the North Star facility for local governments. As is true for the project and a generic 109 MW LWECS, a 109 MW solar farm is not anticipated to significantly change the demographics of its host community.

Mitigation

No mitigation measure would be required because the project (as well as a generic 109 MW LWECS or a 109 MW solar farm) would not have a significant impact on the demographics of its host community and socioeconomic impacts associated with the three compared facilities are expected to be positive.

6.5.2 Environmental Justice

Environmental justice is the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to environmental law and policies. Environmental justice is intended to ensure that all people benefit from equal levels of environmental protection and have the same opportunities to participate in decisions that may affect their environment or health (MPCA 2017). Environmental justice concerns are raised when a proposed project differentially impacts specific communities, e.g., placing a project that releases pollutants in a low-income neighborhood.

Buffalo Ridge Wind Project

Demographics of the project area are relatively similar to the state of Minnesota as a whole (Table 12). Incomes are slightly lower in the project area than in the state of Minnesota, but not significantly so. Minority populations are similar to and slightly less than the state of Minnesota as a whole. Thus, negative differential impacts to communities in the project area are not anticipated as a result of the project, and environmental justice concerns are minimal.

BRW conducted tribal outreach by providing detailed Project information to various Native American tribes with ancestral ties to the area. Interested tribes were invited to participate in micrositing and subsequent archaeological surveys to identify sites of cultural and religious significance to the Tribes which were avoided during design of the Project layout. Participating tribes included the Spirit Lake Sioux Tribe, Rosebud Sioux Tribe, Yankton Sioux Tribe, and Upper Sioux Community.

Generic 109 MW LWECS

Environmental justice impacts for a generic 109 MW LWECS would depend on the location of the project. As most LWECS in Minnesota have, to date, been sited in rural, agricultural communities, environmental justice impacts are anticipated to be similar to those of the project.

109 MW Solar Farm

Environmental justice impacts for a 109 MW solar farm would depend on the location of the project. As most solar farms in Minnesota have, to date, been sited in rural, agricultural communities, environmental justice impacts are anticipated to be similar to those of the project.

6.5.3 Aesthetic Impact and Visibility Impairment

Large energy projects can the impact the aesthetics of an area or region. Aesthetic, or visual resources, are generally defined as the natural and built features of a landscape that may be viewed by the public and contribute to the visual quality and character of an area. Aesthetic resources form the overall impression that an observer has of an area or its landscape character. Distinctive landforms, water bodies, vegetation, and human-made features that contribute to an area's aesthetic qualities are elements that contribute to an area's visual character. Visual quality is generally defined as the visual significance or appeal of a landscape based on cultural values and the landscape's intrinsic physical elements.

Visual sensitivity is a measure of viewer interest and concern for the visual quality of the landscape and potential changes to it, which is determined based on a combination of viewer sensitivity and viewer exposure. Viewer sensitivity varies for individuals and groups depending on the activities viewers are engaged in, their values and expectations related to the appearance and character of the landscape, and their potential level of concern for changes to the landscape. High viewer sensitivity is typically assigned to viewer groups engaged in: recreational or leisure activities; traveling on scenic routes for pleasure or to and from recreational or scenic areas; experiencing or traveling to or from protected, natural, cultural, or historic areas; or experiencing views from resort areas or their residences. Low viewer sensitivity is typically assigned to viewer groups engaged in work activities or commuting to or from work.

Viewer exposure varies for any particular view location or travel route depending on the number of viewers and the frequency and duration of their views. Viewer exposure would typically be highest for views experienced by high numbers of people, frequently, and for long periods. Other factors, such as viewing angle and viewer position relative to a feature or area, can also be contributing factors to viewer exposure.

Buffalo Ridge Wind Project

The general topography of the project area is undulating, rolling relief with approximate elevations between 1,742 and 1,982 feet amsl (Figure 13**)**. The project area generally has higher elevations in the central and northwestern sections with lower elevations in the northeast, southeast, and southwest. Agricultural fields, farmsteads, grasslands, and rolling topography visually dominate the project area. The landscape can generally be classified as rural open space.

The project will be visible to residents of the area and to people traveling north and south along US Hwy 75 and County State Aid Highway (CSAH) 7, east and west along US Hwy 14 and CSAH 6. However, the project will not create a new feature type within the landscape because several wind farms occur within project area and its immediate vicinity. Additionally, other power related infrastructure exists within the landscape.

Vegetation within the project area is predominantly agricultural crops, pasture, and wooded shelter belts surrounding residences and riparian areas. The main visual focal points within the project area are aspects of an agricultural landscape, which are broken up by residences, buildings, shelter belts, and small wood lots. Viewsheds in the area are generally long and open with only small scattered areas where the view from a location would be blocked by vegetation, topography, or existing structures.

There are no wind turbines within the project area. However, the Lake Benton II Wind Farm and the Ruthton Wind Farm are located within one mile of the project area. These existing wind facilities contain turbines of various heights and rotor diameters (RD). An additional eight wind farms are located within 10 miles of the project area (Figure 15).

MET towers associated with these wind facilities may also be present on the landscape. Generally, wind farms adjacent to the project area contain slightly smaller sized turbine models than those proposed for this project, with total heights ranging from approximately 300 feet to approximately 400 feet.

The FAA requires obstruction lighting or marking of structures over 200 feet above mean sea level because they have the potential to obstruct air navigation. The project will utilize a full coverage ADLS. The ADLS units will be positioned to provide full 360-degree surveillance of the airspace around the wind farm in order to provide advance detection of approaching aircraft and automatic activation of the wind farm obstruction lighting at sufficient ranges for operational safety in compliance with FAA regulations. The system will turn off the obstruction lighting when aircraft have cleared the control zone around the wind farm or at altitudes above the wind farm regulatory minimums.

The proposed project infrastructure including turbines, O&M building, access roads, substation, and construction equipment will be visible to permanent observers (residents) and temporary observers (motorists, tourists, or recreationalists passing by or using the area intermittently). Visual impacts may also be noticeable to users of public lands and public snowmobile trails within and within the vicinity of the project area. The project will not be introducing a new feature type to the landscape because existing wind turbines and other power related infrastructure are prevalent within and in the vicinity of the project area.

Turbines will likely be viewed in one of three perspectives:

- As a visual disruption
- As generally compatible with the rural agricultural heritage of the area, which includes existing wind turbines
- As adding a positive aesthetic quality to the landscape.

Additionally, alterations of the land with temporary impacts related to construction activities, such as temporary land use associated with equipment staging and laydown areas, crane paths, and installation of underground collection lines would be short-term and converted back to cropland or replanted with grasses and vegetation native to the area following the completion of construction. Visual impacts from an increase in traffic and human activity within the project area associated with project construction would also be short-term. The long-term operation of the project is not anticipated to increase visual impacts associated with human activity or traffic within the project area.

Generic 109 MW LWECS

The potential aesthetic impacts and visibility impairments from a generic 109 MW LWECS are expected to be similar to those of associated with the project.

109 MW Solar Farm

A 109 MW solar farm would likely require more land than the project or a generic 109 MW LWECS. Therefore, more land would be visibly impacted by its conversion to features associated with the solar farm. However, solar farms have a lower profile than wind farms and are typically not visible from great distances. The aesthetic impacts and visibility impairments of a 109 MW solar farm would be primarily perceived by adjacent residents and by people traveling on roads adjacent to the solar farm.

Mitigation

The following mitigation measures could minimize potential visual impacts of the project and generic LWECS:

- Turbines should be uniform in color.
- Turbines should not be located in sensitive areas such as public parks, WMAs, or WPAs.
- Turbines should be illuminated to meet the minimum requirements of FAA regulations for obstruction lighting of wind turbine projects.
- The project should utilize an ADLS system to be in compliance with FAA regulations. ADLS systems turn off when aircraft have cleared the control zone around the wind farm or at altitudes above the wind farm regulatory minimums.
- Electrical collection lines should be buried to minimize aboveground structures within the project area.
- Existing roads should be used for construction and maintenance, as appropriate, to minimize the number of new roads constructed.
- Temporarily disturbed areas should be converted back to cropland or otherwise reseeded with seed mixes appropriate for the region.

Mitigation measures for a solar farm could include siting the facility within the existing landscape, but as far as possible from existing homes, and the use of landscaping, such as berms, fencing, or vegetation that helps to block the view of the solar farm and minimize visual impacts associated with it.

