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February 8, 2016

RECEIVED
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NORTH DAKOTA
PUBLIC SERVICE COMMISSION

Mr. Darrell Nitschke
Executive Director
North Dakota Public Service Commission
600 E. Boulevard, Dept. 408
Bismarck, ND 58505-0480

Dear Mr. Nitschke:

In re: Brady Wind, LLC
Application for Certificate of Site Compatibility
PSC Case No. PU-15-690
Our File No. 35-218-026

Enclosed please find for filing 11 copies of the following documents for the Brady Wind Energy Center in Stark County, North Dakota:

1. 2015 Fall Avian Survey

2. Whopping Crane Likelihood of Occurrence Report

3. Bat Habitat Assessment.

Please call should you have any questions.

Very truly yours,

Brian R. Bjella

bw
Enc.

15 PU-15-690 Filed 02/08/2016 Pages: 115
2015 Fall Avian Survey, Whopping Crane Likelihood of Occurrence Report, Bat Habitat Assessment
Brady Wind, LLC
Brian Bjella, Crowley Fleck, PLLP

2015 Fall Avian Survey

Brady Wind Energy Center
Stark County, North Dakota

Prepared for:

Brady Wind, LLC

NEXTera ENERGY RESOURCES

January 2016

TETRA TECH

Executive Summary

Tetra Tech, Inc. was contracted by Brady Wind, LLC, a wholly-owned, indirect subsidiary of NextEra Energy Resources, LLC, to undertake fall avian use surveys for the proposed Brady Wind Energy Center (Project) located in Stark County, North Dakota. The studies were conducted to identify potential avian impacts associated with building and operating a wind energy facility. Birds have been identified as a group potentially at risk because of collisions with wind turbines and power lines, and displacement due to the presence of the associated structures. Weekly surveys were performed at the Project from August 20th through November 4th, 2015, which included the fall migration season. Point-count surveys (fixed 800-meter [m] radius) were conducted at 15 point-count locations distributed throughout the Project Area. These points were originally sited following an earlier Project layout and boundary (Figure 2); however, following changes to the Project Area, two of the points (Points 14 and 15) were no longer within the Project Area. Data from Points 14 and 15 were included in the analysis, although these two points do not sample the hazardous area around turbines as defined in the Eagle Conservation Plan (ECP) Guidance.

A total of 4,851 birds from 34 species were observed within the Project Area. Overall mean bird use within the Project Area was 26.95 birds/20 minute (min) and ranged from 0 to 440 birds/20-min point count. Mean use was highest for songbirds, pigeons/dove and gamebirds (20.19, 2.23 and 2.19 birds/20 min, respectively). The species with the highest mean use were the red-winged blackbird (11.62 birds/20 min), mourning dove (2.19 birds/20 min), ring-necked pheasant (1.84 birds/20 min), horned lark (1.62 birds/20min) and American crow (1.48 birds/20min). The red-winged blackbird had the highest encounter rate (5.92 birds flying at rotor swept area [RSA] height/20 min). All other species had an encounter rate less than 0.79 birds flying at RSA height/20 min.

The avian community detected within the Project Area during fall avian surveys was characterized by species typical of agricultural lands and cattle pastures in North Dakota. Within disturbed habitats such as these, the greatest potential impact of wind facilities to avian species is risk of collisions with turbines rather than disturbance or displacement. Songbirds were identified as having potential risk of collision due to species within this group having the highest encounter rate within the Project Area and/or relatively high mean use. Songbird species with the highest potential risk was the red-winged blackbird due to an encounter rate of 5.92 birds flying at RSA height/20min. Red-winged blackbirds may be at the greatest fatality risk during the spring and fall due to their flocking characteristics throughout migration, which may also contribute to their relatively high encounter rate. Although risk of turbine-related fatalities at the Project exists, should they occur, they are unlikely to have population-level impacts because North Dakota red-winged blackbird populations are large and relatively stable (8.2 million, PIFSC

2013, Sauer et al. 2012). Pigeons/doves and gamebirds were two other species groups that contained species demonstrating collision risk factors. Mean use was highest for mourning dove and ring-necked pheasant; however, both had low encounter rates (both with 0.00 birds flying at RSA height/20 min respectively). Project-related fatalities of the mourning dove and ring-necked pheasant, should they occur, are unlikely to have population-level impacts because North Dakota populations for each species are large and relatively stable (4.1 and 2.0 million, respectively; PIFSC 2013, Sauer et al. 2012).

High raptor use (greater than 2.0 birds/20 min) has been associated with high raptor mortality at wind facilities. Conversely, raptor mortality appears to be low when raptor use is low (less than 1.0 birds/20 min). In the case of this Project, overall raptor use was 1.07 birds/20 minutes, which is just above the low mean use mark of 1.0 birds/20 min. Nesting activity can also contribute to risk of turbine-related mortality. Because raptor activity is typically higher near active nests than areas without active nests, nesting raptors may have increased potential for collision as they repeatedly fly within the Project Area during nesting activities. Raptor nests detected within the Project Area included five occupied Swainson's hawk nests, one occupied red-tailed hawk nest and six small unoccupied nests. Within a 2-mile buffer outside of the Project Area, surveyors located two occupied Swainson's hawk nests, two occupied red-tailed hawk nests, six large unoccupied nests, and 13 small unoccupied nests.

Raptor species observed during the point-count surveys are typical of species found in western North Dakota. Swainson's hawk, northern harriers and red-tailed hawk had the highest mean use among raptors (0.26, 0.26 and 0.23 birds/20 min, respectively). Given the relatively low mean use of Swainson's and red-tailed hawks within the Project Area and relatively low encounter rate (0.15 and 0.16 birds flying at RSA height/20 min, respectively); turbine-related fatalities at the Project are likely to be low. Risk of collision for northern harriers is expected to be low at the Project Area because of the relatively low mean use within the Project Area and relatively low encounter rate (0.00 birds flying at RSA height/20 min). Results from post-construction fatality monitoring studies indicate that red-tailed hawks are frequently found as turbine-related fatalities. The red-tailed hawk encounter rate and presence of active nests within the Project Area suggest the Project may pose a collision risk for this species. However, any fatalities at the Project are not expected to have population-level impacts because North Dakota red-tailed hawk populations are large and relatively stable (57,000, PIFSC 2013, Sauer et al. 2012). Other raptor species detected during spring surveys included turkey vulture, American kestrel and ferruginous hawk. Although turkey vultures and American kestrels are commonly found as fatalities at wind facilities, the low mean use and encounter rates of all 3 species (less than 0.22 birds/20min and less than 0.22 birds flying at RSA height, respectively) suggest turbine related fatalities for these species at the Project are likely to be low.

Protected Species

No federally threatened or endangered species were observed during avian point-count surveys, raptor nest survey, or as incidental observations. Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA). Although no eagles were observed during avian point-count surveys, eight individual golden eagles and three individual bald eagles were observed incidentally to raptor nest surveys. Five of these eagles were observed within the Project Area and six were observed outside the Project Area. These sightings suggest that golden and bald eagles may occur in the Project Area. No bald or golden eagle nests were found within the Project Area or 2-mile buffer surrounding the Project Area during the raptor nest surveys conducted in June and November 2015; however, there are several known eagle nests within 10 miles of the Project Area, based on data provided by North Dakota Game and Fish Department. Additionally, six large unoccupied stick nests were located on buttes approximately 2-6 miles to the northwest of the Project Area. These nests could be used by nesting golden eagles or ferruginous hawks, and a golden eagle was subsequently viewed perching in proximity to the nests in December 2015. Bald eagles are believed to be at less risk of turbine collision than golden eagles because they tend to focus their hunting efforts for fish and waterfowl in lakes and rivers (Buehler 2000). Golden eagles are believed to be more at risk of turbine collision than bald eagles because they hunt for land-based prey along topographic contours where turbines are often located (Kochert et al. 2002). Although golden eagles may occur in the Project Area during any time of the year, the species is unlikely to breed within the Project Area due to a lack of suitable habitat. Eagle use surveys are underway to evaluate risk of Project activities to eagles.

Most native birds are protected under the Migratory Bird Treaty Act (MBTA), and take of even a single individual is prohibited. Currently, there are no permits for incidental take of migratory birds. Historically, permits were not available under the BGEPA for incidental take from otherwise lawful activities; however, USFWS-promulgated regulations in 2009 provided for permits for incidental take of eagles associated with otherwise lawful activities, including wind energy (50 Code of Federal Regulations § 22.26). Only one incidental take permit for golden eagles has been approved fora wind energy project, and no permits have been issued for incidental take of bald eagles at a wind energy facility to date.

Table ES-1. Fall avian use summary

Variable	Result	Details
Non-raptors		
Mean use	25.88 birds/20 min	(Section 3.1)
Species detected at Brady that are commonly (> 15 records) detected as wind farm fatalities	Yes	Red-winged blackbird, western meadowlark, horned lark, American robin, European starling, mourning dove, ring-necked pheasant, gray partridge, mallard, killdeer. (Section 4.1)
Federally listed[1] species observed within the Project Area	No	
State-listed[2] species within the Project Area	No	
State-listed[2] species within RSA	No	
Raptors		
Mean use	1.07 birds/20 min	(Section 3.1)
Species detected at Brady that are commonly (> 15 records) detected as wind farm fatalities	Yes	Red-tailed hawk, turkey vulture, American kestrel (Section 4.2)
Eagles observed within the Project Area	Yes	Incidental to raptor nest surveys (Section 4.3)
Eagles observed within the RSA	No	
Eagles observed nesting within the Project Area	No	
Federally listed species observed within the Project Area	No	
State-listed[2] species within the Project Area	No	
State-listed[2] species within the RSA	No	
Habitat		
Native habitat likely to be affected by development	Yes	Grassland prairie
Lakes (waterfowl and crane attractant)	No	
Wetlands (attractant for cranes, waterfowl, and other water-based species)	No	
Cliffs (raptor nesting and traveling)	No	
Rivers (permanent water source, migration corridor)	No	
Known refuges or habitat features that may funnel migrants	No	

1 Federally listed species include species listed as endangered, threatened, or candidate under the Endangered Species Act (ESA).

2 Only species protected by the federal ESA are considered threatened or endangered in North Dakota. The North Dakota Game and Fish Department maintains a list of Species of Conservation Priority (Hagen et al. 2005) but these species are not afforded any formal protection by the state of North Dakota and there are no state permitting requirements covering them.

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1 Introduction

1.1 Wind Energy and Birds

Wind energy provides a clean, renewable energy source. As wind power has become more common, the need to address potential environmental impacts has increased. Birds have been identified as a group potentially at risk because of collisions with wind turbines and power lines, and displacement due to the presence of the associated structures (Erickson et al. 2005, Drewitt and Langston 2006, Arnett et al. 2007). Specifically, migrant passerines (e.g., songbirds) are found more often in post-construction mortality monitoring compared to other groups of birds (Arnett et al. 2007). In fact, at newer generation wind energy facilities outside of California, approximately 80 percent of documented fatalities have been songbirds, of which 50 percent are often nocturnal migrants (Erickson et al. 2001, Johnson et al. 2002, Drewitt and Langston 2006, Strickland and Morrison 2008). Although nocturnal migrants comprise the majority of songbird fatalities, the proportion of migrating songbirds killed at any given wind project during migration is reported to be low (Strickland et al. 2011), and effects of these fatalities upon population trends appear to be minimal (Erickson et al. 2014). Locally breeding songbirds may experience lower mortality rates than migrants because many of these species tend not to fly at turbine heights during the breeding season. However, some breeding songbird species have behaviors that increase the risk of collisions with turbines. For example, horned larks have been commonly found (> 15 records) as fatalities at wind farms and mortality may be partially attributed to the breeding flight displays within the rotor swept area (Pickwell 1931, Johnson and Erickson 2011).

Despite the observation that most wind farm fatalities are songbirds, raptor mortality historically has received the most attention due to high fatality rates at the Altamont Wind Project in California (Thelander et al. 2003). Raptor mortality at newer generation wind projects has been low relative to previous generation wind farms, although there is substantial regional variation (Johnson et al. 2002, Erickson et al. 2002, 2004, Kerns and Kerlinger 2004, Jain et al. 2007). Although raptor mortality is lower at newer generation facilities, raptors remain the avian species group considered most susceptible to collisions with turbines (Strickland et al. 2011). Therefore local micro-siting and site evaluation efforts are still necessary to minimize potential project-related impacts to raptors.

In addition to mortality associated with wind farms, there is potential for bird species to avoid areas near turbines or experience habitat displacement after the wind farm is in operation (Drewitt and Langston 2006). To date, evidence of this potential impact to birds does not demonstrate a distinct trend; some studies have found decreased density or abundance of birds near turbines (e.g., grassland songbirds, Leddy et al. 1999, Erickson et al. 2004, Shaffer and Johnson 2009), while others have found no evidence of declines near turbines (Devereux et al.

2008, Shaffer and Johnson 2009, Pearce-Higgins et al. 2012). However, Pearce-Higgins et al. (2012) detected disturbance-related effects during construction, indicating that disturbance effects may occur on a short-term basis.

Agencies and non-governmental groups have raised particular concern over avoidance issues (e.g., habitat displacement) with respect to grouse species (Manville 2004, USFWS 2012). The existing information on avoidance by grouse species is limited to observational studies, with results varying by grouse species and source of disturbance (roads, oil and gas wells, vertical structures, transmission lines). Studies of grouse and anthropogenic features have observed that some species of grouse avoid transmission lines, improved roads, buildings, oil and gas wells, and communication towers (Pitman et al. 2005, Pruett et al. 2009, Johnson et al. 2011). But other studies have found no evidence of avoidance of transmission lines or of wind facilities (Johnson et al. 2011, Johnson et al. 2012, Sandercock et al. 2013).

Finally, most native, migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918. Under the MBTA it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any native migratory bird, part, nest, egg or product. The USFWS has established a permitting scheme for a variety of intentional activities, such as hunting and scientific research, but has not done so for the incidental take of migratory birds associated with otherwise lawful activities. As a result, currently there is no permitting framework that allows a wind energy company to protect itself from liability at wind energy facilities.

Brady Wind, LLC (Brady Wind), a wholly-owned, indirect subsidiary of NextEra Energy Resources, LLC is planning to develop the Brady Wind Energy Center (Project) in Stark County, North Dakota (Figure 1), located on private lands. Brady Wind is committed to environmental due diligence and has contracted Tetra Tech, Inc. (Tetra Tech) to conduct fall avian surveys at the Project to quantify local avian use in the area and to evaluate the potential impacts of the Project on bird species detected during the survey. These study objectives are consistent with recommendations from Tier 3 of the *USFWS Land-Based Wind Energy Guidelines* (USFWS 2012; USFWS Guidelines).

The Project Area covers 29,983 acres and is located in the Missouri Plateau Ecoregion of the Northwestern Great Plains Ecoregion (Bryce et al. 1996). This semi-arid region of North Dakota includes level to rolling plains topography with isolated sandstone buttes or badland formations. Historically, much of the landscape was a mix of western mixed-grass prairie and short-grass grassland prairie with associated wetlands (Bryce et al. 1996). Today, most grassland prairie has been largely replaced by agriculture in level areas. Remnant grassland prairie may still persist in areas of steep or broken topography. Agriculture in the area consists predominantly of dry-land farming of wheat and alfalfa interspersed with cattle grazing pastures. The Project Area consists of wide open agricultural grasslands and various cattle ranches.

North Dakota has 353 documented bird species (Faanes and Stewart 1982) and is situated within the Central Flyway, one of several broad bird migratory routes in North America (USFWS 2011). During fall migration, most birds that move along the Central Flyway travel from breeding grounds as far away as Alaska and northern Canada through the central states and eventually reach wintering grounds near the Gulf of Mexico and as far away as South America (USFWS 2011).

2 Methods

To evaluate avian risk at wind energy facilities, standardized protocols for pre-construction point counts have been established and were used in this study. This protocol is designed to be responsive to the level of effort recommended in the *National Wind Coordinating Committee's Comprehensive Guide to Studying Wind Energy/Wildlife Interactions* (Strickland et al. 2011) and the USFWS *Wind Energy Guidelines* (WEG; USFWS 2012). Data collected from these counts are used to identify species or species groups that may be at risk from Project development, and may provide additional information for micro-siting wind facilities to minimize impacts to birds. Results in this report are presented in terms of species groups, and highlight any federal and state-listed species as well as eagles.

2.1 Avian Surveys

2.1.1 Point-Count Surveys

An experienced field biologist (biologist) conducted 20-minute (min) point-count surveys at 15 locations to evaluate avian use, behavior, and species. These points were originally sited following an earlier Project layout and boundary (Figure 2); however, following changes to the Project boundary, two of the points (Points 14 and 15) were no longer within the boundary. Data from Points 14 and 15 were included in the analysis, although these two points do not sample the hazardous area around turbines as defined in the ECP Guidance. The biologist conducted 12 weekly surveys from August 20th through November 4th, 2015 (Table 1), thereby encompassing the fall migration. Tetra Tech distributed the survey locations throughout the Project Area and chose locations that maximized 360-degree sight viewshed for the biologist while covering a diversity of habitats (Figure 2).

Data were collected on all birds detected within an 800-meter (m) radius of the point-count location. Surveys at each point-count location lasted for 20 minutes, during which time the biologist continuously recorded any avian visual or auditory observations including: species, number of individuals, time of observation, height above ground, flight distance, flight direction and behavior. The biologist estimated flight heights and distances using existing reference points such as meteorological towers and local transmission lines, as well as landscape contours shown on topographic maps. Flight direction was recorded for individuals making directional flights, but was not recorded for individuals making localized movements.