6.5.4 Shadow Flicker

Wind turbines are known to create shadow flicker. Shadow flicker is the intermittent change in light intensity due to rotating wind turbine blades casting shadows on the ground. Three conditions must be present for shadow flicker to occur:

- The sun must be shining with no clouds to obscure it.
- The rotor blades must be spinning and located between the receptor and the light source.
- The receptor must be close enough to the turbine to be able to distinguish the shadow created by the turbine.

Shadow intensity, or how “light” or “dark” a shadow appears at a specific receptor, will vary with distance from the turbine. The closer a receptor is to a turbine, the more turbine blades block out the sun’s rays, and shadows will be wider and darker. Receptors located farther away from a turbine experience thinner and less distinct shadows since the blades block out less sunlight. Shadow flicker is reduced or eliminated when buildings, trees, blinds, or curtains are located between the turbine and receptor.

While there are no rules for a Minnesota “light standard” defining the amount of shadow flicker that is acceptable for a commercial wind project, the default industry standard is for no occupied residence to receive more than 30 hours per year of shadow flicker. No other states have adopted a standard for shadow flicker, however, other countries have examined the issue and have adopted standards. Standards depend on assumptions about how flicker impacts are to be calculated:

- Germany has established a "norm" for shadow flicker that does not exceed 30 hours/yr. or 30 minutes/day at a receptor. It is unclear whether this is a worst-case scenario (e.g., clear skies every day) or a real-case scenario (e.g., weather representative of the project area).
- Belgium has adopted the German norm, adding a requirement for modeling.
- Denmark recommends a maximum of 10 hours/yr. assuming average cloud cover in the project area.
- France has adopted no standard but requires shadow flicker modeling.
- The Netherlands have adopted a yearly maximum of 5 hours and 40 minutes assuming clear skies.
- The State of Victoria, Australia, has adopted a shadow flicker standard of 30 hours/yr.

Buffalo Ridge Wind Project

BRW conducted shadow flicker modeling for the project. This modeling predicts that the highest expected shadow flicker hours per year at a participating receptor is 40 hours and 49 minutes. The highest expected shadow flicker per year at a non-participant is 29 hours and 39 minutes. The majority of the receptors (295) were predicted to experience no annual shadow flicker. Sixty-seven locations were predicted to experience some shadow flicker but less than 10 hours per year. The modeling results showed that 40 locations would be expected to have 10 to 30 hours of shadow flicker per year. Nine receptors are expected to have over 30 hours of flicker per year, none of which are non-participating receptors. The modeling receptors were treated as “greenhouses” and the surrounding area was assumed to be without vegetation or structures (“bare earth”). All modeled receptors and project shadow flicker levels are identified on **Figure 16 (Shadow Flicker Modeling Results)** and are distinguished as participating, participating-assumed, or non-participating. Any non-participating parcel that was within or partially within the 5 RD by 3 RD setbacks has been assigned a participating-assumed status.

Generic 109 MW LWECS

A generic 109 MW wind farm would have similar shadow flicker modeling results; depending on the surrounding landscape (relative receptor locations, availability of natural shielding, etc.) and topography, the potential impacts and mitigation may vary. Shadow flicker could be reduced in an area with greater variation in topography and vegetation, such as a landscape with hills and greater tree cover.

109 MW Solar Farm

Solar farms do not produce shadow flicker; thus, no shadow flicker impacts would occur.

Mitigation

Shadow flicker impacts at receptors within and adjacent to the project area can be minimized by micrositing wind turbines to avoid shadow flicker. Standard Commission setbacks from residences and property lines also minimize shadow flicker.

Shadow flicker is not expected to harm the health of photosensitive individuals, including those with epilepsy. Shadow flicker frequencies from modern wind turbines are below the frequency of 5 to 30 flashes per second identified by the Epilepsy Foundation as most likely to trigger seizures (Epilepsy Foundation et al. 2013).

The following mitigation measures could be used for the project or a generic LWECS, should shadow flicker complaints occur:

- Meeting with the homeowner to determine the specifics of their complaint.
- Investigating the cause of the complaint.
- Providing the homeowner with reasonable mitigation alternatives including shades, blinds, awnings, or plantings.

Additionally, shadow flicker impacts could be mitigated by operational limitations, e.g., limiting the operation of specific turbines during certain times of the year and day.

6.5.5 Facility and Turbine Lighting

Large energy projects typically have some type of lighting at the facility for safety. The FAA requires obstruction lighting or marking of structures over 200 feet above mean sea level because they have the potential to obstruct air navigation. To meet this requirement, turbines are lighted with red flashing lights, which can create an undesirable aesthetic impact in rural settings.

Buffalo Ridge Wind Project

Wind turbines and other tall structures will have lighting consistent with FAA guidelines. This includes lighting turbines with red flashing lights for nighttime safety of aircrafts. Other facilities will be lighted for worker safety during construction and operation of the project.

To mitigate aesthetic impacts of the turbine lighting, the project will utilize an aircraft detection system (ADLS). The ADLS will survey the airspace around the wind farm, provide advance detection of approaching aircraft, and automatically activate the project's obstruction lighting. The system will turn off the obstruction lighting when aircraft have cleared the project area. FAA approval of a lighting plan that is compliant with FAA requirements will be required for the project. For all non-turbine facilities, lighting will only be used when workers are present and only downward facing lights will be used.

Generic 109 MW LWECS

A generic 109 MW LWECS would have similar lighting impacts to the proposed project, provided the LWECS used an ADLS system. Without such a system, a generic 109 MW LWECS would have relatively greater aesthetic impacts.

109 MW Solar Farm

Solar farms have a low profile and do not typically trigger FAA lighting requirements. Lighting on solar farms is typically associated with security. This includes perimeter gates and security gates with motion-activated lights that face downward to minimize impacts on adjacent land uses. Otherwise, lighting is temporarily installed for construction of the facilities and taken down afterward.

Mitigation

Aesthetic impacts due to facility and turbine lighting can be mitigated by using an ADLS or similar system that minimizes nighttime obstruction lighting. Impacts can also be mitigated by using downward facing lighting on facility buildings.

6.5.6 Noise

Large electric generation facilities produce noise. Potential human impacts due to noise include hearing loss, stress, annoyance, and sleep disturbance. Noise can be defined as unwanted or inappropriate sound. Sound has multiple characteristics which determine whether a sound is too loud or otherwise inappropriate. Sound travels in a wave motion and produces a sound pressure level. This sound pressure level is commonly measured in decibels (dB). Sounds also consists of frequencies, e.g., the high frequency (or pitch) of a whistle. Most sounds are not a single frequency but a mixture of frequencies. Finally, sounds can be constant or intermittent. The perceived loudness of a sound depends on all of these characteristics.

A sound meter is used to measure loudness. The meter sums up the sound pressure levels for all frequencies of a sound and calculates a single loudness reading. This loudness reading is reported in decibels, with a suffix indicating the type of calculation used. The A-weighted decibel scale (dBA) is commonly used to measure the selective sensitivity of human hearing. This scales the physical sound levels that are measured as a pressure wave to match an equivalent "loudness" level across the audible spectrum that more closely resembles what a human ear would perceive. The A-weighted scale effectively puts more relative weight on the range of frequencies that the average human ear perceives clearly (e.g., mid-level frequencies) and less weight on those that humans do not perceive as well (e.g., very high and lower frequencies).

Noise levels depend on the distance from the noise source and the attenuation of the surrounding environment. Table 13 below provides an estimate of decibel levels of common noise sources.

Table 13. Common Noise Sources and Levels

Sound Pressure Level (dBA)	Common Indoor and Outdoor Noises
100–110	Rock band at 5 m Jet flyover at 300 m
90–100	Gas lawnmower at 1 m
80–90	Food blender at 1 m
70–80	Shouting at 1 m Vacuum cleaner at 3 m
60–70	Normal speech at 1 m
50–60	Large business office Dishwasher next room, quiet urban daytime
40–50	Library, quiet urban nighttime
30–40	Quiet suburban nighttime
20–30	Bedroom at night
10–20	Quiet rural nighttime Broadcast recording studio
0	Threshold of hearing

Source: MPCA (2015)

The State of Minnesota has promulgated noise standards designed to ensure public health and minimize citizen exposure to inappropriate sounds. The rules for permissible noise vary according to land use, i.e., according to their noise area classification (NAC).

In a residential setting, for example, noise restrictions are more stringent than in an industrial setting. Rural residential homes are considered NAC 1 (residential), while agricultural land and agricultural activities are classified as NAC 3 (industrial). The rules also distinguish between nighttime and daytime noise; less noise is permitted at night. Sound levels are not to be exceeded for 10 percent and 50 percent of the time in a one-hour survey (L_{10} and L_{50}) for each noise area classification. Table 14 lists Minnesota's noise standards by area classification.