The survey protocol used in this study is designed to collect data on all bird species and to provide results that are comparable with other studies at wind farms, rather than to target specific taxa. The benefit of using this protocol is that it estimates avian use throughout the day and captures activity by a variety of bird species. During the breeding season, and to a lesser extent in the fall and winter, songbirds are most active in the morning and can be difficult to detect during the afternoon. In contrast, raptors become active as the sunlight heats the air and creates thermals, used for soaring (Ballam 1984). Thus, raptors are more readily detected several hours after sunrise. Therefore, this protocol is appropriate for characterizing the entire bird community using the Project. It should be noted, however, that this survey protocol can only detect nocturnal migrants should they be local breeders within the Project Area or if they utilize the Project as stopover habitat.

Tetra Tech chose 20-min survey periods because they provide adequate time to detect both raptors and non-raptors. However, time periods of 20 minutes may lead to double-counting of songbirds (i.e., counting the same individual more than once) because individuals may appear and disappear from view. For example, if a horned lark is detected perched on a fence then disappears from view and, 6 minutes later, a horned lark is seen flying, these birds are recorded as separate observations because it is not possible to distinguish individuals. Double-counting of birds is not problematic for this type of survey because the objective is to document use in terms of number of birds noted per 20-min survey, not number of distinct individual birds.

Detectability varies among species and potentially not all individuals within the 800-m radius were counted. This variation in detectability could result in an overestimate of mean use for conspicuous species and an underestimate of mean use for reclusive species (Thompson 2002). Birds not easily identifiable, such as those seen under low light conditions or small birds seen at a distance were identified to the lowest taxonomic level possible. Hence, unidentified birds are included in the results.

2.1.2 Raptor Nest Surveys

Tetra Tech conducted raptor nest surveys with the primary objective of documenting the presence of bald and golden eagles and other large raptor nests within and adjacent to the Project. An initial ground-based survey was conducted on June 10-11, 2015. The survey was conducted from public roadways by a local field biologist equipped with a spotting scope. The primary objective was to locate any nesting raptors within 2 miles of the Project Area.

A follow up aerial survey for the purpose of inventorying nests was conducted on November 17-18, 2015, during the non-breeding season, but after trees had dropped their leaves to increase visibility of raptor nests. The aerial survey consisted of searches of suitable habitat for all raptors within the Brady Project Area plus a 2-mile buffer. The aerial survey was conducted from a Bell-206 Jet Ranger helicopter (Double M Helicopters, Mandan, North Dakota) that was flown approximately 200 feet above ground level at an approximate speed of 60 miles per hour. The crew consisted of a Tetra Tech biologist, a local field biologist, and pilot. Surveyors primarily focused on potentially suitable nesting habitat on buttes and any large trees sufficient to support nesting by large raptors.

A global positioning system (GPS) receiver using World Geodetic System 1984 (WGS84) Datum coordinates was used to aid in navigation and data recording. Additionally, standardized data forms were used to record information.

If a nest was found, the following data were collected:

- **Nest Identification Number:** corresponding with GPS waypoint number.
- **Raptor Species:** using 4-letter American Ornithologists' Union codes (e.g., RTHA = red-tailed hawk, GHOW = great-horned owl).
- **Proximity of Adult:** On = bird sitting on nest, NEAR = bird near the nest, UNK = Unknown.
- **Eggs or Young:** number of eggs or young observed.
- **Nest Substrate:** structure in which nest was located (e.g., broadleaf tree, cut bank, transmission pole, etc.).
- **Nest Height:** Height relative to the structure it is on (e.g., on top of transmission pole, ¾ of height of tree).

To assess nest activity, the following criteria were used (Postupalsky 1974, USFWS 2013):

- **Occupied:** nest containing eggs, young, or an adult sitting on the nest indicating incubation or brooding or a nest showing evidence of use in the survey year such as fresh lining, droppings, feathers on or underneath, or adults near the nest (i.e., in tree) but not sitting on the nest.
- **Unoccupied:** nest showing no evidence of use and no adults present at the nest. Unoccupied eagle nests are categorized as eagle nests based on size of nest, size of material used in construction, and location (i.e., ospreys do not build nests as large as bald eagles and rarely builds nests in live trees).

- **Unknown:** The nest cannot be found or the nest is present, but because of its location (e.g., a tree cavity, rock cavity), a determination cannot be made.
- **Gone:** A nest that was located during a previous survey, but has subsequently been found to be destroyed and no longer exists. No evidence remains.

To assess nest condition, the following criteria were used (Postupalsky 1974, USFWS 2013):

- **Excellent:** defined cup or nest bowl with a well-maintained rim.
- **Good:** nest bowl intact and rim defined; minor repair needed for nest to be used; margins of nest in loose configuration, minor slumping occurring.
- **Fair:** nest bowl intact and nest not dilapidated; but needs significant repair in order to be used; material is slumping or sliding.
- **Poor:** loose structure of nest bowl still present; nest walls and side falling out; nest is in need of major repair to be used.
- **Remnant:** nest bowl not defined; scant material remaining and not usable unless fully rebuilt.

Data collected within the survey area included an inventory of all stick nests (occupied or unoccupied), status of nests, numbers of eggs or nestlings, and any observations of bald or golden eagles.

2.1.3 Incidental Observations

Incidental observations included observations that occurred 1) during travel between point-count locations, 2) before or after the official 20-min survey period, 3) outside of the 800-m radius circular plot, and 4) during the raptor nest survey. The biologist recorded these observations on separate data sheets and these data were not used in the formal analysis; however, a summary of incidental observed species is presented to provide additional information about species found in the local area.

2.2 Protected Species Information

The Endangered Species Act (ESA), administered by the U.S. Fish and Wildlife Service (USFWS), mandates protection of species federally listed as threatened or endangered and their associated habitats. The ESA makes it unlawful to knowingly violate the "take" provisions of the ESA. "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct" (USFWS 2013a). Significant modification or degradation of listed species' habitats where the modification actually kills or injures wildlife by significantly impairing essential behavioral patterns is considered "harm" under ESA regulations. According to a current list of endangered, threatened and candidate species for North Dakota Counties maintained by the USFWS, the only listed avian species known to occur in Stark County is the whooping crane (USFWS 2015a).

The Bald and Golden Eagle Protection Act (BGEPA) prohibits the take of any bald or golden eagle, alive or dead, including any part, nest, or egg. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" a bald or golden eagle. "Disturb" means to agitate or bother an eagle to a degree that causes, or is likely to cause, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. The USFWS promulgated regulations in 2009 which provided for permits for incidental take of bald and golden eagles associated with otherwise lawful activities, including wind energy (50 Code of Federal Regulations § 22.26). Applications for incidental take permits under BGEPA are being considered by USFWS for bald eagles throughout the contiguous U.S. Incidental take permits for golden eagles are available only to projects located west of the 100th meridian, and this project would qualify (USFWS 2013b). However, since 2009, only one incidental take permit for golden eagles has been granted to a wind energy project, and no permits for incidental take of bald eagles at a wind energy facility have been issued. The USFWS issued an Advanced Notice of Rulemaking in April 2012 and is currently undergoing a process to revise the permit regulations in response to public comment relative to eagle population management objectives, compensatory mitigation, and programmatic permit issuance. It is unknown at this time what changes will be made or how they may affect the permitting process.

In addition to federal listing, the North Dakota Game and Fish Department (NDGF) maintains a list of Species of Conservation Priority (Hagen et al. 2005) although these species are not afforded any formal protection by the state of North Dakota and there are no state permitting requirements covering them. Only species protected by the federal ESA are considered threatened or endangered in North Dakota, therefore the only state-listed species with potential to occur in Stark County is the whooping crane.

2.3 Data Quality Assurance/Quality Control

Tetra Tech implemented quality assurance and quality control measures during all stages of data collection, analysis, and report preparation. To ensure legibility and completeness of data sheets, the field biologist reviewed all data sheets, providing clarification as needed, before data entry into a FileMaker Pro™ relational database for data storage and analysis. Prior to analysis, an independent reviewer conducted a 100-percent quality review of the data entries. Any questions that arose at this time were directed toward and answered by the field biologist.

2.4 Analysis

2.4.1 Species Groupings

Tetra Tech considered two primary groups of interest: raptors and non-raptors. Tetra Tech defined raptors as vultures, hawks, eagles, falcons, kites, harriers, and owls. All other species groups are defined as non-raptors.

2.4.2 Avian Use

Tetra Tech derived avian use (mean use) of the Project Area by calculating the average number of birds observed per 20-min (birds/20 min) survey at each point-count location. To evaluate the diversity and composition of avian species using the Project Area, Tetra Tech summarized the number of individuals and frequency (percentage of surveys where a species was detected) for each species observed. Tetra Tech also calculated a measure of variability (90 percent confidence intervals) for all mean use values. In addition, the number of observations is also presented, where an observation can be either an individual bird or a discrete flock of birds. This information helps evaluate whether relative high mean use values are driven by a single event (e.g., a large flock of birds moving through the Project Area on migration) or the result of more sustained use of the area by species. Because individual birds are not uniquely marked nor easy to distinguish from one another, actual population size or abundance cannot be determined. One individual may be counted multiple times during a survey period or across survey periods. Although mean use of a given species does not equate to abundance, it does provide an index that is likely proportional to abundance and activity within the Project for species with similar detectability.

2.4.3 Flight Behavior

Tetra Tech evaluated flight behavior by calculating the proportion of flying birds observed below, within, or above the height of the anticipated turbine rotor swept area (RSA). Brady Wind plans to develop the Project using GE (General Electric) 1.715 MW and 1.79 MW (Megawatt) Xle turbines. These turbines have a hub height of 80 meters and rotor diameter of 103 meters. With these specifications, the anticipated RSA is estimated to be between approximately 28.5 and 131.5 m above ground. Tetra Tech considered a bird to have flown within the height range of the anticipated RSA if any of its recorded heights fell within the upper or lower limits of the anticipated RSA.

2.4.4 Encounter Rate

To estimate the rate at which a given species flew at the height of the anticipated RSA, Tetra Tech applied the following equation to every species observed in the Project Area:

$$\textbf{\textit{Encounter Rate}} = \boldsymbol{A} \times \boldsymbol{P_f} \times \boldsymbol{P_t}$$

$\boldsymbol{A}$ is the mean number of birds/20 min for a given species, $\boldsymbol{P_f}$ is the proportion of all activity observations for a given species that were flying; and $\boldsymbol{P_t}$ is the proportion of flying observations that were within the height range of a turbine RSA for a given species. The encounter rate provides information on the rate at which a species may move at a height that is consistent with the RSA of the proposed turbines. This information is an important component in evaluating risk of collisions; however, this number alone does not indicate project-related impact to a species. Species with a high encounter rate are considered at a higher risk of collision than species with a low encounter rate, but it does not mean that turbine-related mortality is certain. Other factors such as turbine location or a species ability to detect turbine blades, flight maneuverability, and habitat selection also influence mortality (Orloff and Flannery 1992, Drewitt and Langston 2008, Martin 2011, Garvin et al. 2011, Nagy et al. 2011). Encounter values are sensitive to large flocks of birds flying within the RSA height; that is, a species will have a high encounter rate even if only observed once as a large flock in flight.

2.4.5 Mortality Risk

The highly regional nature of avian mean use across North America and the scarce data on avian mortality at wind farms in many parts of the continent, combined with other risk influences such as individual species behavior and weather, contribute to uncertainty in predicting fatality rates (Arnett et al. 2007, Strickland et al. 2011). A recent meta-analysis suggests that pre-construction studies provide poor indicators of post-construction mortality (Ferrer et al. 2012). WEST (2011) suggests that the most accurate predictor of mortality at a wind project are records of species-specific fatalities detected at nearby wind projects. As a result of uncertainty in predicting fatality rates, Tetra Tech did not attempt to derive mortality estimates from mean use data, but instead highlights those species or species groups with high use values that may experience Project-related mortality or whose regional population could be impacted by the Project development. Additionally, in this report, Tetra Tech highlights species with high frequencies (greater than 50 percent) of observation, high encounter rates (greater than 0.99 birds flying at RSA height/20 min), and those with records of turbine-related fatality at other wind projects, as these variables may also indicate potential collision risk at the Project.

3 Results

3.1 Avian Use and Frequency of Occurrence

The biologist surveyed 6,448 acres of the Project Area during point-count surveys, covering approximately 21.5 percent of the total Project Area (29, 983 acres). The 15 point-count locations were surveyed 12 times each, resulting in 180 total 20-minute surveys. A total of 4,851 birds from 34 species were recorded during the point-count surveys (Table 2). A total of 9 species groups were identified within the Project Area during point-count surveys: Songbirds, Pigeons/Doves, Gamebirds, Raptors, Waterfowl, Waterbirds, Gulls/Terns, Cranes/Rails, and Woodpeckers (Table 2). Overall mean bird use for the Brady Wind Energy Center was 26.95 birds/20 min (Table 2) and ranged from 0 to 440 birds observed during all surveys.

Overall mean use by non-raptors was 25.88 birds/20 min. Species with the highest mean use belonged to three species groups: Songbirds, Pigeons/Doves and Gamebirds. Songbirds had the highest mean use (20.19 birds/20 min) among non-raptor species groups, and comprised 74.9 percent of all birds observed (Table 2). The songbird species with the highest mean use were the red-winged blackbird, horned lark and American crow (11.62, 1.62 and 1.48 birds/20 min, and observed in 22.8, 24.4 and 16.7 percent of all surveys, respectively; Table 2). Overall, these 3 species accounted for 54.6 percent of all birds observed in the Project Area (Table 2). Pigeons/Doves had the second highest mean use (2.23 birds/20 min) and comprised 8.3 percent of all birds observed (Table 2). The pigeon/dove species with the highest mean use was the mourning dove (2.19 birds/20 min and observed in 39.4 percent of all surveys; Table 2). The mourning dove comprised 8.1 percent of all birds observed and was distributed throughout the Project Area (Table 3). Gamebirds had the third highest mean use (2.19 birds/20 min) and comprised 8.1 percent of all birds observed (Tables 2). The gamebird species with the highest mean use was the ring-necked pheasant (1.84 birds/20 min and observed in 41.7 percent of all surveys; Table 2). The ring-necked pheasant comprised 6.8 percent of all birds observed and was distributed throughout the Project Area (Table 3). The remaining non-raptor species groups that were observed during surveys included Waterfowl, Waterbirds, Gulls/Terns, Cranes/Rails, and Woodpeckers. Each of the species within these groups had mean use values less than 1.00 birds/20 min.

Although western meadowlark was not among the top 3 songbirds with highest mean use, it had a relatively high frequency of observation in comparison to other species (observed in 35.0 percent of all surveys). Additionally, the sharp-tailed grouse was observed 9 times with a total of 45 individuals and had a mean use of 0.25 birds/20 min and were observed in 5.0 percent of all surveys (Table 2).

Non-raptor use was relatively consistent through mid-September and then slightly decreased for the remainder of the season (Figure 3). The primary contributors to the high mean use observed on September 1 were observations of red-winged blackbirds (1120 individuals in 8 flocks of 60 to 250 individuals). Non-raptor mean use was highest at point-count location 6 (52.08 birds/20 min;

Figure 4). Red-winged blackbird was the species primarily contributing to the high mean use at point-count location 6 (400 individuals; Table 3). The habitat at point-count location 6 consists of agriculture (wheat) and grassland that is not unique within the Project Area.

Raptors are a group of special interest because of their propensity to fly at heights similar to a turbine RSA. Overall mean use for raptors was 1.07 birds/20 min (Table 2); the fourth highest value among the nine species groups. The raptor species with the highest mean use were the Swainson's hawk, northern harrier and red-tailed hawk (0.26, 0.26 and 0.23 birds/20 min and observed in 24.4, 24.4 and 22.2 percent of all surveys, respectively; Table 2). Other raptor species detected were the turkey vulture, American kestrel and ferruginous hawk, each with mean use values less than 0.22 birds/20 min and observed in less than 11.0 percent of all surveys (Table 2).

Raptor use was highest during early fall and tapered off as the season progressed. Mean use by raptors was highest from August 20th through September 1st (ranging from 1.60 to 1.80 birds/20 min; Figure 5). Mean use for raptors was less than 1.30 birds/20 min on all other survey dates (Figure 5) and highest at point-count location 9 (2.33 birds/20 min; Figure 6). Species contributing to the high mean use at this point-count location was turkey vulture, Swainson's hawk and northern harrier (15, 7 and 5 individuals, respectively; Table 3). The habitat at point-count location 9 consists of row crop agriculture (wheat and alfalfa) and pastureland that may provide foraging opportunities for raptors, however these features are not unique to this point-count location or within the Project Area. Raptor mean use was less than 1.85 birds/20 min at all other point-count locations.

3.2 Flight Height and Encounter Rate

During fall avian use surveys, the biologist collected behavioral data for all birds observed during point-count surveys and 92.8 percent of these were observed flying. The biologist collected flight height data for 100 percent and flight direction for 72.7 percent of the individuals observed flying. Of non-raptor individuals observed flying, 69.1 percent flew below the height of the anticipated RSA and 30.9 percent flew at the height of the anticipated RSA (Table 4). Of raptor individuals observed flying, 49.7 percent flew below the height of the anticipated RSA and 50.3 percent flew at the height of the anticipated RSA. There were no raptor or non-raptor species observed flying above the height of the anticipated RSA during point-count surveys. Generally, birds observed in flight were moving in a southerly direction (55.6 percent). Data on flight direction are located in Appendix 1.

The red-winged blackbird had the highest encounter rate (5.92 birds flying at RSA height/20 min; Table 5). All other species had an encounter rate less than 1.0 birds flying at RSA height/20 min.

3.3 Raptor Nest Surveys

Raptor nests detected within the Project Area included five occupied Swainson's hawk nests, one occupied red-tailed hawk nest and six small unoccupied nests (Figure 7). Outside of the Project Area, surveyors located two occupied Swainson's hawk nests, two occupied red-tailed hawk nests, six large unoccupied nests, and 13 small unoccupied nests (Figure 7). There were two groups of large unoccupied nests detected during the fall 2015 aerial survey; a cluster of five nests and a single nest. All 6 of the large unoccupied nests were located on sandstone buttes. These large stick nests are most likely to be used by large raptor species such as golden eagles or ferruginous hawks, and a golden eagle was subsequently viewed perching in proximity to the cluster of 5 large unoccupied nests. The small unoccupied nests were all located in trees and are most likely used by smaller raptor species found within the Project Area (e.g., red-tailed hawk and Swainson's hawk). The presence of raptor nests may increase the risk for collisions during breeding season.

3.4 Incidental Observations

The biologist documented three species incidentally to point-count surveys (Table 6), all of which were also observed during point-count surveys. Most of these observations occurred north or northeast of point-count locations 8 and 9 outside of the Project Area. In addition, surveyors observed eight golden and three bald eagles, (five within and six outside the Project Area), during the aerial raptor nest surveys.

3.5 Protected Species

No federally threatened or endangered species were observed during avian point-count surveys, the raptor nest survey, or as an incidental observation. No eagles were observed during avian point-count surveys, however eight individual golden eagles and three individual bald eagles were observed incidentally during the raptor nest surveys (Section 3.4).

4 Discussion

The avian community detected within the Project Area during fall surveys was characterized by species associated with agricultural lands and pasture vegetation typical of North Dakota. Within disturbed habitats such as those found in the Project Area, the greatest potential impact of wind facilities to avian species is collisions with turbines rather than disturbance or displacement. Recent meta-analyses relevant to the proposed Project have estimated an average all-bird fatality rate of 1.81 birds/MW/year in the Great Plains (Loss et al. 2013) and 2.29 small birds/MW/year in the Prairie biome (Erickson et al. 2014). Annual avian fatality rates at the Project, should fatalities occur, are expected to fall within this range.

4.1 Non-Raptor Use and Collision Risk

Songbirds were identified as having potential risk of collision due to high encounter rates and/or relatively high mean use rates. These songbird species included the red-winged blackbird, horned lark, American crow and western meadowlark. Encounter rate was highest for red-winged blackbirds (5.92 birds flying at RSA height/20 minutes; Table 5). All other songbird species had encounter rates less than 0.79 birds flying at RSA height/20 min. The western meadowlark had a relatively high frequency of detection compared to the other species (observed in 35.0 percent of all surveys) but relatively low mean use (1.32 birds/20 min) and an encounter rate of 0.00 birds flying at RSA height/20 min. Red-winged blackbirds are local year-round residents and transient migratory species in this region of North Dakota and may be at the greatest fatality risk during the spring and fall due to their flocking characteristics, which may also be contributing to their relatively high encounter rate in comparison to other species. The red-winged blackbird (Kerlinger et al. 2006, Thelander et al. 2003), horned lark (Johnson and Erickson 2011, Downes and Gritski 2012), American crow (Downes and Gritski 2012, Jain et al. 2007oka) and western meadowlark (Johnson and Erickson 2011, Thelander et al. 2003) have been documented as fatalities at wind energy projects according to publically available data, particularly the horned lark which presented the highest fatality numbers of the four species and exhibits breeding flight displays that may bring them into the height of the RSA (Johnson and Erickson 2011). Although risk of turbine-related fatalities at the Project exists for each of these species, should they occur, are unlikely to have population-level impacts because North Dakota populations for each species are large and relatively stable (8.2, 4.3, and 5.6 million, respectively; PIFSC 2013, Sauer et al. 2012).

Mourning dove and ring-necked pheasant were species outside the songbird group with highest mean use and frequency of observation (2.19 and 1.84 birds/20min and 39.4 and 41.7 percent of all surveys, respectively). Sharp-tailed grouse had a mean use of 0.25 birds/20 min and were observed in 5.0 percent of all surveys (Table 2). However, the encounter rates for all 3 species were 0.00 as none were observed flying at the height of the RSA. Project-related fatalities of the mourning dove, ring-necked pheasant and sharp-tailed grouse, should they occur, are unlikely to have population-level impacts because North Dakota populations for each species are large and relatively stable (4.1 million, 2.0 million and 170,000, respectively; PIFSC 2013, Sauer et al. 2012). Additionally, the ring-necked pheasant is an introduced species and not protected by the MBTA.

The remaining non-raptor species detected during spring surveys have low risk of turbine collisions at the Project due to a combination of relatively low mean use rates, infrequent flight within the height of the RSA, and/or few to no records of fatalities at wind facilities with publically available results of mortality studies.

4.2 Raptor Use and Collision Risk

A recent meta-analysis suggests that pre-construction studies provide poor indicators of post-construction mortality (Ferrer et al. 2012). Prior to Ferrer et al. (2012), high raptor use (greater 2.0 birds/20 min) has often been associated with high raptor mortality at wind farms (Strickland et al. 2011). Conversely, raptor mortality often appears to be low when raptor use is low (< 1.0 birds/20 min; Strickland et al. 2011). In the case of this Project, overall raptor use was 1.07 birds/20 minutes, which is just above the low mean use mark of 1.0 birds/20 min. As more wind energy facilities complete both pre- and post-construction studies, the relationship between bird use and fatality rates may be better understood.

Swainson's hawks, northern harriers and red-tailed hawk had the highest mean use (0.26, 0.26 and 0.23 birds/20 min, respectively) for the raptor species group, and were also among the most frequently detected raptor species at the Project Area (observed at 24.4, 24.4 and 22.2 percent of all surveys, respectively). Although the Swainson's hawk and red-tailed hawk had similar mean use and frequency rates to the northern harrier, their encounter rates differed (0.15, 0.16 and 0.00 birds flying at RSA height/20 min, respectively). These species are commonly associated with agricultural and grassland prairie habitats which provide opportunities for foraging, an activity associated with susceptibility to turbine collisions (Thelander et al. 2003); however, there are no known features that would concentrate golden eagles or other large raptors within the Project Area.

Swainson's hawk fatalities have been recorded at other wind energy facilities with publicly available data (Erickson et al. 2004, Gritski et al. 2010, Johnson and Erickson 2011). Additionally, 7 occupied Swainson's hawk nests were found within 2 miles of the Project area during raptor nest surveys (5 within the Project Area and 2 outside the Project Area); this may increase the risk for collisions during nesting activities. Given the low mean use of Swainson's hawks within the Project Area and low encounter rate; turbine-related fatalities at the Project are likely to be low. Although northern harriers have been seldom recorded as fatalities at other wind farms with publicly available data (Erickson et al. 2002, Young et al. 2003, Johnson and Erickson 2011), the majority of foraging flights for the northern harrier occur below typical RSA heights (Whitfield and Madders 2006). The risk of turbine-related fatalities of northern harriers at the Project is expected to be low given the typical flight behavior exhibited by the species and low encounter rate of 0.00 birds flying at the RSA height/20 min within the Project Area. Project-related fatalities of Swainson's hawk and northern harrier, should they occur, are unlikely to have population-level impacts because both species' populations are relatively stable (Sauer et al. 2012).

In a study of raptor response to wind farms, red-tailed hawks were observed engaging in high-risk flight behaviors at operational wind facilities whereas northern harriers were identified as having a low risk flight behavior for collisions (Garvin et al. 2011). Results from post-construction mortality monitoring studies indicate that red-tailed hawks are frequently found as turbine-related fatalities (Jain 2005, Grodsky and Drake 2011, Johnson and Erickson 2011). Drewit and Langston (2008) summarized that bird activity is typically higher near active nests than areas without active nests, as a result, red-tailed hawks may have increased potential for collision as they repeatedly fly within the Project Area during nesting activities and during the time when young begin to fledge from the nests. A total of 3 occupied red-tailed hawk nests were found within 2 miles of the Project Area (1 nest within the Project Area and 2 outside the Project Area); as previously mentioned, the presence of occupied raptor nests may increase the risk for collisions during nesting activities. However, Project-related fatalities are unlikely to have population-level impacts because red-tailed hawks populations are relatively stable (Sauer et al. 2012).

Other raptor species detected during fall point counts included the turkey vulture, American kestrel and ferruginous hawk. Both turkey vultures and American kestrels are commonly found as fatalities at wind facilities (Erickson et al. 2002, Stantec 2010). However, a low encounter rate of 0.00 birds flying at the RSA height/20 min for both of these species suggests a low risk for turbine collisions at the Project. The ferruginous hawk is not commonly found as fatalities at wind energy facilities according to publicly available data. Additionally, low use of the Project Area and an encounter rate of 0.00 birds flying at the RSA height/20 min, suggesting a low risk of collision with Project turbines.

4.3 Protected Species

No federally threatened or endangered species were observed during avian point-count surveys, raptor nest survey, or as an incidental observation. Although no eagles were observed during avian point-count surveys, eight individual golden eagles and three individual bald eagles were observed incidentally to raptor nest surveys. These sightings suggest that golden and bald eagles may occur in the Project Area. No bald or golden eagle nests were found within the Project Area or 2-mile buffer surrounding the Project Area during the raptor nest surveys conducted in June and November 2015; however, there are several known eagle nests within 10 miles of the Project Area. Two bald eagle nests were located during spring 2015 aerial raptor nest surveys conducted in support of another proposed wind energy facility (now canceled). The nearest bald eagle nest is located approximately three miles to the east of the Project Area in an isolated stand of trees surrounded by agricultural habitat. The other bald eagle nest is located approximately 8.5 miles to the northeast of the Project Area, along the Heart River. There are also six known golden eagle nests clustered on large sandstone buttes 8-9 miles to the northwest of the Project Area, possibly indicating 1-2 territories based on spacing of the nests. The nest locations were provided by NDGF in response to a request for locations of known significant ecological communities and sensitive plant and wildlife occurrences within the vicinity of Project Area. Additionally, the presence of large stick nests on buttes approximately 2 miles to the northwest of the Project Area indicate that golden eagles may nest nearby.

Six bald eagle fatalities associated with wind energy facilities within the United States were reported from 1997 through June 2012 (Pagel et al. 2013). Since publication of the Pagel et al (2013) summary, one bald eagle fatality has been reported at a wind energy facility in North Dakota (Public Prairie Broadcasting 2015). Bald eagles are believed to be at less risk of turbine collision than golden eagles because they tend to focus their hunting efforts for fish and waterfowl in lakes and rivers (Buehler 2000). Although the landscape within the Project Area does not support any large waterbodies or an abundance of smaller waterbodies that would attract bald eagles for nesting or foraging, there are 2 known bald eagle nests located within 10 miles of the Project. The presence of occupied bald eagle nests in the vicinity of the Project Area suggests that the species may hunt or pass through the Project Area during the breeding season. Eagles use surveys are underway to evaluate risk of Project activities to eagles.

Seventy-nine golden eagle mortalities associated with wind energy facilities within the United States were reported from 1997 through June 2012, excluding the Altamont Pass Wind Resource Area in California (Pagel et al. 2013.); however, to date no golden eagle mortalities have been reported at wind energy facilities in North Dakota. Golden eagles are believed to be more at risk of turbine collision than bald eagles because they hunt for land-based prey along topographic contours where turbines are often located (Kochert et al. 2002). Several known golden eagle nests occur on sandstone bluffs within 10 miles of the Project Area. Although golden eagles may occur in the Project Area during any time of the year, the species is unlikely to breed within the Project Area due to a lack of suitable habitat. Eagles use surveys are underway to evaluate risk of Project activities to eagles.

Hagen et al. (2005) has provided a list of North Dakota's 100 Species of Conservation Priority. There were six species of conservation priority found within the Project Area. The level 1 species observed were the Swainson's hawk and Ferruginous hawk. The level 2 species observed at the Project Area were northern harrier, golden eagle, bald eagle and sharp-tailed grouse. According to Hagen et al (2005), Level 1 species are those having a high level of conservation priority because of declining status in North Dakota or across their range; or have a high rate of occurrence in North Dakota, constituting the core of the species breeding range, but may be at-risk range-wide. These are species that are in decline and presently receive little or no monetary support or conservation efforts.

5 Brady Wind Energy Center Conclusions

Results of the fall 2015 avian surveys at the Brady Wind Energy Center suggest an overall low impact of the Project on the local avian community. The mean-use rate at the Project by non-raptors is primarily driven by flock observations of a few common residents and migratory species. Although there is potential for turbine-related fatalities of red-winged blackbirds and Swainson's hawks at the Project, fatalities involving these species are not expected to have population-level impacts (e.g., Erickson et al. 2014). If avian fatality rates are similar to other wind facilities within the region, we would expect them to fall between 0.38 and 11.83 birds/turbine/year (0.42 – 7.17 birds/MW/year). Additionally, the potential for turbine-related fatalities exists for nocturnal migrant species not identifiable by the methods of this study.

No federally listed threatened or endangered species were detected during avian point-count surveys. There were no eagles observed during avian point-count surveys, however eight golden eagles and three bald eagles were observed incidentally to raptor nest surveys. Additionally, there is a confirmed bald eagle nest approximately 3 miles from the Project Area and potential golden eagle nests approximately 2 miles from the Project Area. Both bald and golden eagles are protected under the BGEPA and all native migratory avian species are protected by the Migratory Bird Treaty Act of 1918. Currently, there are no permits for incidental take of migratory birds.

6 References

Arnett, E.B., D.B. Inkley, D.H. Johnson, R.P. Larkin, S. Manes, A.M. Manville, J.R. Mason, M.L. Morrison, M.D. Strickland, and R. Thresher. 2007. Impacts of wind energy facilities on wildlife and wildlife habitat. Wildlife Society Technical Review 07-2. The Wildlife Society, Bethesda, MD.

Ballam, J.M. 1984. The use of soaring by the red-tailed hawk (*Buteo jamaicensis*). Auk 3:519-524.

Beveridge, L. J. 2005. The Migratory Bird Treaty Act and wind development. North American Wind Power September: 36-38.

Bryce, S.A., J.M. Omernik, D.A. Pater, M. Ulmer, J. Schaar, J, Freeouf, R. Johnson, P. Kuck, and S.H. Azevedo. 1996. Ecoregions of North Dakota and South Dakota, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Devereux, C.L., M.J.H. Denny, and M.J. Whittingham. 2008. Minimal effects of wind turbines on the distribution of wintering farmland birds. Journal of Applied Ecology 45:1689-1694.

Downes, S.D., and B. Gristki. 2012. White Creek Wind I wildlife monitoring report, November 2007- November 2011. Prepared for White Creek Wind I, LLC. Roosevelt, Washington. May 1, 2012

Drewitt, A.L. and R.H.W. Langston. 2008. Collision effects of wind-power generators and other obstacles on birds. Pages 233-266 *in* R. S. Ostfeld and W. H. Schlesinger, editors. Year in Ecology and Conservation Biology 2008. Blackwell Publishing, Oxford.

Drewitt, A.L. and R.H.W. Langston. 2006. Assessing the impacts of wind farms on birds. Ibis 148:29-42.

Erickson, W.P., M.M. Wolfe, K.J. Bay, D. H. Johnson, and J.L. Gehring. 2014. A comprehensive analysis of small-passerine fatalities from collision with turbines at wind energy facilities. PLOS One 9 (9): e107491. Doi:10.1371/journal.pone.0107491.

Erickson, W. P., G. D. Johnson and D. P. Young Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collision. USDA Forest Service Gen. Tech. Rep PSWGTR (191): 1029-1042.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Annual Report. July 2001 - December 2003. Technical report peer-reviewed by and submitted to FPL Energy, the Oregon Energy Facility Siting Council, and the Stateline Technical Advisory Committee. Western EcoSystems Technology, Inc.(WEST), Cheyenne, Wyoming. December 2004.

Erickson, W.P., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Technical report prepared by WEST, Inc., for Bonneville Power Administration, Portland, OR.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R E. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee, Washington, DC. Available online at http://www.osti.gov/scitech/servlets/purl/822418. Accessed December 2015.

Faanes, C.A., and R.E. Stewart. 1982. Revised checklist of North Dakota birds. Version 16JUL97. The Prairie Naturalist 14(3):81-92. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Available online at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1019&context=usgsnpwrc. Accessed December 2015.

Ferrer, M., M. de Lucas, G.F.E. Janss, E. Casado, A.R. Muñoz, M.J. Bechard, and C.P. Calabuig. 2012. Weak relationship between risk assessment studies and recorded mortality in wind farms. Journal of Applied Ecology. 49(1): 38-46. Available online at http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2664.2011.02054.x/pdf.

Garvin, J. C., Jennelle, C. S., Drake, D. and Grodsky, S. M. 2011, Response of raptors to a windfarm. Journal of Applied Ecology, 48: 199–209.

Gritski, B., S. Downes, and K. Kronner. 2010. Klondike III (Phase 1) Wind Power Project Wildlife Monitoring Study October 2007–October 2009. Prepared for Iberdrola Renewables, Klondike Wind Power III, LLC, Portland, OR. Prepared by Northwest Wildlife Consultants, Inc. (NWC), Pendeleton, Oregon. April 21, 2010.