Table 14. Minnesota Noise Standards by Area Classification (expressed in dBA)

Noise Area Classification	Daytime		Nighttime	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

The state noise standards are public health standards. They protect receptors from noise generated by all sources at a specific time and place. The total sum of noise at a particular time and location cannot violate the standards. A specific noise source is in violation of the standards if the source causes or significantly contributes to a violation of the standards.

The C-weighted scale (dBC) is used to measure human sensitivity at louder levels. C-weighted decibels are often used as a proxy to estimate the impact of low frequency noise. This scale puts more weight on the lower frequencies than the A-weighted scale. The G-Weighted scale (dBG) is designed for sound or noise whose spectrum lies partly or wholly within the frequency band of 1 to 20 Hz.

The numerical value of decibels will, in general, differ between the A-weightings, C-weightings and G-weightings. Numerical values across weightings should be compared with caution, since the respective results relate to different frequencies of the noise spectrum. Measurement programs for wind turbine noise have documented a significant correlation between dBA and dBC levels. Additionally, measurements comparing A-weighted noise levels and G-weighted noise levels show a significant correlation between the dBA and dBG as well.

Low frequency noise is considered audible but only at high amplitudes. Low frequency noise is commonly considered to be in the range of 20 to 200 Hz. Infrasound occurs in even lower frequency ranges (less than 20 Hz) and is generally inaudible to the human ear. However, it may still interact with the body and may be felt as vibrations. Studies have shown that pain from infrasound can result when sound levels are 165 dB or above at 2 Hz and 145 dB or above at 20 Hz. (Massachusetts Department of Public Health 2012). The magnitude of existing background low frequency noise/infrasound levels vary but can be of sufficient strength to mask the low frequency noise and infrasound contributions from wind turbines. Common background sound sources of low frequency noise and infrasound include wind interacting with vegetation, agricultural machinery and roadway noise.

Buffalo Ridge Wind Project

For wind turbines, sound can originate from two different sources: mechanical sound from the interaction of turbine components, and aerodynamic sound produced by the flow of air over the rotor blades. Recent advances in wind turbine design have greatly reduced the contribution of mechanical sound. Aerodynamic sound has also been reduced from modern wind turbines due to slower rotational speeds and changes in materials of construction.

Aerodynamic sound, in general, is broadband (has contributions from a wide range of frequencies). It originates from encounters of the wind turbine blades with localized airflow inhomogeneity and wakes from other turbine blades and from airflow across the surface of the blades, particularly the front and trailing edges. Aerodynamic sound generally increases with increasing wind speed up to a certain point, then typically remains constant, even with higher wind speeds. However, sound levels in general also increase with increasing wind speed with or without the presence of wind turbines.

An ambient measurement program and a sound level modeling analysis were conducted for the project. Ambient sounds include existing noise sources in the project area, e.g., wind passing through vegetation, roadways, farm equipment, as well as existing wind turbines in the area. A wind project that has been permitted and recently entered commercial operation, Lake Benton Wind II, was included as an ambient sound source through modeling.

Sound modeling by the applicant indicates it is likely that the project will not cause or significantly contribute to an exceedance of Minnesota's noise standards. The highest modeled sound level due to current and proposed wind turbines in the project area is 52 dBA (receptor #44). The second highest modeled sound level is 48 dBA, which occurs at receptors #42, #64, and #841. All modeled receptors and project sound levels are identified on **Figure 17 (Sound Level Modeling Results)** and are distinguished as participating, participating-assumed, or non-participating. Any non-participating parcel that was within or partially within the 5 RD by 3 RD setbacks has been assigned a participating-assumed status.

Commission site permits require permittees to meet Minnesota noise standards. Commission permits require permittees to conduct post-construction noise monitoring to ensure state noise standards are met. Noise impacts can be mitigated and brought within standards by several means including operating select turbines in a noise reduction mode (e.g., limiting turbine rotation speeds), using noise reducing edges on turbines blades, and curtailing the operation of select turbines under specific environmental conditions.

Generic 109 MW LWECS

A generic 109 MW LWECS could be expected have similar noise impacts to the project; however, the turbine selection, location of receptors, existing sources of ambient noise, surrounding vegetation, and topography could result in greater or lesser impacts than those expected of the project. Like the proposed project, a generic 109 MW LWECS would have to meet Minnesota noise standards.

109 MW Solar Farm

A 109 MW solar farm would primarily emit noise from the inverters, transformers, and rotation of tracking systems at each facility. This noise would only occur during the day because solar farms do not generate electricity at night and their inverters, transformers, and tracking systems would be operating at less than peak levels.

Noise impacts from a 109 MW solar farm would be less than those of the project or a generic 109 MW LWECS. Low voltage inverters and transformers produce less noise than turbine nacelles and blades.

Mitigation

The primary means of mitigating sound (noise) produced by wind turbines is siting. Turbines must be sited to comply with noise standards in Minnesota Rule 7030. For rural residential areas, this means sound levels must meet an L_{50} standard of 50 dBA.

Noise impacts can be mitigated and brought within standards by several means including operating select turbines in a noise reduction mode (e.g., limiting turbine rotation speeds), using noise reducing edges on turbines blades, and curtailing the operation of select turbines under specific environmental conditions.

Solar farms are not anticipated to exceed state noise standards; thus, no mitigation is required.

6.5.7 Property Values

Large electric generation facilities have the potential to impact property values. Because property values are influenced by a complex interaction between factors specific to each individual piece of real estate as well as local and national market conditions, the effect of one particular project on the value of one particular property is difficult to determine.

The placement of infrastructure near human settlements has the potential to impact property values. The impacts can be positive and negative. The type and extent of impacts depends on the relative location of the infrastructure and existing land uses in the project area. For example, a new highway may increase the value of properties anticipated to be used for commercial purposes but decrease the value of nearby residential properties.

Potential impacts to property values due to large energy facilities are related to three main concerns:

- Potential aesthetic impacts of the facility
- Concern over potential health effects from emissions (e.g., air emissions, wastewater discharges, electric and magnetic fields, etc.)
- Potential interference with agriculture or other land uses.

Buffalo Ridge Wind Project

Impacts on property values due to the project are difficult to quantify. Many factors influence a property's market value such as acreage, schools, parks, neighborhood characteristics and improvements. A direct influence on property value is often due to the status of the housing/land market at the time of sale.

A growing body of research suggests that wind turbines do not have a statistically significant effect on home values near wind facilities (e.g., Sims and Dent 2007; Sims et al. 2008; Heintzelman and Tuttle 2011; Carter 2011; Hoen et al. 2013, 2015; and Hoen and Atkinson-Palombo 2016). It is generally thought that effects of wind farms on property values, if they do exist, are too small to be statistically observable. However, the analysis done cannot dismiss the possibility that property values for individual homes may be negatively affected due to the proximity of a wind farm. The Buffalo Ridge area of Minnesota has seen significant wind development. The addition of another wind farm in this area may be less influential on property values than if it was placed in an area that has fewer wind farms.

Generic 109 MW LWECS

The impacts of a generic 109 MW LWECS on property values would be similar to those associated with the project. If a generic 109 MW LWECS were constructed in an area of the state with minimal or no wind farms on the landscape there could be more noticeable impacts on property values, but this impact is difficult to quantify or estimate.

109 MW Solar Farm

Electrical generating facilities have the potential to impact property values. Often, negative effects from these facilities are the result of impacts that extend beyond the immediate footprint. Examples include noise, emissions, and visual impacts. Unlike fossil-fueled electric generating facilities however, a 109 MW solar farm would have no emissions and essentially no noise impacts to adjacent land uses during operation of the facility. The installation of PV facilities would create a visual impact, but lacking the height of smokestacks or wind turbines, the visual impact at ground level, or within a neighboring building, would be limited.

A review of the literature found no research specifically aimed at quantifying impacts to property values based solely on proximity to utility-scale solar facilities. As the recently permitted Aurora and North Star solar project involve the first utility-scale solar facilities in Minnesota, comparable sales data are just becoming available. Very initial results from the North Star project show no impact on property values.

Mitigation

Potential property value impacts can be mitigated by siting turbines away from residences and by reducing aesthetic impacts. For solar facilities, impacts to property values can be mitigated through proper siting and measures to reduce aesthetic impacts such as restoration and vegetation management as well as screening the site with berms, deer fencing, and vegetation.

6.5.8 Local Economy

Wind facilities and solar farms have the potential to benefit the local economy as they create new jobs during their construction and operation. They also bring increased tax revenue and opportunities for business development. However, their presence can limit the landscape from being developed for other purposes, primarily land-based opportunities.

Buffalo Ridge Wind Project

Overall, the project will positively impact the region by adding infrastructure, temporary and permanent jobs, increasing the tax base, and providing lease payments to project participants. The project will pay a wind energy production tax to the local units of government of $0.0012 per kWh of electricity produced. This would result in an annual tax benefit of $500,000 to $600,000 for Lincoln County once the project is operational. The communities near the project are also expected to receive positive economic benefits as construction will necessitate the need for temporary and full-time positions. Approximately 200 construction and 7 to 12 full-time O&M jobs are expected as part of the project. Using local contractors and suppliers, where feasible, will contribute to the overall economy of the region. Purchases of products to construct and operate the facilities such as fuel, equipment, services, and supplies will benefit businesses in the counties as well as the state.

Minor negative impacts to the socioeconomic resources of the area are anticipated. An average of 0.75 acres of land per turbine will be taken out of agricultural production for the life of the project to accommodate the turbine pad, access roads, and ancillary facilities. This loss of agricultural production will negatively impact the local economy. However, landowners may continue to plant crops near, and graze livestock up to the gravel roadway and around each turbine pad. This negative impact will be offset through annual payments over the life of the project to those landowners having a turbine or other project facility constructed on their land.

Generic 109 MW LWECS

The impacts on the local economy from a generic 109 MW LWECS would likely be similar to those from the project.

109 MW Solar Farm

The impacts on the local economy from a 109 MW solar farm would likely be similar to those for the project and a generic 109 MW LWECS.

6.5.9 Public Health and Safety

Public health and safety can be impacted by the construction and operation of large electric generation facilities.

6.5.9.1 Electromagnetic Fields

Electromagnetic fields (EMF) are invisible regions of force resulting from the presence of electricity. EMF is often raised as a concern with electric transmission facilities. Naturally occurring EMF are caused by the earth's weather and geomagnetic field. Man-made EMF are caused by any electrical device and found wherever people use electricity.

- Electric fields are created by the electric charge (i.e., voltage) on a transmission line. Electric fields are solely dependent upon the voltage of a line (volts), not the current (amps). Electric field strength is measured in kilovolts per meter (kV/m). The strength of an electric field decreases rapidly as the distance from the source increases. Electric fields are easily shielded or weakened by most objects and materials, such as trees and buildings.
- Magnetic fields are created by the electrical current moving through a transmission line. The magnetic field strength is proportional to the electrical current (amps). Magnetic field strength is typically measured in milliGauss (mG). Similar to electric fields, the strength of a magnetic field decreases rapidly as the distance from the source increases. However, unlike electric fields, magnetic fields are not easily shielded or weakened by objects or materials.

Although EMF is often raised as a concern with electrical transmission projects, the Commission has consistently found that there is insufficient evidence to demonstrate a causal relationship between EMF exposure and human health effects.

Buffalo Ridge Wind Project

The 34.5 kV underground power cable used in the project collector system is shielded, meaning the energized conductor is located at the center of the cable and is completely surrounded by a grounded metallic shield. This construction confines the electric field to the interior of the cable. Thus, there is no detectable electric field produced by the cable or by any other components of the project collection system.

A magnetic field is produced by the flow of current through a conductor or cable. The project's collector system is a three-phase system, which requires three separate cables to make up each circuit. The three cables that comprise a circuit are installed in close proximity to each other, with the entire assembly buried approximately 48 inches below grade. This method of installation causes the magnetic fields produced by each cable to be largely cancelled out by the fields produced by the other cables, resulting in relatively low magnetic fields even at ground level directly above the cables.

Generic 109 MW LWECS

The EMF impacts from a generic 109 MW LWECS are likely to be similar to that from the project.

109 MW Solar Farm

A 109 MW solar farm would require similar infrastructure as a LWECS to deliver power to the grid. This includes transmission lines and substation(s) associated with on-site facilities. On site facilities such as PV arrays, electrical cables, electrical cabinets, step-up transformers, and access roads would be unique to a solar farm and the infrastructure plan. As with the project and a generic 109 MW LWECS, impacts to human health due to EMF are not anticipated.

Mitigation

Based upon current research regarding EMFs, and the separation distances being maintained between transformers, turbines, and collector lines from public access and occupied residences, EMFs associated with the project are not expected to have an impact on public health and safety. Therefore, no mitigation is needed.

6.5.9.2 Stray Voltage

Stray voltage, as defined by the Institute of Electrical and Electronics Engineers, is "a voltage resulting from the normal delivery and/or use of electricity (usually smaller than 10 volts) that may be present between two conductive surfaces that can be simultaneously contacted by members of the general public and/or animals." Stray voltage generally refers to a voltage that is found on buildings, barns and other structures that are grounded to earth. Most instances of stray voltage are experienced by livestock who simultaneously come into contact with two metal objects through which a small current flows. Electrical systems, including farm systems and utility distribution systems, must be adequately grounded to ensure continuous safety and reliability and to minimize this current flow. A number of factors affect whether or not an object is actually grounded. This includes wire size and length, the quality of the connection, the number and resistance of ground rods, and the current being grounded. Thus, stray voltage can exist in any facility that uses electricity, independent of whether or not there is a transmission line nearby.

Stray voltage is commonly associated with small electrical distribution lines, which connect residences or farms to larger transmission lines. Data indicates that stray voltage is not linked to the distance of a farm from a substation or transmission line or the voltage of the transmission line (Wisconsin Public Service 2011).

Buffalo Ridge Wind Project

BRW's collector circuits are inherently balanced, so no appreciable neutral-to-earth voltage is expected. Additionally, there will be no direct connection between BRW's collection system and the local electrical distribution system, and, therefore, no stray voltage impacts are anticipated.

Electrical equipment will be grounded per ASNI and NESC guidelines to ensure safety and reliability. Correctly connecting and grounding electrical equipment will prevent potential issues related to stray voltage. Stray voltage is typically not associated with underground electric collector lines, which connect to the project substation and are not tapped or diverted for other uses. Therefore, stray voltage is not expected to have an impact on public health and safety.

Generic 109 MW LWECS

A generic 109 MW LWECS would have similar impacts on stray voltage as the project.

109 MW Solar Farm

A 109 MW solar farm would require similar infrastructure to gather power as a LWECS. During development of the system design, stray voltage concerns from collection and feeder lines are addressed. Therefore, similar to an LWECS, no impacts on public health or safety are expected.

6.6 Associated Electrical Facilities and Existing Infrastructure

Electric generation facilities have the potential to impact existing infrastructure. This infrastructure includes existing electrical facilities, road networks, and communication infrastructure.

6.6.1 Associated Electrical Facilities

Electric generation facilities typically require construction of electrical facilities beyond the project boundaries, such as transmission lines and substations to deliver the generated power to the electric grid.

Impacts associated with construction of new transmission lines and substations can include impacts to plants and animals due to the loss of vegetation, habitat fragmentation, potential migratory bird collisions with the transmission line, visual impacts due to placement of poles or structures, and additional impacts to farmland.

Buffalo Ridge Wind Project

BRW plans to construct a new collector substation to the east of the city of Lake Benton, Minnesota. The BRW collector substation graveled footprint is anticipated to be no larger than one acre, but more detailed design engineering will confirm the size based on equipment needs.

The electrical power produced by each wind turbine will be stepped up to 34.5 kV and channeled into the wind farm collection system, which in turn will feed into the proposed new BRW 34.5 kV collector substation. The BRW collector substation will then step up the 34.5 kV voltage to 115 kV and deliver the project's output to Xcel Energy's existing Buffalo Ridge Substation.

The new collector substation will include 34.5 kV and 115 kV busses, transformers, circuit breakers, reactive equipment, steel structures, a control building, metering units, and air break disconnect switches. Utility-grade ceramic/porcelain or composite/polymer insulators will be used.

The proposed BRW collector substation is east of the existing Buffalo Ridge Substation owned by Xcel Energy and will connect via a short transmission jumper that will need to cross existing transmission lines owned by NSP. The 115 kV expansion at the existing Buffalo Ridge Substation is anticipated to include a new take-off structure, breaker, bus work, and ancillary equipment to satisfy the requirements of the system impact study.

Power from each wind turbine will be fed down the tower from the generator through the power conditioning equipment and circuit breaker. The electricity from each turbine step up transformer is connected to the project's collector substation through approximately 28 miles of underground collector lines. The underground collection line cable installation will be buried approximately 36 to 48 inches underground.