Grodsky, S.M. and D. Drake. 2011. Assessing Bird and Bat Mortality at the Forward Energy Center. Final Report. Public Service Commission (PSC) of Wisconsin. PSC REF#:152052. Prepared for Forward Energy LLC. Prepared by Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, Wisconsin. August 2011.

Hagen, S.K., P.T. Isakson, and S.R. Dyke. 2005. North Dakota Comprehensive Wildlife Conservation Strategy. North Dakota Game and Fish Department. Bismarck, ND.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual report for the Maple Ridge wind power project post-construction bird and bat fatality study—2006. Prepared by Curry and Kerlinger, LLC for PPM Energy, Horizon Energy, and Technical Advisory Committee for the Maple Ridge Project.

Jain, A.A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. Thesis submitted to Iowa State University, Ames, IA. 113 pgs.

Johnson, G.D., C. LeBeau, R. Neilsen, T. Rintz and J. Eddy. 2012. Greater Sage-Grouse Habitat Use and Population Demographics at the Simpson Ridge Wind Resource Area, Carbon County, Wyoming. Final Report prepared for EBP Renewables, Houston, Texas.

Johnson, D.H., M.J. Holloran, J.W. Connelly, S.E. Hanser, C.L. Amundson, and S.T. Knick. 2011. Influences of Environmental and Anthropogenic Features on Greater Sage-grouse Populations, 1997-2007. Pages 407-450 in S.T. Knick and J.W. Connelly. Greater Sage-Grouse: ecology and conservation of a landscape species and its habitat. Studies in Avian Biology 38. University of California Press, Berkeley, CA.

Johnson, G.D. and W.P. Erickson. 2011. Avian, Bat and Habitat Cumulative Impacts Associated with Wind Energy Development in the Columbia Plateau Ecoregion of Eastern Washington and Oregon. Prepared by West, Inc. for Klickitat County, Washington

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Kerlinger, P., R. Curry, L. Culp, A. Jain, C. Wilkerson, B. Fischer, and A. Hasch. 2006. Post-Construction Avian and Bat Fatality Monitoring for the High Winds Wind Power Project, Solano County, California: Two Year Report. Prepared for High Winds LLC, FPL Energy by Curry and Kerlinger, LLC. April 2006.

Kerns, J. and P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Technical report prepared by Curry and Kerlinger, LLC for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee.

Leddy, K.L., K.F. Higgins, and D.E. Naugle. 1999. Effects of wind turbines on upland nesting birds in CRP grasslands. Wilson Bulletin 111:100-104.

Loss, S.R., T Will, and P.P. Marra. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168:201-209.

Manville, A.M., II. 2004. Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations. Division of Migratory Bird Management, USFWS, Arlington, VA, peer-reviewed briefing paper.

Martin, G.R. 2011. Understanding bird collisions with man-made objects: a sensory ecology approach. Ibis 153(2):239-254.

Nagy, L., B. Gibson, K.L. Kosciuch, J. Jones, and J. Taylor. 2011. Whooping and Sandhill Crane Behavior at an Operating Wind Farm. Poster presented at American Wind Energy Association Annual Meeting, Pasadena, CA.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final report prepared by Biosystems Analysis, Inc. for Alameda, Contra Costa, and Solano Counties and the California Energy Commission.

Pagel, J.E, K.J. Kritz, B.A. Millsap and R.K. Murphy, E.L. Kershner and S. Covington. 2013. Bald Eagle and Golden Eagle Mortalities at Wind Energy Facilities in the Contiguous United States. J. of Raptor Research, 47(3):311-315.

Pearce-Higgins, J.W., L. Stephen, A. Douse, and R.H.W. Langston. 2012. Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis. Journal of Applied Ecology 49: 386-394.

Pickwell, B. 1931. The prairie horned lark. St. Louis Academy of Sciences Transactions 27:1-153.

PIFSC (Partners in Flight Science Committee) 2013. Population Estimates Database, version 2013. Available at http://rmbo.org/pifpopestimates. Accessed December 2015.

Pitman, J.C., C.A. Hagen, R.J. Robel, T.M. Loughin, and R.D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. Journal of Wildlife Management 69:1259-1269.

Pruett, C.L., M.A. Patten and D.H. Wolfe. 2009. Avoidance Behavior by Prairie Grouse: Implications for Development of Wind Energy. Conservation Biology 23:1253-1259.

Postupalsky, S. 1974. Raptor reproductive success: some problems with methods, criteria and terminology. Raptor Research Report No. 2:21-31.

Public Prairie Broadcasting. 2015. Bald eagle death could mean a new look at wind turbine siting rules. Reported by Dave Thompson on Oct 6, 2015. Available at: http://news.prairiepublic.org/post/bald-eagle-death-could-mean-new-look-wind-turbine-siting-rules. Accessed December 2015.

Sandercock, B., S. Wisely, L. McNew, A. Gregary, V. Winder, L. Hunt. 2013. Environmental Impacts of Wind Power Development on the Population Biology of Greater Prairie-Chickens. Final Technical Report for Department of Energy: DE-EE0000526.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2012. The North American Breeding Bird Survey, Results and Analysis 1966 - 2011. Version - 07.03.2013 USGS Patuxent Wildlife Research Center, Laurel, MD

Shaffer, J.A. and D.H. Johnson. 2009. Displacement effects of wind developments on grassland birds in the northern Great Plains. NWCC Wind Wildlife Conference [Presentation], October 2008. Milwaukee, WI. Prepared for NWCC by S.S Schwartz and Published 2009. Available online at: https://nationalwind.org/wp-content/uploads/assets/research_meetings/Research_Meeting_VII_Shaffer.pdf. Accessed December 2015.

Stantec Consulting, Inc. (Stantec). 2010. Cohocton and Dutch Hill Wind Farms Year 1 Post-Construction Monitoring Report, 2009, for the Cohocton and Dutch Hill Wind Farms in Cohocton, New York. Prepared for Canandaigua Power Partners, LLC and Canandaigua Power Partners II, LLC, Portland, Maine. Prepared by Stantec, Topsham, Maine. January 2010.

Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A. Shaffer, and W. Warren-Hicks. 2011. Comprehensive Guide to Studying Wind Energy/Wildlife Interactions. Prepared for the National Wind Coordinating Collaborative, Washington, D.C. Available online at: https://nationalwind.org/wp-content/uploads/assets/publications/Comprehensive_Guide_to_Studying_Wind_Energy_Wildlife_Interactions_2011_Updated.pdf. Accessed December 2015.

Strickland, D. and M.L. Morrison. 2008. A summary of avian/wind facility interactions in the U.S. Federal Guidelines Committee for Wind Siting Guidelines, February 26, 2008, Washington, DC.

Thelander, C.G., K.S. Smallwood, and L. Rugge. 2003. Bird Risk Behaviors and Fatalities at the Altamont Pass Wind Resource Area: Period of Performance: March 1998-December 2000.

Thompson, W.L. 2002. Towards reliable bird surveys: accounting for individuals present but not detected. Auk 119:18-25.

USFWS. 2015a. County Occurrences of Endangered, Threatened, Proposed and Candidate Species Designated and Proposed Critical Habitat in North Dakota. Retrieved from: http://www.fws.gov/northdakotafieldoffice/SEtable.pdf. Accessed December 2015.

USFWS. 2015b. Information for Planning and Conservation: Species list of Stark County, North Dakota. Retrieved from: http://ecos.fws.gov/ipac/project/ICCICLDRPRAALEPKBFMDCJXOUQ/resources. Accessed December 2015.

USFWS. 2013a. ESA Basics: More Than 40 Years of Conserving Endangered Species. Retrieved from: http://www.fws.gov/endangered/esa-library/pdf/ESA_basics.pdf. Accessed December 2015.

USFWS. 2013b. Eagle Conservation Plan Guidance. Module 1 – Land-based Wind Energy. Version 2. USFWS Division of Migratory Bird Management. April 2013.

USFWS. 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. Available from: http://www.fws.gov/windenergy/docs/WEG_final.pdf.

USFWS. 2011a. Flyways. Retrieved from: http://flyways.us/flyways/info Accessed December 2015.

WEST (Western EcoSystems Technology, Inc.). 2011. Presentation at the Northwest Wind Energy and Wildlife Workshop. June 7-8, 2011, Portland, Oregon.

Whitfield, D.P. and M. Madders. 2006. Flight height in the hen harrier *Circus cyaneus* and its incorporation in wind turbine collision risk modeling. Natural Research Information Note 2. Natural Research Ltd, Banchory, UK.

Young, D.P. Jr., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003. Avian and Bat Mortality Associated with the Initial Phase of the Foote Creek Rim Wind power Project, Carbon County, Wyoming.

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FIGURES

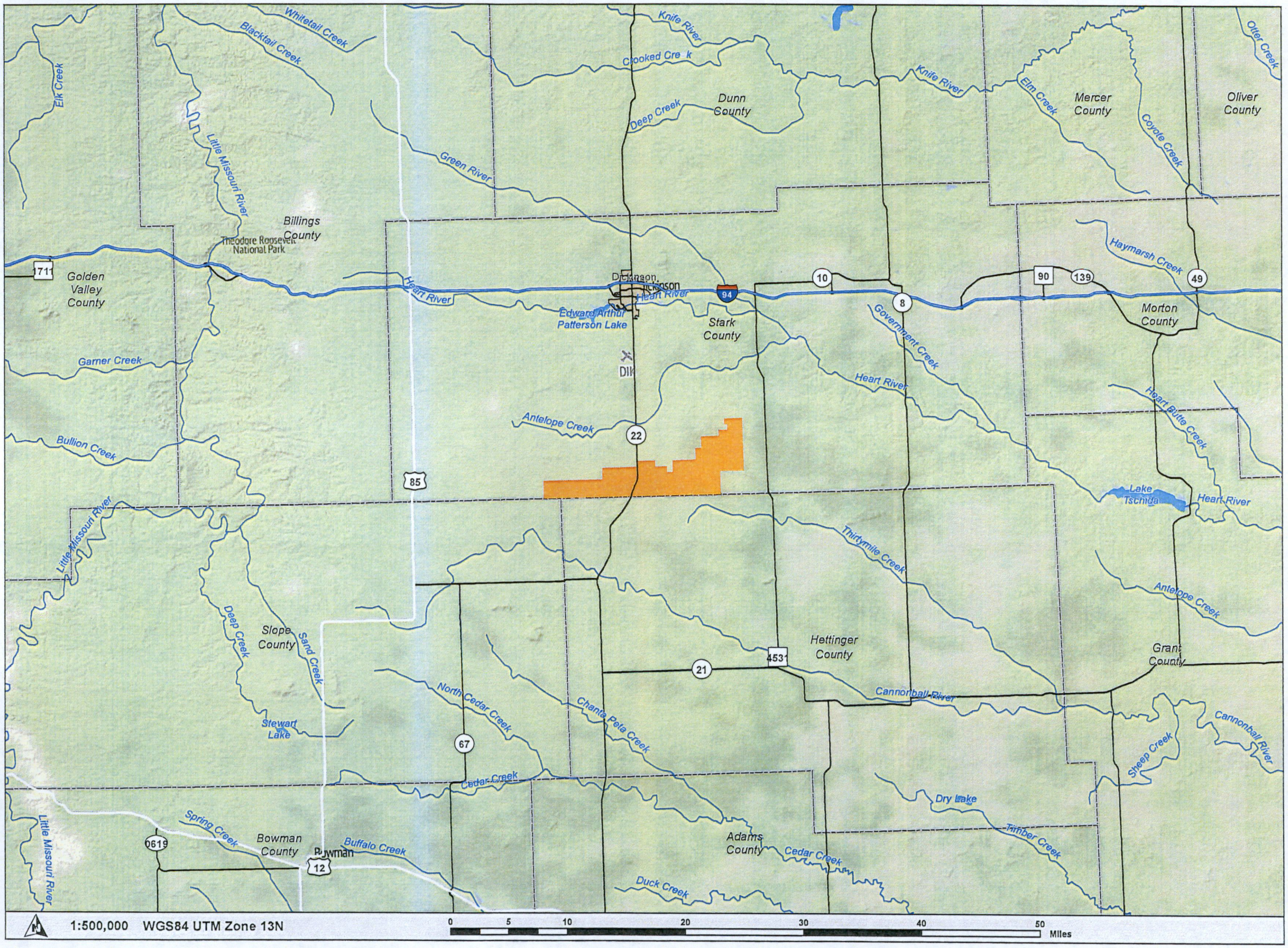


Figure 1

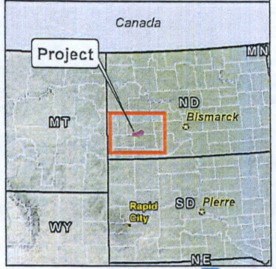
Vicinity Map

NEXTera ENERGY RESOURCES

Brady Wind Energy Center

Stark County, ND

- Proposed Project Area (10-21-2015)
- State Boundary
- County Boundary
- Urban area
- Interstate Highway
- Secondary Highway
- Secondary Road
- River/Stream
- Lake/Pond



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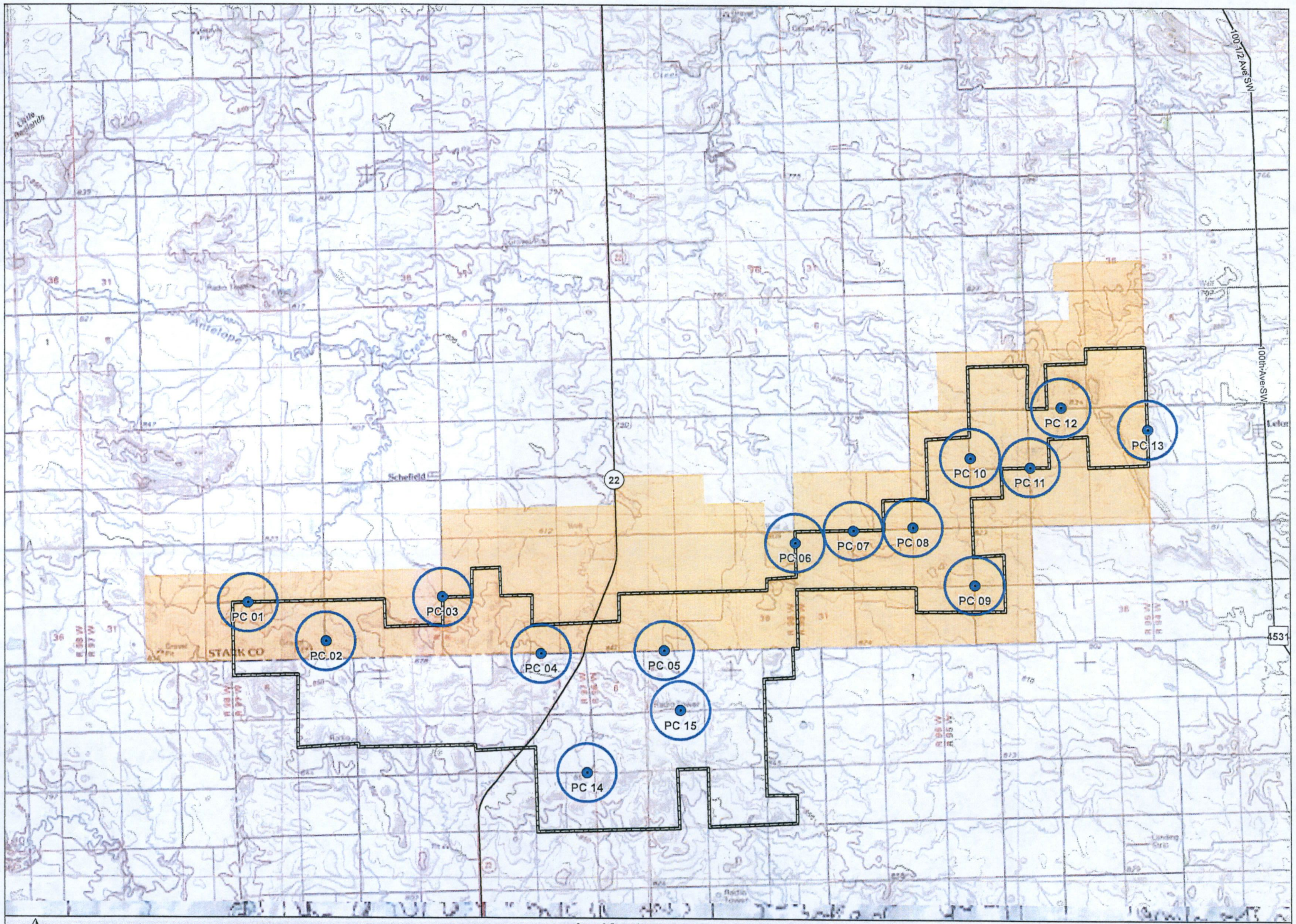

1:100,000 WGS84 UTM Zone 13N

0 0.5 1 2 3 4 5 Miles

Figure 2

Point-count location map (Fall 2015)

NEXTera ENERGY RESOURCES

Brady Wind Energy Center

Stark County, ND
Last modified: 01-18-2016

- Avian Survey Point
- Avian Survey Point 800-m Radius
- PC# Point count number
- Proposed Project Area (10-21-2015)
- Original Proposed Project Boundary (05-28-2015)
- Secondary Road