Construction and operation of the electrical facilities associated with the project could potentially impact both natural and built environments. These impacts are anticipated to be minimal and are mitigated by conditions in Commission's site permits. Since there is no need to construct a new transmission line for this project, the effects will be less than other wind projects that require the construction of a transmission line.

Generic 109 MW LWECS

Dependent on project design, a generic 109 MW LWECS would have similar impacts and mitigation due to similar electrical facilities as the project. However, given that the BRW project will only require a short transmission jumper cable, a generic 109 MW LWECS could have the potential for greater impacts depending on the length of transmission line needed and existing infrastructure in the surrounding area.

109 MW Solar Farm

Similar to the LWECS, impacts associated with a 109 MW solar farm would be dependent both on project design (i.e., transmission line length and route, PV arrays, access roads, and existing infrastructure in the surrounding area).

Mitigation

The responsible siting of infrastructure is the primary way to lessen potential impacts of associated electrical facilities. Additionally, use of proper BMPs can lessen adverse impacts from associated electrical facilities that cannot be avoided. Mitigation measures and impacts would likely be similar for LWECS and solar farms. The extent of impacts can be affected by the size and length of associated electrical facilities (i.e., the length of transmission line needed to connect the power generated from the LWECS or solar farm to the grid).

6.6.2 Existing Infrastructure

The construction of electric generation facilities typically requires that existing transportation infrastructure be adequate or improvable to handle large project specific deliveries (i.e., turbine blades, tower segments, etc.). Upgrades to existing transportation infrastructure may need to take place before transportation occurs and repairs may be required following delivery activities.

6.6.2.1 Roads

Buffalo Ridge Wind Project

Existing road infrastructure within the project area consists primarily of county and township roads that typically follow section lines, as well as farmstead driveways and farming access roads. The primary route through the project area is CSAH 6 that travels north and south, and CSAH 9 and US Hwy 14 that travel east and west. Though not in the project area boundary, US Highway 75 and State Highway 23 are the main access routes into the project and to nearby communities. The county roads and township roads used to access the proposed project access roads and turbine locations are either two-lane paved roads or gravel roads. A summary of roadways within the project area are found in Table 15.

Table 15. Miles of Roads in the Project Area

Road Type	Length within Project Boundary (miles/km)
Federal Highways	4.6/7.4
State Highways	11.7/18.8
County Highways/Roads	15.4/24.8
Township Roads	23.8/38.3

Traffic within and around the project area has been summarized in Table 16 (MnDOT 2018a). Trunk Highway (TH) 75 has the highest average annual daily traffic (AADT) count with 2,400 vehicles per day, using 2016 data, while the lowest traffic volume was County Road (CR) 117 with 45 vehicles per day, using 2012 data. AADT data was not available for several roads within the project area; however, with the exception of TH 75, the AADT data ranged from 30 to 1,250 vehicles per day. Therefore, it can be inferred that roads lacking AADT data would likely support similar traffic, or potentially less traffic, per day.

Table 16. Existing Daily Traffic Levels

Roadway Segment Description[1]	Approx. Length Within Project Boundary	Traffic Volume	Year Data Collected
CR 117	2.5 miles	45	2012
CR 108	3.6 miles	105	2012
CR 118	3 miles	115	2012
CR 107	0.5 miles	145	2012
CR 111	0.1 miles	170	2016
CSAH 6	3.9 miles	425	2016
CSAH 16	0.3 miles	200	2016
CSAH 9	4.1 miles	235	2016
TH 14	3.1 miles	1,850	2016
TH 75	1.1 miles	2,400	2016

[1]Roads included if AADT data was available. Several roads within the project area did not have AADT data.
Sources: MnDOT (2018), Office of Transportation Data and Analysis, Traffic Volume Program, 2016 AADT Product

Temporary impacts are expected to public roads during the construction phase of the project as materials, personnel, and equipment will be brought in via existing roads. Construction traffic is expected to generate approximately 500 trips per day during peak construction. Local roads can accommodate this additional traffic as the functional capacity of a two-lane paved rural highway is in excess of 5,000 vehicles per day. However, some minor, short-term traffic delays within and near the project site may occur during turbine and equipment delivery and construction activities.

Additionally, public road and intersection improvements, as well as temporary access road approaches and turning radii, are required for transportation and turbine component delivery during the construction phase of the project. Also, a temporary route is required for oversized crane machinery movement between turbine assembly points (i.e., crane walk). Once a turbine is constructed, the crane will be mobilized to access the next turbine assembly point. In order to minimize damage over roads, temporary base material, such as sand, may be applied where the crane will cross. Road improvements and traffic delays associated with the project will require coordination with appropriate agencies.

During operations, a small maintenance crew will utilize roads within the project area for regular inspections and maintenance. Nearby county roads have AADTs between 45 and 170 and traffic is not expected to noticeably increase during the operations phase of the project.

Generic 109 MW LWECS

Similar utilization of regional roadways would be expected for a generic 109 MW LWECS to those identified for the project but would depend on the location of the project. Impacts and mitigation on roads from a generic 109 MW LWECS would be similar to those from the project.

109 MW Solar Farm

The construction of a solar farm would require use of regional and local roadways for delivery of materials and equipment and for laborers to enter and exit the site. Impacts would likely be less than those for a wind farm.

Mitigation

Mitigation measures are similar for the Buffalo Ridge Wind Project, the generic 109 MW LWECS, and the 109 MW solar farm. These measures include coordination with applicable local and state agencies regarding potential concerns. Additionally, development of any large energy generation facility would necessitate that all applicable permits are obtained, management plans are implemented where necessary, and weight limits are not exceeded so as to avoid any potential impacts to existing road networks. Temporary impacts to the landscape and existing road infrastructure will need to be restored equivalent to or better than pre-construction conditions.

Commission site permits for LWECS require permittees to enter into road agreements with local road authorities. These agreements must address the use, maintenance, and repair of roads that could be impacted by the project.

6.6.2.2 Airports and Aviation

Airports serve as a source of transportation, tourism, employment, and business for local and national economies. The development of large energy projects needs to consider the potential impacts to air service and operations within a project area. Developments around airports and under flight-paths can constrain operations, either directly where they conflict with safety/operational requirements, or indirectly where they interfere with radar or other navigational aids.

The aviation industry is concerned that the growth of wind energy development will endanger agricultural aviators and restrict the business opportunities for aerial application of seeds, fertilizers and crop protection chemicals. A wind turbine in a farm field subject to aerial spraying represents an obstacle for the pilot; agricultural aviators fly below the height of turbine blades while distributing (as low as 10 feet above ground level) but need to rise to a higher altitude to turn around for their next pass. This turn can take a half mile to complete. In addition to collision risk, the vortices and the turbulence that the wind turbines generate can also be a concern for agricultural aviators.

According to the National Agricultural Aircraft Association (NAAA), there are about 1,560 aerial agricultural application businesses within the United States. Minnesota has approximately 150 agricultural aircraft pilots. Fixed-wing aircraft account for 87 percent of the aircraft used by agricultural applicators, helicopters and other rotorcraft account for the rest. Approximately 208 million acres of U.S. croplands are treated with crop protection products; aerial application accounts for about a fifth to a quarter of that acreage.

The NAAA reports that between 2009 and 2019, nine percent of aerial application fatalities were the result of collisions with various types of towers and 13 percent were the result of collisions with wires.

The development of wind farms provides numerous economic and environmental benefits to both individuals and surrounding communities. Less apparent are the negative consequences of these projects, especially when they constrain a landowner’s agribusiness. Both participating and non-participating landowner’s operations may be affected; if one landowner erects a wind tower that resides too close to an adjacent landowner’s field, the second landowner may lose their current or future opportunity to spray their crops, detrimentally affecting agricultural production.

Additionally, where aerial applications in the vicinity of wind farms are still possible, the increased complexity and time required results in higher cost (most spray policies charge premiums up to 50 percent above standard costs on fields within a mile of the towers, whether a participating landowner or not) to the farmer.

While ground application can be just as effective as aerial spraying, there are certain circumstances where aerial application is preferred or required, such as specific stages of growth (i.e., height of corn and sunflower), weather conditions (i.e., wet, saturated soils subject to compaction), areas requiring split applications of fertilizer (i.e., for groundwater protection), and where timing is urgent (i.e., emergency pest control). Furthermore, ground sprayers can increase the spread of disease by carrying it through the crop on the sprayer components after it brushes by diseased plants.

Meteorological towers (MET), used to collect wind data at wind farm sites, can pose a special threat to aviation. These towers are typically 197 feet, which fall just under the requirements for FAA lighting and marking.

The type of MET towers that are used in development and siting (pre-construction) typically consist of sections of galvanized tubing that are assembled at the site and raised and supported using guy wires fitted with safety shields. These towers can be erected or removed in as little as a few hours. The tower may be at one location for a short period of time and then moved to a different location, as the wind developer checks the area for the best wind conditions for the placement of wind turbines. The fact that these towers are narrow, unmarked and grey in color makes for a structure that is nearly invisible under some atmospheric conditions. The temporary and mobile nature of these MET towers makes their location difficult to maintain in a database. In some cases, a wind company may install a temporary met tower to gather information on a potential site without general public knowledge. In some cases, the landowner's contract requires the landowner to keep this information confidential.

Post-construction MET towers are used to transmit to the control center the meteorological situation in the location and it has a principal importance for the management of the site. The type used during the operation of a wind conversion facility is built heavier and may or may not use guy wires; they usually still fall under the height required for FAA lighting and marking.

The major risk factor for pilots is that the dull metal used for the tower, and the supporting guy wires, are difficult to see from the air. The tower and wires easily blend into the surroundings, making them a hazard to pilots of low-flying aircraft.

Buffalo Ridge Wind Project

There are no registered public airports located within the project area. The only registered airport located within 10 miles of the project area is the Tyler Municipal Airport, which is located approximately 1.6 miles east of the project area (Figure 4). The project must be located away from this airport at a distance consistent with MnDOT and FAA requirements.

Under FAA requirements, all structures more than 200 feet tall, including wind turbines, must be submitted to the FAA for an aeronautical study. The purpose of the study is to identify obstacle clearance surfaces that could limit the placement of wind turbines. The end result of the aeronautical study is the issuance of an FAA determination of “hazard” or “no hazard.” A project may not proceed until the FAA determines that, with mitigation measures, the project is not a hazard. Additionally, a tall towers permit may be required by the MnDOT prior to developing the project to ensure the safety of Minnesota airspace.

To determine potential impacts to aviation associated with the development of the project, an obstruction evaluation was conducted for the project area for turbine heights up to 501 feet. At 501 feet, the proposed turbines would exceed certain FAA hazard limitations. BRW will request aeronautical studies to confirm that the turbines present no hazard to air navigation.

Obstacle clearance surfaces overlying the project area are either constant 2,349 or 2,500 feet, and are associated with Southwest Minnesota Regional Marshall/ Ryan Field Airport (approximately 23 miles northeast of the project area) and the Sioux Falls Airport (approximately 45 miles southwest of the project area).

In addition, at 501 feet, all proposed wind turbines would be in line of sight of the Tyler Department of Defense and U.S. Air Force common air route surveillance radar. Proposed wind turbines that create unwanted clutter resulting in false radar returns and a decrease in radar sensitivity could impact air traffic control operations. The FAA may conduct additional analysis to identify potential safety hazards and the associated risks to the national airspace system.

Potential impacts to agricultural aviation, e.g., spraying, are uncertain. Impacts will depend, in part, on the location of turbines relative to agricultural fields that utilize crop spraying.

Generic 109 MW LWECS

A generic 109 MW LWECS would have similar impacts to airports and aviation as the project but would depend on site specific characteristics for surrounding operations. Like the proposed project, a generic 109 MW LWECS would need to comply with FAA and MnDOT standards.

109 MW Solar Farm

Solar farms have a lower profile than wind facilities. Accordingly, they do not have the same potential impacts to aviation as wind facilities. The main concern for solar farms, with regards to impacts to aviation operations, is their potential to cast glints (momentary flashes of light) or glare on passing aircraft, which could compromise the safety of the passing aircraft. FAA review of a potential solar farm project can provide feedback on project’s potential to cast glints or glare on passing aircraft. The FAA would likely issue a “no hazard” determination to a 109 MW solar farm with proper site prescreening.

Mitigation

Site permits granted by the Commission contain requirements for the design and siting of meteorological towers. Permanent towers for meteorological equipment are required to be free standing (no guy wires). Permanent meteorological towers shall not be placed less than 250 feet from the edge of the nearest public road right-of-way and from the boundary of the Permittee's site control, or in compliance with the county ordinance regulating meteorological towers in the county the tower is built, whichever is more restrictive. Meteorological towers must be placed on property the Permittee holds the wind or other development rights. Meteorological towers must also be marked as required by the FAA.

LWECS projects must be planned, constructed, and operated in cooperation with the FAA, local airports, and state air traffic agencies to ensure public safety is not negatively impacted by the project. Commission site permits for LWECS require the applicant to follow FAA requirements for marking towers and implementing the necessary safety lighting. Notification of construction and operation of the wind farm must be sent to the FAA and steps taken to ensure compliance with FAA requirements.

6.6.2.3 Communication Systems

Large electric generation facilities can impact electronic communications, such as cell phone, radio, television, and microwave.

Buffalo Ridge Wind Project

The proposed project has the potential to impact electronic communications by causing interference and obstructing the reception of signals. Wind turbines do not impact digital signals (e.g., internet, cell phones, digital television), unless the turbine is located directly in the line-of-sight. However, the project has the potential to interfere with analog communications (e.g., AM signals, microwaves) directly though physical obstruction and indirectly through signal interference.

A review of the FCC national database and the universal licensing system was conducted to identify microwave links, microwave towers, local cellular towers, media towers, television, and aviation towers within the project area as part of the project's electromagnetic interference analysis (EIA). A Federal communications study by the National Telecommunications and Information Administration (NTIA) has been conducted stating no harmful interference is expected in the project area.

Radio

Radio communication facilities are wireless communication systems that rely on radio waves to send and receive signals and communications. This form of communication is utilized across a broad spectrum of activities and purposes such as police and fire departments, commercial fleet operations for business and public works organizations. FM and AM radio can potentially be impacted by direct obstruction (signal fading) and indirect signal interference.

Based on the EIA conducted by NextEra Analytics no AM or FM radio towers were identified within the project area. One AM tower and one FM tower were identified within 25 kilometers (15.5 miles) of the project area. The AM tower has the call sign KLOH and the FM tower has the call sign KARZ.

The EIA determined that interference to AM or FM signals are expected to be minimal. Some AM/FM signal loss may occur in close proximity to individual turbines, but most AM/FM radio receptors are expected to be near residences and residences will have sufficient setback to minimize signal interruptions. Interference to AM towers would be limited to a distance equal to one wavelength from nondirectional antennas and 10 wavelengths, or 3 kilometers (1.9 miles), from directional antennas. The closest AM tower, KLOH, is located 23 kilometers (14.3 miles) from the project area and has a wavelength of 285.7 meters (937 feet). The project area is greater than 10 wavelengths from the closest tower, and thus impacts are not anticipated. Wind turbines have minimal effect to FM frequencies near 100 megahertz at distances over 100 meters (328 feet) from the tower. There is also a potential for FM stations to experience interference at distances closer than 4 kilometers (2.5 miles) from turbines. However, there are no FM towers within four kilometers (2.5 miles) of the project area and thus impacts to FM frequencies are not anticipated.

Microwave Beam Paths

Microwave beam paths are a form of information transmission through the use of microwave radio waves. This form of transmission is often utilized by telecommunication companies, leveraging the beam paths to provide wireless networks, digital television, and long-distance telephone services. Project infrastructure can potentially impact microwave beam path activities through direct obstruction between transmitting and receiving facilities.

The EIA examined microwave beam paths in the vicinity of the project area and identified no microwave towers in the project area, but seven microwave links have been identified near the project area and four have been found to intersect the project area. The worst-case Fresnel zone (WCFZ) for all of these links have been calculated, and the appropriate turbine offset has been used to minimize any harmful impact.

No impacts to microwave links are anticipated in the project area. The applicant calculated the WCFZ for microwave beam paths within the project area and added a 70-meter (229.7-foot) offset to reduce the probability of harmful interference. Turbines have been planned to avoid microwave links and comply with the WCFZ offset.

Telephone Service

Telephone service in the project area is provided to farmsteads, rural residences, and businesses by Alltel Corporation and AT&T Mobility Spectrum. There is one cellular tower within the project area and eleven cellular towers were within 25 kilometers (15.5 miles) of the project area.

The project is not anticipated to impact telephone or internet services. Underground utilities, if any, will be located using a utility locate service and collection line locations will be coordinated with local telecommunications providers to ensure there will be no impact to existing telephone lines or other underground utilities. Harmful interference associated with cellular towers is not likely as cellular transitions or packet switching occurs when a cellular link becomes unavailable.