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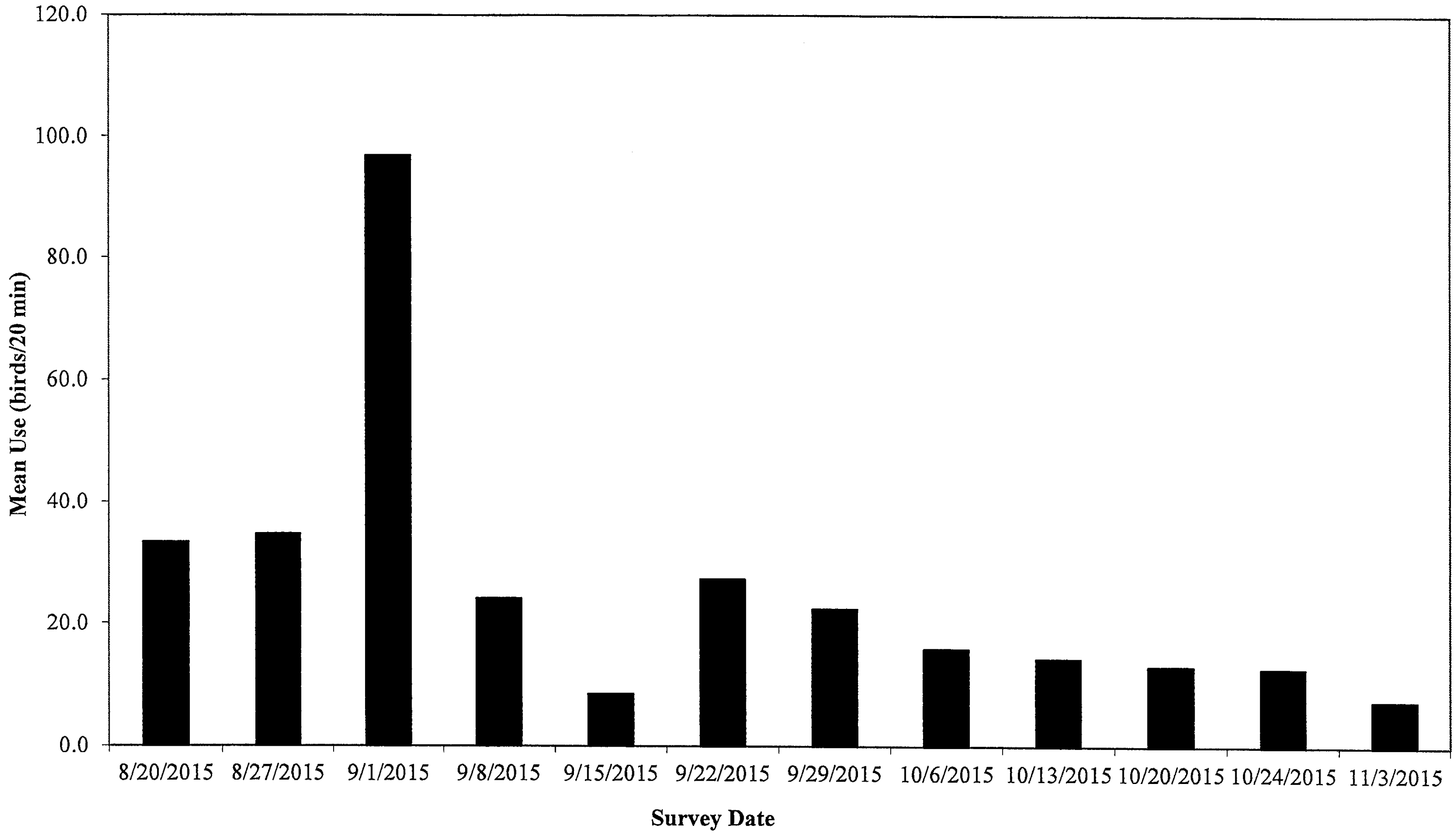
Figure 3. Avian (non-raptor) mean use by survey date during fall 2015 point-count surveys at Brady Wind Energy Center



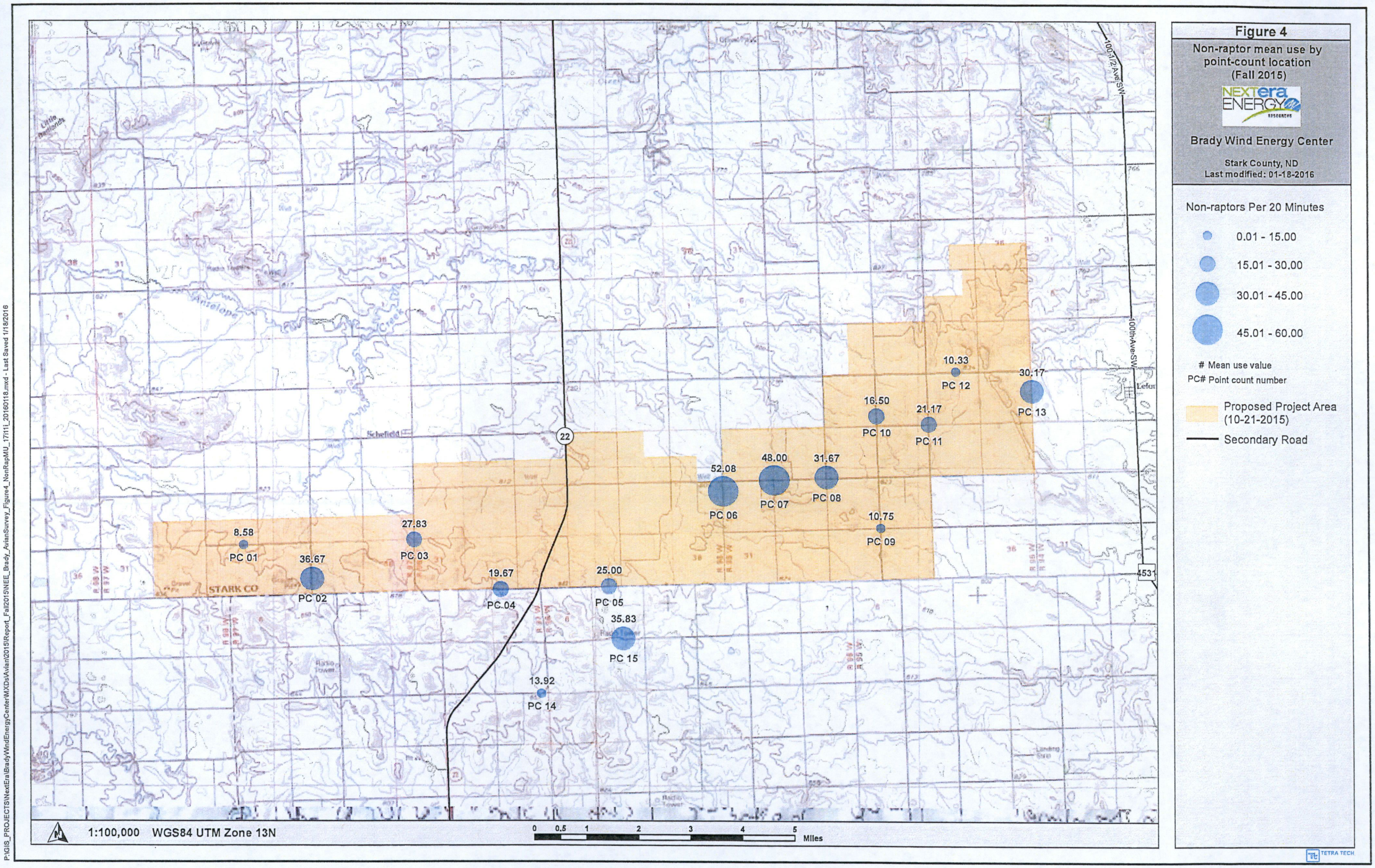


Figure 4
Non-raptor mean use by point-count location (Fall 2015)
NEXTera ENERGY RESOURCES
Brady Wind Energy Center
Stark County, ND
Last modified: 01-18-2016
Non-raptors Per 20 Minutes
0.01 - 15.00
15.01 - 30.00
30.01 - 45.00
45.01 - 60.00
Mean use value
PC# Point count number
Proposed Project Area (10-21-2015)
Secondary Road
8.58
PC 01
36.67
PC 02
27.83
PC 03
19.67
PC 04
25.00
PC 05
52.08
PC 06
48.00
PC 07
31.67
PC 08
10.75
PC 09
16.50
PC 10
21.17
PC 11
10.33
PC 12
30.17
PC 13
13.92
PC 14
35.83
PC 15
22
100 1/2 Ave SW
100th Ave SW
Schefield
STARK CO
1:100,000 WGS84 UTM Zone 13N
0 0.5 1 2 3 4 5 Miles
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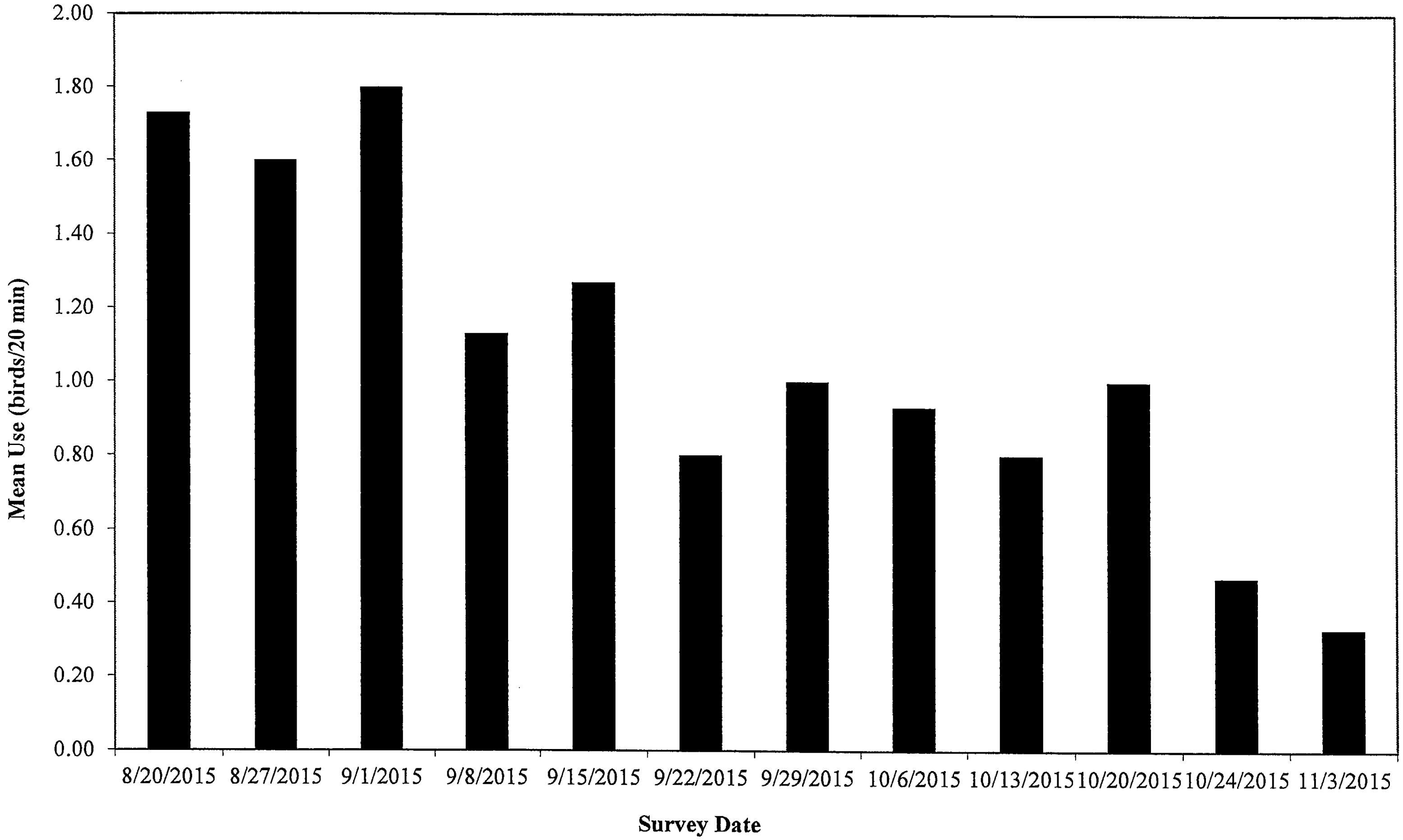
Figure 5. Raptor mean use by survey date during fall 2015 point-count surveys at Brady Wind Energy Center



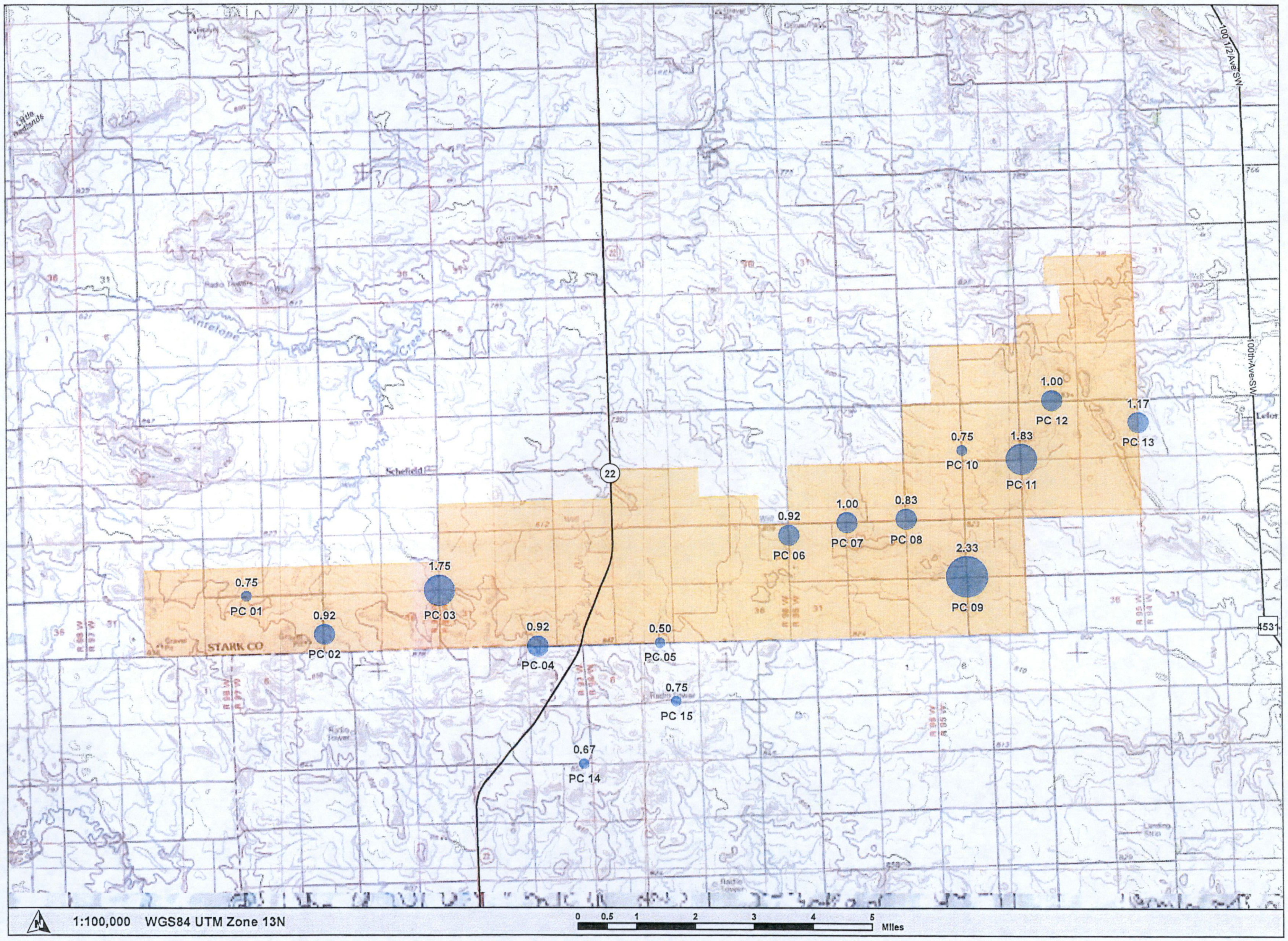


Figure 6

Raptor mean use by point-count location (Fall 2015)

NEXTera ENERGY RESOURCES

Brady Wind Energy Center

Stark County, ND
Last modified: 01-18-2016

Raptors Per 20 Minutes

- Zero
- 0.01 - 0.75
- 0.76 - 1.50
- 1.51 - 2.25
- 2.26 - 3.00

Mean use value
PC# Point count number

Proposed Project Area (10-21-2015)