Broadcast Facilities

Project infrastructure has the potential to impact broadcast facilities within the project area, though impacts are expected to be minimal. The EIA examined impacts to television (TV) services (Table 17). While impacts to television reception are still not well understood, interference is expected to be limited to areas near a turbine that is within the line-of-site between a transmitting tower and a TV receptor, areas near the edge of TV station reception, and in areas of complex topography. Impacts to low power stations and translator stations are not anticipated to occur because those stations have a limited range. Full power TV stations have the potential to experience impacts if the wind farm is located in the line-of-site of the TV tower. Two full power TV towers (call signs KDLT-TV and KSMN) could possibly experience reception degradation if the project is in the line-of-sight between the towers and their receptors.

Table 17. Digital Television Signals in the Vicinity of the Project Area

Call Sign	Station	Licensee	Signal Strength (kw)
K35GR-D	35	Red River Broadcast Co., LLC	11.9
K42FI-D	42	Red River Broadcast Co., LLC	6.5
K56GF	23	Digital Networks-Midwest, LLC	15.0
K56GF	56	Digital Networks-Midwest, LLC	10.1
KAUN-LP	42	J.F. Broadcasting, LLC	0.9
KCPO-LP	26	G.I.G., Inc.	7.6
KCSD-TV	24	South Dakota Board of Directors for Educational	80.9
KCWS-LP	44	J.F. Broadcasting, LLC	0.7
KDLT-TV	47	Red River Broadcast Co., LLC	589.0

Call Sign	Station	Licensee	Signal Strength (kw)
KELO-TV	11	Nextstar Broadcasting, Inc.	30.0
KESD-TV	8	South Dakota Board of Directors for Educational Telecommunications	N/A
KRWF	27	KSAX-TV, Inc.	N/A
KSFY-TV	13	Gray Television Licensee, LLC	22.7
KSMN	15	West Central Minnesota Educational TV Corporation	200.0
KTTW	7	Independent Communications, Inc.	7.5
KWCM-TV	10	West Central Minnesota Educational TV Corporation	50.0
KWSD	36	J.F. Broadcasting, LLC	36.9

Global Positioning Systems

Global positioning systems (GPS) use satellite signals to determine locations on the earth's surface and are commonly used to guide agricultural equipment. Because GPS uses multiple digital satellite signals, interference with the signals or subsequent uses is not anticipated. Obstruction of any one satellite signal would require direct line-of-sight obstruction due to a wind turbine. Such an obstruction would be temporary (i.e., there is concurrent GPS receiver movement, satellite movement, and wind turbine blade movement such that the obstruction should be resolved).

Generic 109 MW LWECS

A generic 109 MW LWECS would have similar impacts and mitigation to those associated with the project. Layout and design would greatly determine the extent of which types of communications are potentially impacted and to what extent these impacts occur. For example, a generic 109 MW LWECS could potentially impact radio communications in the surrounding area depending on the location of existing radio communication infrastructure in relation to the location of wind turbines and MET towers. However, this can be addressed by siting project infrastructure further from communication facilities and by reducing line-of-sight obstruction and interference. Impacts to telephone services, broadcast facilities, and GPS would not be expected from a generic LWECS.

109 MW Solar Farm

As solar farms have lower profiles than LWECSs, impacts to digital and analog communication signals are not anticipated.

Mitigation

BRW indicates that the presence of communication systems in the area has been taken into consideration during turbine siting to avoid impacts to these systems. Impacts can be avoided by minimizing line of sight obstructions and operating in accordance with FCC regulation and other laws to avoid impacts to microwave, radio, or other communication/navigation systems.

The BRW project was sited in such a manner that AM/FM radio stations are located far enough away from the project area that typical impacts are not expected. TV interference is expected to be limited to areas near a turbine that are within the line-of-site between a transmitting tower and a TV receptor. If interference is noted following project construction, Commission site permits for LWECS require permittees to alleviate the interference.

6.6.2.4 Wireless Broadband Internet

It is unknown if there are impacts to wireless broadband internet signals due to the operation of a wind project. The effects of LWECS on wireless broadband internet signals have not been significantly studied and there is little data regarding potential effects. Anecdotally, EERA staff has confirmed that a wind turbine operating along the "line of sight" between a broadband signal tower and residential antenna could cause intermittent signal loss, but that such cases are relatively rare.

6.7 Fuel Availability

Large electric power generating facilities require some type of fuel. Depending upon the amount and type of fuel required and the location of the fuel relative to the proposed project, the project can create impacts related to harvesting and delivery of the fuel.

Buffalo Ridge Wind Project

LWECS utilize wind power, a renewable energy source, to generate electricity. Minnesota's wind regime varies across the state (Figure 5A). During project development, turbines are sited to maximize wind capacity.

The frequency of attaining optimal wind speeds is expressed as a capacity factor, i.e., how much power the turbine generates compared to how much it could generate if it was operating all of the time. Capacity factors of 35 to 40 percent are common in Minnesota. The project area has ample wind resources. Mean annual wind speeds across the project area are between 8.7 and 9.4 m/s at turbine hub heights. The project is anticipated to have a capacity factor of approximately 47% to

54%. The average annual electrical output of the project is project to be approximately 478,600 megawatt hours (MWh).

Generic 109 MW LWECS

A LWECS sited elsewhere would need to be sited in an area of Minnesota that will meet comparable generation projections. Minnesota's wind regime varies across the state; wind resources in the southwest tend to be more abundant. Therefore, a generic 109 MW LWECS would likely need to be sited in the southwest, similar to the proposed project.

109 MW Solar Farm

Solar energy is distributed fairly consistently across Minnesota (Figure 5B). Southwest Minnesota has slightly higher irradiance levels. With respect to fuel availability, a 109 MW solar farm could be sited successfully in most all areas of the state.

Mitigation

Renewable energy is energy that is collected from renewable resources (fuel), which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy plays an important role in reducing greenhouse gas emissions. When renewable energy sources are used, the demand for fossil fuels is reduced. Unlike fossil fuels, non-biomass renewable sources of energy (hydropower, geothermal, wind, and solar) do not directly emit greenhouse gases.

Overall, using wind to produce energy has fewer effects on the environment than many other energy sources. Wind turbines do not release emissions that can pollute the air or water, and they do not require water for cooling.

Solar energy does not produce air or water pollution or greenhouse gases, although present technology requires large areas of land. Solar energy can have a positive, indirect effect on the environment when using solar energy replaces or reduces the use of other energy sources that have greater effects on the environment.

6.8 Agriculture

Construction and operation of large electric generation projects may have impacts on cropland and livestock operations.

6.8.1 Cropland

Facilities placed in cultivated lands will take a limited amount of acreage out of production. However, LWECS are generally compatible with agricultural uses.

Buffalo Ridge Wind Project

The project area is primarily cultivated cropland. Cropland covers approximately 13,462 acres or about 79.7 percent of the project area (Figure 10). Approximately 59.1 percent of the project area is classified as prime farmland, while 26.3 percent is classified as prime farmland, if drained. Additionally, 8.0 percent is considered farmland of statewide importance and 5.9 percent of land within the project area is not prime farmland (NRCS 2018). The main agricultural crops grown in the project area include corn and soybeans.

The project is not expected to significantly impact agricultural land use or the general character of the area. The primary impact to agricultural land will be the reduction of crop production on a total of approximately 30 acres of farmland in the project area. An average of 0.75 acres of land per turbine will be taken out of agricultural production for the life of the project to accommodate the turbine pad, access roads, and ancillary facilities.

Land that is used for agricultural production will largely remain unchanged. Crops will be able to be planted up to the gravel roadway and around each turbine pad and up to the access roads. Changes in agricultural field management around turbine structures will be required but impacts on overall production are anticipated to be minimal. Potential changes to field management are discussed and negotiated with each potentially affected landowner. Temporary impacts to farmland will include access road approaches, crane walks, turning radii, equipment laydown areas, and intersection improvements. When construction occurs outside of winter months, there is a higher possibility for temporary minor impacts including soil compaction, loss of planting opportunity, crop damage, and drain tile damage. The only farmland that will remain permanently altered will be land where permanent access roads, turbine pads, and supporting aboveground infrastructure are erected. Landowners will be compensated through lease payments for land taken out of agricultural production; lands adjacent to project infrastructure can remain in agricultural use.

Generic 109 MW LWECS

Without site specific information on cropland or land use, a comparison of agricultural impacts to the proposed project cannot be drawn. However, it can be assumed that the overall effects due to construction and operation of the LWECS will be similar to the project if sited in a predominantly agricultural area.

109 MW Solar Farm

A 109 MW solar farm would likely have a larger impact on cropland than a LWECS. Ground-mounted solar farms require 7 to 10 acres per MW. Thus, a 109 MW solar farm would impact approximately 760 to 1,090 acres.

Mitigation

After construction is completed, land surrounding the turbines and access roads can be returned to existing uses. The permanent loss of agricultural land in areas where access roads and turbines are placed is relatively small and is not expected to result in the loss of agricultural-related jobs or net loss of income. Revenue associated with land taken out of production is offset by lease payments to landowners.

Coordination with landowners helps to identify features, such as drain tiles and fencing, that need to be avoided during construction activities or repaired as needed. Where identified features, such as drain tiles, cannot be avoided, the applicant will repair the drain tile or other features according to the agreement made with the landowner. Staging areas and associated infrastructure can be placed in areas where previous soil impacts have occurred to avoid impacting undisturbed farmland. Should incidental soil compaction occur as a result of temporary construction activities, including staging areas, laydown areas, and crane paths, appropriate measures can be taken to ensure farmland is restored in accordance with the lease agreement with the landowners.

6.8.2 Livestock

Construction and operation of large electric generation facilities have the potential to impact livestock health through environmental impacts. Clean water, fresh air, and healthy soils and crops affect quality of life for livestock. Stress and pollution caused by a large electric generation facility due to stray voltage, lights, and noise are also possible concerns.

Buffalo Ridge Wind Project

Impacts to livestock in the project area may arise during construction, operation, and maintenance activities. Livestock adjacent to the area may be exposed to noise and shadow flicker created by wind turbines. Exposure depends on grazing, housing, and distance between livestock and the turbines. These health impacts are hard to quantify and therefore are uncertain. Animals will be able to graze near, under and up to the turbine towers. Information about potential animal impacts is anecdotal and indicates no impacts due to turbine operations. The BRW project is designed to have no stray voltage impacts on livestock in the area. Restricting livestock may be stressful and fences may be left open during travel or damaged inadvertently. This would put the livestock at risk of roaming free or getting hit by a vehicle if they wander into a public roadway.

Generic 109 MW LWECS

It can be assumed that the overall effects to livestock due to construction and operation of a generic 109 MW LWECS would similar to the project if sited in the same area or elsewhere in Minnesota.

109 MW Solar Farm

Some solar farms have been compatible with a rotational grazing system for sheep or possibly young cattle, yearlings, and calves. This compatibility offers siting and design challenges. Larger livestock may need physical barriers to separate them from solar arrays. Solar panels are fixed relatively close to the ground, so cattle cannot graze beneath them.

Mitigation

Livestock in pastureland may be temporarily displaced during construction. Appropriate measures can be taken to ensure fenced pastureland is secure. Potential stray voltage impacts would be mitigated by ensuring all safety requirements are met during construction and operation of the project. This includes making good electrical connections and choosing proper materials for wet and corrosive locations to improve grounding.

7.0 FEASIBILITY AND AVAILABILITY OF ALTERNATIVES

Having analyzed comparative impacts of alternatives, an Environmental Report is required to offer an assessment of the feasibility and availability of those alternatives. This section describes the feasibility and availability of alternatives to the Buffalo Ridge Wind Project.

7.1 Buffalo Ridge Wind Project

The Buffalo Ridge Wind Project is located in a rural area with a primarily farm-based economy. Wind projects have typically been well integrated into similar settings. Wind resources are among some of the best in the State of Minnesota. In addition, access to the electrical grid to interconnect the project is readily available. The proposed wind farm is feasible and available.

7.2 Generic 109 MW LWECS

A generic LWECS sited elsewhere in Minnesota is an alternative to the BRW project. Wind resources do vary across the state with other areas displaying potential for supporting a 109 MW project or a combination of smaller projects that add up to the same capacity (Figure 5A). Because of this relative abundance of wind resources, it is feasible that a generic LWECS generating 109 MW could be built elsewhere in the state. Transmission access is another factor that has constrained the development of wind energy in Minnesota and would be just as important as wind resource availability for an alternative project to be feasible. Overall, a generic 109 MW LWECS is feasible and available.

7.3 109 MW Solar Farm

In pursuit of Minnesota's clean energy goals, solar energy projects have seen an increase in the past decade. Solar power generation capacity in Minnesota nearly tripled in 2017 over 2016, but its overall contribution to the state's electric power is still relatively small at 1.2 percent of in-state generation (Minnesota DOC, Division of Energy Resources 2018).

The cost of wind power continues to be more favorable than for solar power despite recent substantial decreases in cost for solar. Wind continues to be more cost-effective than solar-powered electricity and remains the lowest-cost new source of renewable energy. From a land-use perspective, a MW of solar requires more land be temporarily used for the life of the project, compared to an LWECS, to achieve the same number of MW. Additionally, crop production with the proposed project will not be significantly impacted, whereas for a solar facility a large area of land would be taken out of production for the life of a solar plant. This said, a solar farm would have significantly fewer impacts on wildlife, particularly bird and bats, compared with an LWECS. Overall, a 109 MW solar farm is feasible and available.

7.4 No Build Alternative

A no build alternative is feasible and available.

Minn. R. 7849.0340 requires an applicant to submit data for a no build alternative, including a discussion of the impact of this alternative on the applicant's generation and transmission facilities, system, and operations. This rule also requires an analysis of "equipment and measures that may be used to reduce the environmental impact of the alternative of no facility" (Minn. R. 7849.0340(C)). BRW does not have a "system," nor does it have other generation and transmission facilities in Minnesota, and, therefore, the Commission provided a partial exemption of this requirement, conditioned upon BRW providing equivalent data from GRE, the purchaser, regarding a no build alternative. On this point, GRE represents that a no build alternative would have a detrimental impact to GRE in that the purpose of the project is to help it address and exceed its RES requirements and provide carbon-free energy to its customers and the state. Thus, a no build alternative is feasible and available, but it would not meet GRE's need for the project.

Minnesota has committed to a renewable energy objective of generating 25 percent of its electricity from eligible renewable sources by the year 2025. Minnesota utilities had approximately 3,700 MW of wind generation in their portfolios at the end of 2017, with an additional 3,000 MW of wind generation planned for the Minnesota market. In addition to Minnesota's renewable energy objective, there is a regional need and desire for wind energy. It is uncertain what the effect of a no build alternative would be on meeting Minnesota and regional demand for electric power and for renewable generation in particular.

7.5 Additional Renewable Alternatives

Other renewable energy sources that could be used instead wind, include hydropower, biomass, and hydrogen derived from renewable sources.

There has been very little increase in the use of hydropower in Minnesota over the last decade. The use of hydropower increased from 774,729 MWh in 2005 to 849,054 MWh in 2015, an increase of less than 10 percent over that 10-year period. In that same time period, electricity generated from wind power increased more than 517 percent. According to the 2016 Quad Report, the reason for the minimal investment in hydroelectric power is likely due to the "[c]osts of maintaining and operating dams compared to other sources of energy . . . as well as increased concern about the potential negative effect dams can have on Minnesota's river ecosystems". Hydropower is an available alternative to the project; the technology is well established. However, because of costs and potential impacts to Minnesota's rivers, hydropower is not a feasible alternative. Additionally, hydropower facilities of the same size as the project do not qualify under the renewable portfolio standard (hydropower project must be less than 100 MW to qualify), and thus would not meet GRE's need for the project.

Minnesota communities do have accessible and low-value biomass feedstocks. However, the costs of these feedstocks vary widely, and the unsubsidized levelized cost of energy from biomass tends to be much greater than that of wind. Further, the environmental impacts of a biomass facility are likely to be greater than the project, due to both the facility itself and the machinery and equipment needed to gather and transport the biomass fuel. For these reasons, a biomass plant is an available alternative to the project but is likely not feasible.

Hydrogen can be produced via electrolysis by reforming natural gas. The energy used for electrolysis could be from a renewable resource, e.g., wind, solar. Thus, hydrogen could be generated by renewable resources. To date, hydrogen has not been used for commercial electrical energy production; it has been used, to some extent, for powering fuel cells that can be used for many purposes including backup power and transportation. Most hydrogen in the United States is used for petroleum refining, fertilizer production, and food processing. Accordingly, hydrogen is not a feasible or available alternative to the project.

There is no combination of the above renewable technologies that is likely to be a feasible and available alternative to the project.

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