Secondary Road

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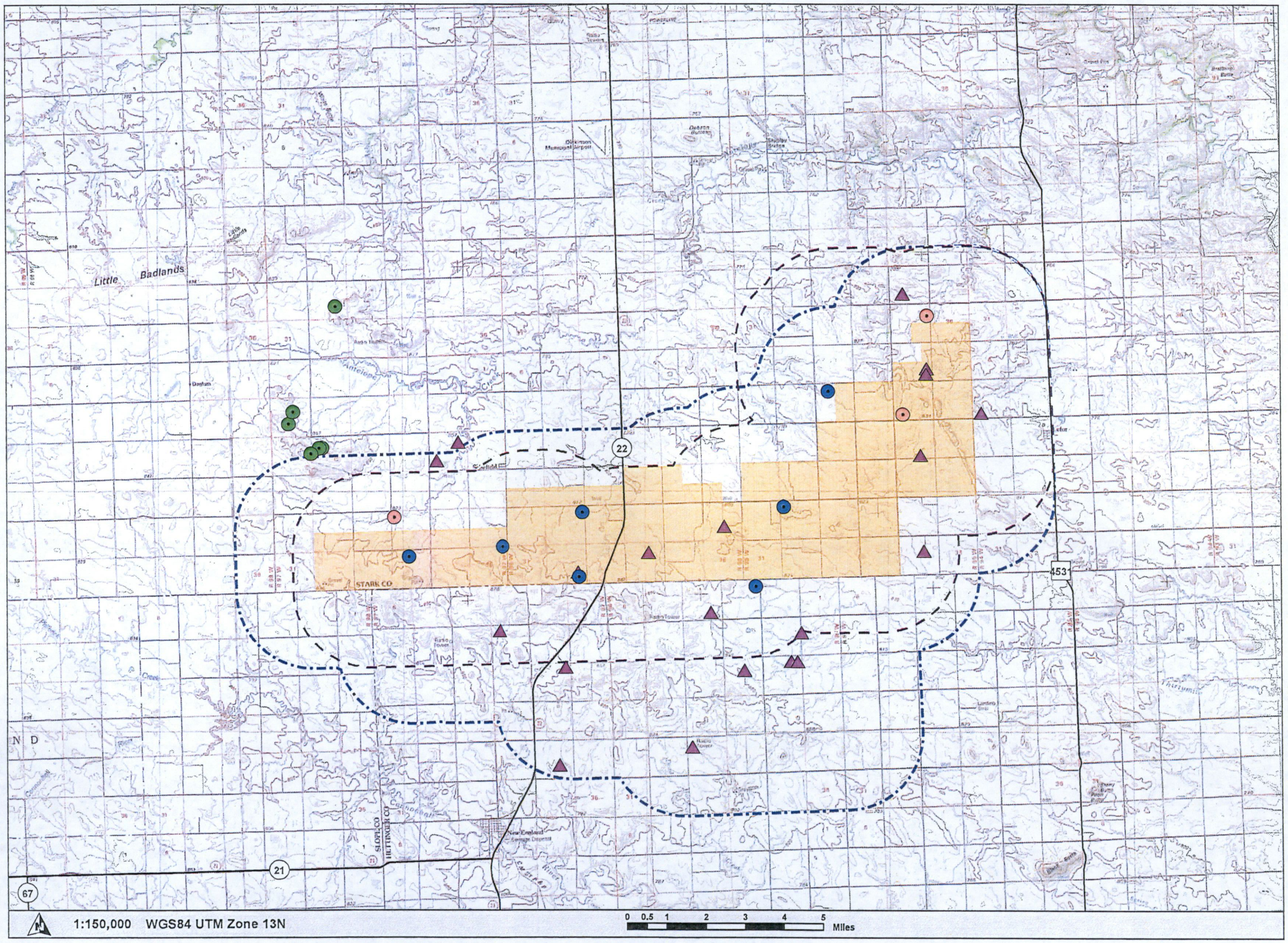

Figure 7

Raptor nest location map (Summer and Fall 2015)

NEXTera ENERGY RESOURCES

Brady Wind Energy Center

Stark County, ND
Last modified: 01-27-2016

Raptor Nest Species

- Red-tailed Hawk
- Swainson's Hawk
- Small Unoccupied Nests
- Large Unoccupied Nests
- Proposed Project Area (10-21-2015)
- Secondary Road
- Summer 2015 Survey Area
- Fall 2015 Survey Area

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TABLES

Table 1. Fall 2015 point-count survey dates at the Brady Wind Energy Center

Survey number	Date(s)	
1	8/20-8/21	2015
2	8/27	2015
3	9/1-9/2	2015
4	9/8	2015
5	9/15-9/16	2015
6	9/22	2015
7	9/29-10/1	2015
8	10/6	2015
9	10/13-10/15	2015
10	10/20	2015
11	10/24-10/27	2015
12	11/3-11/4	2015

Table 2. Avian species, by species grouping, observed during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species Grouping	Overall Rank[1]	Number of Birds	Number of Observations	Mean Use # birds per 20 min. (90% confidence interval)	Frequency % of surveys detected	Percent Composition Group	Percent Composition Overall
Songbirds							
red-winged blackbird	1	2091	43	11.62 (6.68-16.56)	22.8	57.5%	43.1%
horned lark	4	292	45	1.62 (1.21-2.03)	24.4	8.0%	6.0%
American crow	5	267	30	1.48 (1.00-1.96)	16.7	7.3%	5.5%
western meadowlark	6	237	65	1.32 (1.00-1.64)	35.0	6.5%	4.9%
American robin	7	220	20	1.22 (0.73-1.71)	11.1	6.1%	4.5%
barn swallow	8	151	17	0.84 (0.43-1.25)	9.4	4.2%	3.1%
common grackle	9	132	9	0.73 (0.32-1.14)	5.0	3.6%	2.7%
eastern kingbird	11	76	20	0.42 (0.22-0.62)	11.1	2.1%	1.6%
brown-headed cowbird	12	74	4	0.41 (0.00-0.82)	1.7	2.0%	1.5%
European starling	13	54	8	0.30 (0.11-0.49)	4.4	1.5%	1.1%
western kingbird	20	34	15	0.19 (0.09-0.29)	8.3	0.9%	0.7%
dark-eyed junco	29	3	1	0.02 (0.00-0.05)	0.6	0.1%	0.1%
vesper sparrow	30	2	1	0.01 (0.00-0.03)	0.6	0.1%	0.0%
northern shrike	30	1	1	0.01 (0.00-0.02)	0.6	0.0%	0.0%
Group Total		**3634**	**279**	**20.19** (14.87-25.51)	**71.1**		**74.9%**
Pigeons/Doves							
mourning dove	2	394	91	2.19 (1.74-2.64)	39.4	98.0%	8.1%
rock pigeon	26	8	4	0.04 (0.00-0.08)	2.2	2.0%	0.2%
Group Total		**402**	**95**	**2.23** (1.78-2.68)	**41.7**		**8.3%**
Gamebirds							
ring-necked pheasant	3	331	85	1.84 (1.43-2.25)	41.7	84.0%	6.8%
sharp-tailed grouse	17	45	9	0.25 (0.10-0.40)	5.0	11.4%	0.9%
gray partridge	24	18	4	0.10 (0.01-0.19)	2.2	4.6%	0.4%
Group Total		**394**	**98**	**2.19** (1.76-2.62)	**47.8**		**8.1%**
Raptors							
Swainson's hawk	15	47	45	0.26 (0.20-0.32)	24.4	24.4%	1.0%

Table 2. Avian species, by species grouping, observed during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species Grouping	Overall Rank[1]	Number of Birds	Number of Observations	Mean Use # birds per 20 min. (90% confidence interval)	Frequency % of surveys detected	Percent Composition	
						Group	Overall
northern harrier	15	46	46	0.26 (0.20-0.32)	24.4	23.8%	0.9%
red-tailed hawk	18	42	42	0.23 (0.17-0.29)	22.2	21.8%	0.9%
turkey vulture	19	37	5	0.21 (0.05-0.37)	2.8	19.2%	0.8%
American kestrel	21	20	19	0.11 (0.07-0.15)	10.6	10.4%	0.4%
ferruginous hawk	30	1	1	0.01 (0.00-0.02)	0.6	0.5%	0.0%
Group Total		**193**	**158**	**1.07** (0.89-1.25)	**70.0**		**4.0%**
Waterfowl							
Canada goose	10	111	12	0.62 (0.30-0.94)	6.1	76.6%	2.3%
blue-winged teal	21	19	4	0.11 (0.02-0.20)	2.2	13.1%	0.4%
gadwall	26	8	1	0.04 (0.00-0.11)	0.6	5.5%	0.2%
mallard	26	7	2	0.04 (0.00-0.09)	1.1	4.8%	0.1%
Group Total		**145**	**19**	**0.81** (0.47-1.15)	**10.0**		**3.0%**
Waterbirds							
killdeer	14	49	24	0.27 (0.15-0.39)	13.3	96.1%	1.0%
pied-billed grebe	30	2	1	0.01 (0.00-0.03)	0.6	3.9%	0.0%
Group Total		**51**	**25**	**0.28** (0.16-0.40)	**13.9**		**1.1%**
Gulls/Terns							
ring-billed gull	21	20	2	0.11 (0.00-0.24)	1.1	100.0%	0.4%
Group Total		**20**	**2**	**0.11** (0.00-0.24)	**1.1**		**0.4%**
Cranes/Rails							
sandhill crane	25	11	1	0.06 (0.00-0.16)	0.6	100.0%	0.2%
Group Total		**11**	**1**	**0.06** (0.00-0.16)	**0.6**		**0.2%**
Woodpeckers							
northern flicker	30	1	1	0.01 (0.00-0.02)	0.6	100.0%	0.0%
Group Total		**1**	**1**	**0.01** (0.00-0.02)	**0.6**		**0.0%**
Grand Total		**4851**	**678**	**26.95** (21.27-32.63)			

[1] A ranking of 1 indicates highest mean use

Table 3. Avian species observed by point during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species	Number of Birds	Number of Obs.	Points														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
red-winged blackbird	2091	43	0	148	164	140	91	400	370	186	9	30	40	29	239	9	236
mourning dove	394	91	18	31	51	19	16	39	37	26	25	21	25	22	26	7	31
ring-necked pheasant	331	85	1	22	16	30	42	16	14	21	23	20	18	32	13	49	14
horned lark	292	45	21	12	5	7	34	41	6	11	20	17	23	11	32	24	28
American crow	267	30	0	25	5	0	41	33	40	21	0	48	28	0	0	15	11
western meadowlark	237	65	16	20	13	8	26	11	19	17	9	13	9	16	15	31	14
American robin	220	20	7	67	16	0	20	28	40	0	0	0	20	0	16	6	0
barn swallow	151	17	16	19	14	8	3	5	0	30	16	13	11	1	0	6	9
common grackle	132	9	17	0	0	0	0	22	0	37	15	24	0	0	11	0	6
Canada goose	111	12	0	17	0	0	6	0	0	0	0	0	17	0	0	17	54
eastern kingbird	76	20	2	0	9	1	12	1	9	8	1	0	22	6	0	0	5
brown-headed cowbird	74	4	0	0	30	0	0	0	30	0	0	0	14	0	0	0	0
European starling	54	8	0	18	6	0	4	18	4	0	0	0	4	0	0	0	0
killdeer	49	24	1	10	0	3	3	9	0	5	0	5	8	0	5	0	0
Swainson's hawk	47	45	0	3	6	3	3	2	5	3	7	2	5	1	1	1	5
northern harrier	46	46	1	5	1	2	2	5	1	2	5	3	6	4	6	2	1
sharp-tailed grouse	45	9	4	0	0	18	0	1	0	4	0	0	15	3	0	0	0
red-tailed hawk	42	42	8	1	2	6	0	1	4	0	0	3	1	4	7	2	3
turkey vulture	37	5	0	0	9	0	0	0	0	3	15	0	10	0	0	0	0
western kingbird	34	15	0	7	4	2	2	1	7	0	3	0	0	0	1	3	4
American kestrel	20	19	0	2	3	0	1	3	2	2	0	1	0	3	0	3	0
ring-billed gull	20	2	0	9	0	0	0	0	0	11	0	0	0	0	0	0	0
blue-winged teal	19	4	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0
gray partridge	18	4	0	0	1	0	0	0	0	0	0	7	0	0	4	0	6
sandhill crane	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
gadwall	8	1	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
rock pigeon	8	4	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
mallard	7	2	0	3	0	0	0	0	0	0	0	0	0	4	0	0	0
dark-eyed junco	3	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
pied-billed grebe	2	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
vesper sparrow	2	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
ferruginous hawk	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
northern flicker	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
northern shrike	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Grand Total	**4851**	**678**	**112**	**451**	**355**	**247**	**306**	**636**	**588**	**390**	**157**	**207**	**276**	**136**	**376**	**175**	**439**

Table 4. Summary of avian flight heights[1] in relation to the turbine rotor swept area (RSA)[2] during Fall 2015 point-count surveys at the Brady Wind Energy Center

		Birds	
		Number	Percentage
Non-raptors			
	At RSA height (28.5m–131.5m)	1331	30.9%
	Below RSA height (<28.5m)	2980	69.1%
Raptors			
	At RSA height (28.5m–131.5m)	95	50.3%
	Below RSA height (<28.5m)	94	49.7%

[1] Includes only flying birds with flight height data

[2] These values assume a rotor diameter of 103 meters and a hub height of 80 meters

Table 5. Avian flight height characteristics in relation to the turbine rotor swept area (RSA)[1] during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
red-winged blackbird	5.92	11.62 (6.68 - 16.56)	100.0	0.0	51.0	49.0
American crow	0.78	1.48 (1.00 - 1.96)	100.0	0.0	52.8	47.2
Canada goose	0.50	0.62 (0.30 - 0.94)	100.0	0.0	81.1	18.9
turkey vulture	0.21	0.21 (0.05 - 0.37)	100.0	0.0	100.0	0.0
red-tailed hawk	0.16	0.23 (0.17 - 0.29)	100.0	0.0	71.4	28.6
Swainson's hawk	0.15	0.26 (0.20 - 0.32)	93.6	0.0	63.6	36.4
common grackle	0.06	0.73 (0.32 - 1.14)	100.0	0.0	8.3	91.7
sandhill crane	0.06	0.06 (0.00 - 0.16)	100.0	0.0	100.0	0.0
ring-billed gull	0.05	0.11 (0.00 - 0.24)	100.0	0.0	45.0	55.0
American robin	0.02	1.22 (0.73 - 1.71)	100.0	0.0	1.4	98.6
American kestrel	0.00	0.11 (0.07 - 0.15)	95.0	0.0	0.0	100.0
barn swallow	0.00	0.84 (0.43 - 1.25)	100.0	0.0	0.0	100.0
brown-headed cowbird	0.00	0.41 (0.00 - 0.82)	100.0	0.0	0.0	100.0
blue-winged teal	0.00	0.11 (0.02 - 0.20)	100.0	0.0	0.0	100.0
dark-eyed junco	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
eastern kingbird	0.00	0.42 (0.22 - 0.62)	77.6	0.0	0.0	100.0
European starling	0.00	0.30 (0.11 - 0.49)	100.0	0.0	0.0	100.0
ferruginous hawk	0.00	0.01 (0.00 - 0.02)	100.0	0.0	0.0	100.0
gadwall	0.00	0.04 (0.00 - 0.11)	0.0	0.0	0.0	0.0
gray partridge	0.00	0.10 (0.01 - 0.19)	33.3	0.0	0.0	100.0
horned lark	0.00	1.62 (1.21 - 2.03)	100.0	0.0	0.0	100.0
killdeer	0.00	0.27 (0.15 - 0.39)	75.5	0.0	0.0	100.0
mallard	0.00	0.04 (0.00 - 0.09)	100.0	0.0	0.0	100.0
mourning dove	0.00	2.19 (1.74 - 2.64)	80.5	0.0	0.0	100.0
northern flicker	0.00	0.01 (0.00 - 0.02)	100.0	0.0	0.0	100.0
northern harrier	0.00	0.26 (0.20 - 0.32)	100.0	0.0	0.0	100.0
northern shrike	0.00	0.01 (0.00 - 0.02)	0.0	0.0	0.0	0.0
pied-billed grebe	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
ring-necked pheasant	0.00	1.84 (1.43 - 2.25)	39.3	0.0	0.0	100.0

Table 5. Avian flight height characteristics in relation to the turbine rotor swept area (RSA)[1] during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
rock pigeon	0.00	0.04 (0.00 - 0.08)	100.0	0.0	0.0	100.0
sharp-tailed grouse	0.00	0.25 (0.10 - 0.40)	100.0	0.0	0.0	100.0
vesper sparrow	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
western kingbird	0.00	0.19 (0.09 - 0.29)	79.4	0.0	0.0	100.0
western meadowlark	0.00	1.32 (1.00 - 1.64)	95.8	0.0	0.0	100.0

[1]These values assume a rotor diameter of 103 (m) and a hub height of 80 (m)

Table 6. Incidental observations of birds during Fall 2015 point count surveys at the Brady Wind Energy Center

Species	Number of individuals
red-tailed hawk	7
Swainson's hawk	7
northern harrier	1
Grand Total	**15**

APPENDIX

Appendix 1. Flight directions of birds observed during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
red-winged blackbird	1610	36	10.4	0.0	12.4	9.0	67.4	0.8	0.0	0.0	0.0
mourning dove	268	67	29.5	0.0	24.3	0.0	24.3	0.0	22.0	0.0	0.0
American crow	237	28	7.6	0.0	0.0	4.2	85.7	1.3	1.3	0.0	0.0
barn swallow	151	17	29.8	0.0	10.6	0.0	29.8	0.0	29.8	0.0	0.0
common grackle	132	9	11.4	0.0	4.5	13.6	26.5	27.3	16.7	0.0	0.0
horned lark	120	17	9.2	0.0	9.2	0.0	76.7	0.0	5.0	0.0	0.0
Canada goose	111	12	0.0	0.0	0.0	0.0	81.1	7.2	11.7	0.0	0.0
American robin	96	11	24.0	0.0	0.0	7.3	47.9	0.0	20.8	0.0	0.0
ring-necked pheasant	90	11	54.4	0.0	3.3	0.0	15.6	0.0	26.7	0.0	0.0
brown-headed cowbird	74	4	18.9	0.0	58.1	0.0	0.0	0.0	0.0	0.0	23.0
western meadowlark	54	19	46.3	0.0	5.6	0.0	38.9	0.0	9.3	0.0	0.0
European starling	54	8	61.1	7.4	0.0	0.0	7.4	7.4	16.7	0.0	0.0
northern harrier	46	46	21.7	2.2	8.7	2.2	50.0	4.3	8.7	2.2	0.0
Swainson's hawk	39	38	28.2	2.6	5.1	7.7	35.9	5.1	12.8	2.6	0.0
red-tailed hawk	39	39	28.2	2.6	5.1	0.0	33.3	7.7	17.9	5.1	0.0
sharp-tailed grouse	36	8	44.4	0.0	8.3	0.0	0.0	0.0	47.2	0.0	0.0
turkey vulture	25	3	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
ring-billed gull	20	2	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
blue-winged teal	19	4	21.1	0.0	78.9	0.0	0.0	0.0	0.0	0.0	0.0
American kestrel	17	16	17.6	0.0	5.9	11.8	35.3	0.0	29.4	0.0	0.0
sandhill crane	11	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
rock pigeon	8	4	50.0	0.0	25.0	0.0	0.0	0.0	25.0	0.0	0.0
mallard	7	2	42.9	0.0	0.0	0.0	0.0	0.0	57.1	0.0	0.0
eastern kingbird	6	2	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
northern flicker	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0

Appendix 1. Flight directions of birds observed during Fall 2015 point-count surveys at the Brady Wind Energy Center

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
Grand Total	**3271**	**405**	**16.5**	**0.2**	**11.5**	**5.7**	**55.6**	**2.2**	**7.7**	**0.1**	**0.5**

[1] Includes only flying birds with flight directions

WHOOPING CRANE LIKELIHOOD OF OCCURRENCE REPORT

FOR THE

BRADY WIND ENERGY CENTER
STARK COUNTY, NORTH DAKOTA

Prepared For:

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EXECUTIVE SUMMARY

Brady, LLC (Brady) contracted Tetra Tech, Inc. (Tetra Tech) to conduct a landscape-scale analysis to assess the potential occurrence of whooping cranes (*Grus americana*) at the proposed Brady Wind Energy Center (Project) located in Stark County, North Dakota. The whooping crane is a federally endangered species that migrates through the western and central portions of North Dakota during spring and fall. The two most likely impacts of wind development on whooping cranes are: 1) whooping cranes' avoidance of the area around the facility; and 2) direct mortality of whooping cranes due to collisions with transmission lines, turbines, or other facilities. Tetra Tech evaluated the likelihood of whooping cranes to occur within the boundary of the Project (Project Area) using a likelihood index that considers; 1) the location of the Project Area in the well-defined migration corridor, 2) the presence of foraging and roosting sites on the Project Area, and 3) the relative availability of habitat within the Project Area compared to the surrounding landscape. Tetra Tech concluded that the likelihood of whooping cranes occurring on the Project Area is low. The major factor that contributed to this low likelihood finding was the position of the Project Area along the far western portion of the 95-percent isopleth of the whooping crane migration corridor; the majority (95 percent) of whooping crane sightings occur farther east in central North Dakota. Additionally the Project Area had a slightly lower proportion of suitable wetlands compared to the surrounding 35-mile (56km) buffer area. The lower proportion of wetlands within the Project Area compared to the surrounding 35-mile buffer area may potentially make the Project Area less attractive to migrating whooping cranes than the 35-mile buffer area.

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1.0 INTRODUCTION

Brady Wind, LLC (Brady Wind), a wholly owned, indirect subsidiary of NextEra Energy Resources, LLC (NEER), proposes to develop the Brady Wind Energy Center (the Project) in Stark County, North Dakota (Figure 1). One potential constraint when developing wind energy facilities in parts of the Great Plains is the likelihood of the presence of the federally endangered whooping crane (*Grus americana*). Whooping cranes migrate through the western and central portions of North Dakota during spring and fall. Whooping cranes have been killed by collisions with power lines, and the whooping crane recovery plan lists construction of power lines, fences, and other structures in the migration corridor as a threat to the species (CWS and USFWS 2007). Thus, the construction of wind turbines may pose a risk to whooping cranes through avoidance of areas or direct mortality where turbines are located.

Brady Wind contracted Tetra Tech, Inc. (Tetra Tech) to conduct a landscape-scale analysis to assess the potential occurrence of whooping cranes within the boundaries of the Project and associated transmission line (Project Area). The objective of this likelihood of occurrence analysis is to evaluate the biological and landscape features within the Project Area to determine the potential for whooping cranes to occur during migration. Certain landscape features may increase the likelihood of whooping crane occurrence during migration. Therefore, Tetra Tech developed a likelihood index to evaluate the Project Area based on its location in the migration corridor, the presence of feeding and roosting sites, and the availability of habitat within the Project Area compared to the surrounding landscape. The likelihood index does not predict how many whooping cranes may occur in the Project Area; rather, it scores the site based on a suite of variables that are related to whooping crane occurrence. Higher scores denote higher likelihood of occurrence. This likelihood index is not intended to replace field surveys. However, the low probability of detecting a whooping crane during field surveys minimizes the utility of surveys in documenting presence in or absence in a given area. Developing an estimate of the likelihood of occurrence is therefore the best means of evaluating potential impacts to the species. Consequently, this assessment tool was designed to take advantage of available migration and habitat data to provide an empirically based assessment of the likelihood of occurrence of the specie in the Project Area.

2.0 LEGAL STATUS OF THE WHOOPING CRANE IN THE UNITED STATES

The whooping crane is protected by both federal and state laws in the United States. It was considered endangered in the United States in 1970 and the endangered listing was 'grandfathered' into the Endangered Species Act (ESA) of 1973, which makes it unlawful to knowingly violate the "take" provisions of the ESA (CWS and USFWS 2007). "Take" is defined as: "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. §1532(19)). Significant modification or degradation of listed species' habitats where the modification actually kills or injures wildlife by significantly impairing essential behavioral patterns is considered "harm" under ESA regulations. "Incidental take" occurs when a fatality of an ESA-listed species occurs as an unintended consequence of an otherwise legal activity, as would be the case in the unlikely event of a fatality occurring at a wind farm. To Tetra Tech's knowledge, no whooping crane fatality has occurred at a wind energy facility. North Dakota does not have a state endangered or threatened species list, but instead defers to the USFWS federal listing of endangered and threatened species that occur within North Dakota (NDGF 2012).

3.0 ENVIRONMENTAL SETTING AND PROJECT AREA DESCRIPTION

3.1 Environmental Setting

The Project Area, and all of Stark County, is located in the Missouri Plateau subregion of the Northwestern Great Plains Ecoregion (Bryce et al. 1996). The region is mostly used for dryland farming and cattle grazing. The topography of the region is a semiarid rolling plain (Bryce et al. 1996). Vegetation in the region was historically mixed-grass prairie with blue grama (*Bouteloua gracilis*), little bluestem (*Schizachyrium scoparium*), prairie sandreed (*Calamovilfa longifolia*) and a wheatgrass-needlegrass association (Bryce et al. 1996). Native grasslands occur in areas of steep topography.

3.2 Project Area Description

The 34,512 acre Project Area is located on privately owned lands entirely within Stark County in southwest North Dakota. As part of the overall risk assessment, the transmission line extending west outside of the Project boundary was buffered by 0.5 miles on either side and included in the Project Area. The proposed Project turbines will be located approximately 15 miles south of Dickinson in southern Stark County (Figure 1). The Project Area includes the associated approximately 19-mile, 230-kilovolt (kV) overhead transmission line will begin in the central portion of the Project Area and will run west from the Project Area boundary for approximately 6.5 miles. The Project will have a nameplate capacity of approximately 150 megawatts (MW) consisting of 87 General Electric (GE) wind turbine generators. Additional facilities within the Project Area include access roads, underground electrical collection systems, a collection substation, an operation and maintenance (O&M) building, nine temporary meteorological (met) towers and one permanent met tower, and a switchyard. Additionally a temporary construction laydown area and a temporary turbine storage area will be within the Project Area. The transmission line and switchyard will connect the Project to the Belfield to Rhame 230-kV transmission line (Section 29 of Township 137 North, Range 98 West) approximately 19 miles southwest of Dickinson. This line will transmit the power generated by the Project into the Basin Electric Power Cooperative transmission system.

The existing land use in the Project Area is primarily cattle production and agriculture. The area contains numerous small wetlands that vary from shallow vegetated depressions, man-made cattle ponds, and intermittent creeks. There are few wetlands evident that are not associated with a stream system. Residences and a few abandoned farmsteads are scattered throughout the Project Area. Land cover within the Project Area is a mix of cattle pastures, agriculture, and remnant native prairie.

3.3 Whooping Cranes in North Dakota

In North Dakota, whooping cranes migrate annually through the central parts of the state, mostly along the Missouri River, during the spring and fall (NDGF 2013). During migration, whooping cranes primarily use wetlands and cropland ponds for roosting, feeding, or both. Seasonal and semi-permanent wetlands are the most commonly used. Typically, larger wetlands greater than 40 hectares (90.4 acres) are used for roosting and smaller wetlands for foraging (NDGF 2013). Whooping crane sightings in North Dakota have been documented at Lake Sakakawea (approximately 61 miles to the north of the Project Area), Lake Ilo National Wildlife Refuge (approximately 42 miles to the north of the Project Area), and Pretty Rock National Wildlife Refuge (approximately 41 miles to the southeast of the Project Area) during the annual migration periods (Figure 1; Austin and Richert 2001).

4.0 WHOOPING CRANE BIOLOGY

The whooping crane population in North America sharply declined and disappeared from most of its historic range by the late 1800's (CWS and USFWS 2007). The number of whooping cranes in North America prior to 1870 is estimated to have been between 500 and 1,400 individuals (Allen 1952, Banks 1978), but some biologists suggest that the population may have numbered as many as 10,000 individuals (CWS and USFWS 2007). Activities such as habitat destruction, hunting, and displacement due to anthropogenic activities likely led to widespread population declines (CWS and USFWS 2007). One self-sustaining wild population of whooping cranes currently exists in the world. Members of this population breed primarily within the boundaries of Wood Buffalo National Park in Canada and migrate through the central United States to wintering grounds at the Aransas National Wildlife Refuge along the Gulf Coast of Texas (Figure 2). This flock is referred to as the Aransas-Wood Buffalo National Park Population. As a result of intensive management, this population has increased from 15 birds in 1941 to an estimated 308 birds (with a 95% probability of actual flock size being between 267–350 birds) as of the 2014/2015 winter whooping crane survey conducted by USFWS (USFWS 2015a).

The whooping crane is a long-lived species that may reach 28 years old in the wild (Binkley and Miller 1983). Individuals reach sexual maturity at 3 to 5 years of age and form life-long breeding pairs while on the wintering grounds or during spring migration (Stehn 1997; CWS and USFWS 2007). Whooping cranes have low annual reproductive output. Females typically lay two eggs, but only 10 percent of families arrive on the winter grounds with two chicks because the smaller chick usually dies within the first two weeks after hatching (CWS and USFWS 2007). The juveniles become independent of the parents on the wintering ground prior to spring migration. Sexually immature individuals (i.e., subadults) return to the breeding grounds where they may remain solitary or congregate in small groups on the periphery of breeding pairs (CWS and USFWS 2007).

4.1 Reasons for the Population Decline

Populations of long-lived species with low annual reproductive output such as the whooping crane are sensitive to changes in adult survival (Stahl and Oli 2006). Hunting, especially during spring migration, from 1870 to 1930 resulted in 274 documented whooping crane fatalities (Allen 1952). In addition, Hahn (1963) tallied 309 mounts and 9 skeletons in museum collections throughout the world. Because many of these specimens do not contain information regarding the date and location of collection, it is unlikely that the majority were collected by museum personnel. It is possible that mortality from shooting exceeded annual production of juveniles during the early 1900s (CWS and USFWS 2007).

Degradation and loss of breeding habitat eliminated the whooping crane from much of its core breeding range in North America. Whooping cranes once bred from the southern edge of Lake Michigan north through southern Minnesota to northeastern North Dakota through Manitoba, Saskatchewan, and Alberta (Allen 1952). Conversion of prairie and pothole ecosystems to agriculture and ranching made much of the breeding habitat unsuitable (CWS and USFWS 2007).

4.2 Threats to Whooping Cranes

Several factors threaten the whooping crane because of its small population size and concentration of all members of the Aransas-Wood Buffalo National Park population at single breeding and wintering locations. Due to their high degree of site fidelity, members of the Aransas-Wood Buffalo Population are unlikely to naturally recolonize the historic whooping crane range in North America.

Threats to the whooping crane identified in the recovery plan that are related to wind power development include collision with power lines, fences, and other structures, and loss and degradation of stopover and wintering habitat through avoidance (CWS and USFWS 2007; USFWS 2009).

Power lines pose a major threat to whooping cranes when they are located in the vicinity of foraging or roosting habitat because individuals often fly at low altitudes (33 to 49 feet above the ground) when moving among sites (CWS and USFWS 2007; Stehn and Wassenich 2008). The majority of documented fatalities during migration are due to collisions with power lines. Since 1956, 46 whooping cranes have been killed or seriously injured as a result of collisions with power lines (Stehn and Wassenich 2008). Collisions with power lines have resulted in fatalities of whooping cranes in other experimental populations that are maintained by the introduction of captive-reared young (Stehn and Wassenich 2008). Fourteen individuals from the Florida non-migratory population and one individual in the migratory Wisconsin population have died from colliding with power lines (Stehn and Wassenich 2008).

Although no whooping crane mortality has been attributed to wind turbines, the whooping crane recovery plan considers wind power development within the whooping crane migration corridor a threat because of the construction of power lines and associated structures (CWS and USFWS 2007). In a large scale modelling study conducted by Pearse et al. (2015) of the migratory corridor, they found that nearly 10,000 wind turbines have been constructed within the U.S. study area (migration corridor). Most areas with wind turbines in the migration corridor did not contain whooping crane stopover sites (84 percent), and only 2 percent of cells ($20km^2$) were identified as core migration areas (Pearse et al. 2015). During migration, both sandhill and whooping cranes have been seen in the vicinity of operational wind turbines, and Nagy et al. (2012) showed that the cranes flew either above or around the turbines, therefore minimizing the likelihood of turbine collision. Other studies have documented sandhill cranes gradually climbing as they approach marked power lines (Morkill and Anderson 1991, Murphy et al. 2009). The USFWS (2009) believes that whooping cranes will avoid stopping at areas with operational wind turbines. Thus, behavioral avoidance of wind farms by whooping cranes may reduce the probability of collision but may result in loss of stopover habitat.

5.0 WHOOPING CRANE MIGRATION

Whooping cranes undertake an 8,046km (5,000 miles) round-trip migration from the breeding area in Canada (Wood Buffalo) to the wintering area in Texas (Aransas) every year (USFWS 2015b). A one-way trip can take about 50 days to complete in the fall (USFWS 2015b) and approximately 28 days in the spring (CWS and USFWS 2007). Individuals depart the breeding ground in Canada and travel south through Alberta, Canada, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas to the wintering ground at Aransas National Wildlife Refuge on the Texas coast. Whooping cranes may travel as singles, in pairs, or as small flocks or family groups of 3 to 5 birds (Johns 1992, CWS and USFWS 2007). Occasionally, whooping cranes may travel with sandhill cranes during migration and stopover sites also used by sandhill cranes may be used by whooping cranes as well (CWS and USFWS 2007).

The whooping crane migration route is well defined and 95 percent of all recorded observations occur within an approximate 322km (200 mile) wide corridor during spring and fall migration (USFWS 2010; Figure 2). The median location of all crane observations was statistically derived and used to describe the migration route from the breeding grounds to the wintering grounds (CWS and USFWS 2007). Buffers were then calculated based on the percentage of observations to further define the migratory corridor. Tacha et al. (2010) identified the migration corridor width by using a distance-from-centerline approach of each whooping crane observation (through

2008) and determined that 75 percent of stopover sites occurred within 48 km (29 miles) of the centerline, 85 percent within 80 km (49 miles), and 95 percent within 136 km (84 miles) which is used by USFWS and in this assessment report (see figures 2 and 3). Pearse et al. (2015) obtained similar results using only data from satellite-telemetry tracking of whooping cranes for the entire migration corridor and (based on the derived centerline) found the average distance of stopovers to the centerline was 43.8 km (27 miles) (median = 27.5km [17 miles]; SD = 31.4km [19 miles]; max = 480.4km [298 miles]). The 75th percentile was 58.8 km (36 miles), 85th percentile was 82.3 km (51 miles), and 95th percentile was 144.1 km (90 miles) (Pearse et al. 2015).

During migration, whooping cranes can occur where suitable habitat is available. Four sites in the migration corridor are used consistently by whooping cranes and have high annual use: the Platte River in Nebraska, Cheyenne Bottoms Wildlife Management Area and Quivira National Wildlife Refuge in Kansas, and the Salt Plains National Wildlife Refuge in Oklahoma. Additionally, Aransas National Wildlife Refuge in Texas is used yearly by whooping cranes as the wintering grounds. These five sites are designated as critical habitat under the Endangered Species Act (Figure 2; CWS and USFWS 2007). The Platte River in Nebraska is the closest of these four sites to the Project Area and is located over 708 km (440 miles) to the south-southeast.

5.1 Fall Migration

Whooping cranes depart the breeding grounds at Wood Buffalo National Park in mid-September and parents with young are usually the last to depart. Birds may travel alone, in pairs, in family groups, or in small flocks (Johns 1992). The birds first travel southeast about 483km (300 miles) to a major staging area in Saskatchewan, where they may remain for 2 to 4 weeks before resuming migration. During fall migration, birds may stay at traditional stopover sites for 7 to 10 days, but stays as long as 6 weeks have been documented at Quivira National Wildlife Refuge (CWS and USFWS 2007). In North Dakota, Long Lake National Wildlife Refuge (175.4km [109 miles] east of the Project Area) provides stopover habitat for large numbers of migrating sandhill cranes, shorebirds, ducks, geese, swans, and pelicans along with receiving occasional whooping crane use (USFWS 2015b). The majority of whooping cranes reach the wintering grounds by mid-November. In North Dakota, most sightings occur from late September to early November with peak migration occurring in mid-October (Austin and Richert 2001).

5.2 Spring Migration

Whooping cranes depart the wintering grounds in late March; the last birds depart in May. Breeding pairs are typically first to depart and migration is facilitated by winds from the southeast. There is no known staging area in spring as there is in fall, and migration is completed in 2 to 4 weeks. Traditional stopover sites that are used in fall are also used in spring. However, individuals spend fewer days at stopover sites during spring migration. During the spring migration, whooping cranes travel through North Dakota from mid-April to early May with peak migration in late April (Austin and Richert 2001).

5.3 Migration Flight Behavior

Whooping cranes are diurnal (daytime) migrants and primarily fly by using static soaring, but low-level flapping flight may be used when conditions dictate. Migration is initiated after the air has warmed and thermal updrafts are present. Individuals spiral upwards on thermals of warm air to heights of 1,000 to 6,000 feet (Kyut 1992), then enter into long, descending glides. This process is repeated throughout the day until suitable habitat is reached. Static soaring is energy efficient as birds seldom flap after they are airborne. Whooping cranes may travel up to 805km (500 miles) per day in ideal conditions; during average conditions, they may travel 402km (250 miles) per day (Stehn and Wassenich 2008). During the end of the migration flight, individuals will enter long descending glides and use flapping flight at lower altitudes until they reach suitable roosting and feeding habitat. Whooping cranes do not regularly migrate during unfavorable weather conditions such as a strong headwind, rain or other precipitation, or overcast conditions. When visibility is poor, individuals use flapping flight at lower altitudes until they reach suitable roosting or feeding habitat.

5.4 Stopover Habitat Characteristics

Whooping cranes require roosting habitat when they stop during migration. At a broad scale, whooping cranes appear to adhere closely to a specific migratory route and a narrow range of directional headings during migration (Howe 1989, Austin & Richert 2001, Belaire et al. 2013). Within this migratory route, certain areas are often preferred (e.g., areas closer to crops and wet natural habitats), whereas others are avoided (e.g., areas of high road and human settlement cover) as stopover sites (Belaire et al. 2013, Pearse et al. 2015). Whooping cranes often select sites with unobstructed visibility (Austin and Richert 2001). Palustrine wetlands (freshwater wetlands characterized by emergent vegetation) are most often used as roosting sites, but individuals have been found roosting at lacustrine wetlands (wetlands around a lake), and riverine wetlands (wetlands along a river; Howe 1989; Austin and Richert 2001). The size of wetlands used during spring and fall migration ranges from 0.4 hectare (1 acre) to over 500 hectares (1,236 acres), and no seasonal use patterns are evident (Austin and Richert 2001); 75 percent of recorded roost wetlands were smaller than 4 hectares (10 acres). Although size of the wetlands used for roosting varies, water depth ranges from 18 (46cm) to 20 inches (51cm) and little variability is found among sites.

Whooping cranes forage in wetlands and agricultural fields during migration and may commute between roosting and feeding areas. Palustrine wetlands are used most often when whooping cranes forage in wetlands, but lacustrine and riverine wetlands have also been used as feeding sites (Austin and Richert 2001). Among agricultural crops used as feeding sites, the use of winter wheat was higher than other crop types in the fall and the use of row-crop stubble (comprised mostly of corn) was higher in the spring than other crop types (Austin and Richert 2001). Whooping cranes have also been observed feeding in sorghum, sunflower, and soybean stubble

(Austin and Richert 2001). Feeding sites are often located adjacent to roosting sites. For example, 94.9 and 72.9 percent of roosting sites were within 0.62 mile (1km) of feeding sites in spring and fall, respectively (Johns et al. 1997; USFWS 2009).

6.0 ASSESSMENT OF WHOOPING CRANE LIKELIHOOD OF OCCURENCE

The primary threats of wind energy development to whooping cranes are mortality due to collision with transmission lines and associated structures and loss of habitat due to avoidance. Because of the high level of concern regarding whooping cranes, the ability to evaluate the risk to whooping cranes at an individual Project Area is a critical component to understanding the environmental impacts of a proposed wind energy facility. Here, Tetra Tech utilizes a method to evaluate the likelihood of whooping cranes to occur at the Project Area. This evaluation considers the location of the Project Area in the well-defined migration corridor, the presence of feeding and roosting sites, and the availability of habitat within the Project Area compared to the landscape in the 35-mile buffer area (Table 1). In addition, the transmission line extending west outside of the Project Area was buffered by 0.5 miles on either side and included in the overall Project Area boundary. Tetra Tech expects whooping cranes to be more likely to occur over the life of a Project at Project Areas with high scores. For the purposes of this analysis, the scores calculated for each parameter were entered into a formula and the resulting score represented the likelihood of occurrence for whooping cranes in the Project Area which was ranked as: Low (less than 5); Moderate (5-10); or High (greater than 10). This likelihood index is not intended to replace field surveys. However, the low probability of detecting a whooping crane during field surveys minimizes their utility in documenting likelihood of occurrence in a given area. Consequently, this likelihood index was designed to take advantage of available data regarding habitat use by cranes and the availability of habitat in the Project Area. A description of each of the three factors included in this analysis (location in the migration corridor, attractiveness of the landscape, and presence of foraging and roosting sites) and how scores are assigned for each is provided in Table 1.

Table 1. Summary of parameters used in the likelihood index calculation.

Parameter	Score	Justification
Location in the Migration Corridor (L)		
Within the 75-percent buffer	7.5	75 percent of all whooping crane observations occur within the 75-percent buffer
Between the 75-percent and 95-percent buffers	2.0	20 percent of all observations occur between 75-percent and 95-percent buffers
Outside the 95-percent buffer	0.5	5 percent of observations occur outside the 95-percent buffer
Attractiveness on the Landscape (A)		
Ratio of wetlands per total acreage for Project Area / wetland per total acreage for the 35-mile buffer area	Actual ratio	Indicates if the Project Area is similar (=), less (<), or more (>) attractive than the surrounding landscape to migrating cranes searching for roosting habitat

Presence of Foraging and Roosting Habitat (W)		
Proportion of Project Area that is a wetland-agricultural matrix	Actual proportion	Indicates the proportion of the Project Area that is favored by cranes for foraging and roosting habitat

6.1 Location of a Project Area in the Migration Corridor (L)

Biological Justification

Belaire et al. (2013) found that adhering to the appropriate orientation (bearing) appears to be a strong factor acting on whooping cranes during migration which results in a well-defined migratory corridor. As a result, stopover areas further away from the center and areas outside of the migratory corridor, however suitable, are often found to be rarely used (Berthold 2001, Belaire et al. 2013). The location of a potential wind facility in relation to the migratory corridor may influence whooping crane migration and land use as stopover areas. The median location of all crane observations was statistically derived and was used to describe the migration route from the breeding grounds to the wintering grounds (CWS and USFWS 2007). Buffers were then calculated based on the percentage of observations to further define the migratory corridor (Figure 3). These percentile buffers were later identified to have remained relatively the same since the initial 2007 data (Tacha et al. 2010, Pearse et al. 2015). For example, 75 percent of all observations occurred within the 75-percent buffer. If two sites are compared, whooping cranes are more likely to stop over at a site within the 75-percent buffer than at a site outside the 95-percent buffer. Therefore, for modeling purposes, the closer a potential wind energy facility was to the center of the migratory corridor, the greater the chance of risk to whooping cranes being impacted by the project's development.

Scoring

Tetra Tech developed scores for the location of a Project Area based on the percent of observations within each USFWS buffer (CWS and USFWS 2007). If a Project Area fell within the 75-percent buffer, it was given a score of 7.5. If a Project Area fell between the 75-percent and 95-percent buffers, it was given a score of 2.0 because 20 percent of all observations occur between these buffers. If a Project Area fell outside of the 95-percent buffer, it was given a score of 0.5 because 5 percent of all observations occur outside the 95-percent buffer.

Assumptions

- The likelihood of whooping crane occurrence in the future will not deviate from the patterns observed through the fall of 2010 which is the most current available data (USFWS 2010).
- If a portion of the Project Area fell on the boundary of a buffer or in two buffers, the Project Area was assumed to be within the buffer closer to the center of the migratory corridor.

6.2 Attractiveness of the Landscape (A)

Biological Justification and Data Source

Wetlands are used by whooping cranes for feeding and roosting and the amount of wetlands within a given area compared to the surrounding landscape may influence whooping crane use of a site during migration. After whooping cranes have descended from migration flight altitudes, they may travel up to 35 miles in search of suitable roosting habitat (USFWS 2008). Therefore, Tetra Tech determined that if a Project Area contained a higher proportion of wetlands than was found within the 35 miles surrounding the Project Area, the Project Area would be more attractive than the surrounding area.

Scoring

Tetra Tech used National Wetlands Inventory (NWI) data (USFWS 2014c) and National Land Cover Database (NLCD) data (Jin et al. 2013, USGS 2014) to determine the total acreage of wetlands within the Project Area and within 35 miles of the Project Area. The use of multiple data sources helped to avoid the limitations of any one data source (e.g., Stahlecker 1992). Tetra Tech then calculated the proportion of the total acreage of the Project Area and the 35-mile sbuffer area that was comprised of wetlands to get the wetland proportion of each. Tetra Tech then divided the wetland proportion of the Project Area by the wetland proportion of 35-mile buffer area to determine the ratio of Project Area to 35-mile buffer area. Tetra Tech used the ratio as the score in the likelihood index equation. If the ratio was greater than one, the Project Area contained more wetlands and was considered to be more attractive to whooping cranes than the 35-mile buffer area. If the ratio was equal to one, the Project Area contained a similar proportion of wetlands and was considered to be as attractive as the 35-mile buffer area. If the ratio was less than one, the Project Area contained a lower proportion of wetlands and was considered to be less attractive than the 35-mile buffer area.

Assumptions

- The wetlands in the 35-mile buffer area shown in the NWI and NLCD Database were accurate and are considered useable by Whooping Cranes.
- 35 miles is an appropriate scale to examine whooping crane habitat use.

6.3 Presence of Foraging and Roosting Sites (W)

Biological Justification

Whooping cranes often make low altitude flights between roosting and foraging habitat and are thus at risk of collision with power lines and other structures (CWS and USFWS 2007; Stehn and Wassenich 2008; USFWS 2009).

A desktop study conducted by Belaire et al. (2013) indicated that areas of high agricultural cover, low coverage of roads and urban areas, and intermediate wetland cover had higher predicted relative suitability for whooping cranes than other land cover types. In a telemetry study of marked individuals, Pearse et al. (2015) found that areas close to wetlands (less than 100 m) and simultaneously less than1 km from agricultural land were most likely to be used by whooping cranes. This relative suitability increases with proximity to the center of the whooping crane migration corridor (see Section 6.1). An earlier study by Austin and Richert (2001) found the majority of foraging sites were upland crops (73.8 percent) adjacent to wetland roosting sites. Wetland roosting sites were defined in three broad categories as palustrine (58.2 percent), riverine (33.3 percent), or lacustrine (7.8 percent) roost sites (Austin and Richert 2001). For the upland crop foraging sites; 83 percent of grain stubble was wheat stubble, 75 percent of row-crop stubble was corn, and 80 percent of green crops was winter wheat (Austin and Richert 2001). The distances traveled between roost to foraging sites varied by wetland systems with 75 percent feeding sites being 0.8 km (0.5 miles) or less from the palustrine roost sites to over 50 percent of riverine roost sites being 1.2 km or greater from foraging sites (Austin and Richert 2001). Based on these published assessments, Tetra Tech used an average of 1.0 km (0.62 miles) to assess the presence of foraging and roosting sites within the Project Area and a 56.3 km (35 mile) buffer area around the Project Area. Tetra Tech considered wetlands located within 1.0 km (0.62 mile) of agricultural crops to form a wetland-agricultural matrix that may be used by whooping cranes during migration (Austin and Richert 2001). Tetra Tech used a geographic information system (GIS) to calculate the proportion of the Project Area that was comprised of this wetland-agricultural crop matrix, using a minimum 0.41-hectare (1-acre) patch size for both wetlands and crops. The 1-acre minimum for wetlands was used to avoid including wetlands unusable by whooping cranes (e.g., borrow pits). The 1-acre minimum size for agriculture was used because the majority of whooping crane observations occurred in agriculture patches larger than 1.0 acre (Austin and Richert 2001).

Scoring

To quantify the amount of roosting and foraging habitat in the Project Area, GIS land cover data (NLCD data) was obtained for North Dakota (Jin et al. 2013, USGS 2014). Water features and the spatial extent of waters were verified with NWI data (USFWS 2014c). The GIS analysis was designed to calculate the total area of wetland-agricultural matrix, which may have included other habitat types between patches of wetlands and agriculture. Thus, based on the size restrictions and spatial configuration, the total acres of wetland-agricultural matrix could be greater or less than the sum of the acres of wetland and agriculture. Tetra Tech calculated the proportion of the Project Area that was wetland-agricultural matrix by dividing the total acres of wetland-agricultural matrix by the total acres of the Project Area. Tetra Tech used the proportion as the score in the likelihood index; therefore, scores could range from 0 to 1.

Assumptions

- The average distance of foraging habitat from roosting habitat is 1.0 km (0.62) mile.

- Habitats not classified as wetlands or agriculture are of neutral value and do not influence the availability of wetlands or agriculture on the landscape.

6.4 Likelihood Index Formula (LI)

The likelihood index of whooping cranes occurring at the Project Area was calculated by evaluating the landscape features in and around the Project Area. Tetra Tech used the following formula to calculate the likelihood index:

$$LI = (L * A) + W$$

Where L = location of Project Area in relation to the migration corridor score, A = attractiveness score, or the ratio of wetlands in a Project Area to wetlands in a 35-mile area around a Project Area, and W = wetland-agricultural matrix score. The equation places the most weight on the location in the migration corridor because of the wide range of scores for each feature in the likelihood index. Thus, a Project Area within the 75-percent corridor will tend to score higher than a Project Area within the 95-percent corridor unless the attractiveness score for the Project Area within the 75-percent corridor is low (e.g., <0.50) or the attractiveness score for the Project Area within the 95-percent corridor is high (>4.0), when other values are equal. Project Areas located outside of the 95-percent corridor will tend to score low unless the attractiveness score is high because the location score is less than 1.0.

7.0 PROJECT AREA ASSESSMENT AND SUMMARY

The Project is located partially within the 95-percent buffer, which is on the outskirts of the whooping crane migration corridor; therefore, the Location (L) parameter used in the analysis was 2.0. The proportion of wetlands within the Project is slightly lower than the surrounding 35-mile buffer area, with a calculated Attractiveness on the Landscape (A) value of 0.66. Seventy-eight percent of the Project consists of suitable wetland-agriculture matrix habitat, making the Presence of Foraging and Roosting Sites (W) value 0.78 (Figure 4). The likelihood index score was 2.09 for the Project Area (Table 2) implying low likelihood of occurrence. The low likelihood index score was driven by the Location (L) and Attractiveness on the Landscape (A) values, which indicates that whooping cranes migrating in the vicinity of the Project Area would be more likely to stopover outside of the Project because of the slightly higher proportion of wetland habitat compared to the Project Area.

Overall, based on the location of the Project Area at the edge of the migration corridor, whooping cranes have a low chance to occur within the Project Area. The majority of whooping crane sightings (90 percent) occurred closer to the center of the migration corridor and further away from the Project Area. Furthermore, the wetland habitat within the Project Area is slightly lower than the surrounding 35-mile buffer area, which may make the Project Area less attractive to migratory whooping cranes when compared to the surrounding area.

Table 2. Likelihood index scores for the Brady Wind Energy Center.

Location in the Migration Corridor (*L*)[1]	Attractiveness on the Landscape (*A*)[2]	Presence of Foraging and Roosting Habitat (*W*)[3]	Likelihood Index Score (*LI*)[4]	Likelihood Index Category[5]
2.0	0.66	0.78	2.09	Low

1. Location in the Migration Corridor (L) values: 7.5 = within the 75% buffer, 2.0 = between the 75% and 95% buffers, or 0.5 = outside of the 95% buffer
2. Attractiveness on the Landscape (A) value: Ratio of wetlands per total acreage for Project Area / wetland per total acreage for 35-mile area not including Project Area
3. Presence of Foraging and Roosting Habitat (W) value range: Proportion of Project Area that is a wetland-agricultural matrix
4. Likelihood Index Score (LI): LI = (L×A) + W
5. Likelihood Index Category values: Low = less than 5, Medium = 5-10 , High = greater than 10

8.0 LITERATURE CITED

Allen, R.P. 1952. The whooping crane. National Audubon Society Resource Report 3. 246pp.

Austin, J.E. and A.L. Richert. 2001. A comprehensive review of the observational and site evaluation data of migrant whooping cranes in the United States, 1943-99. U.S. Geological Survey, Northern Prairie Wildlife Research Center, Jamestown, North Dakota, and State Museum, University of Nebraska, Lincoln, Nebraska. 157 pp.

Banks, R. 1978. The size of the early whooping crane populations. Unpublished Report USFWS files. 10pp.

Belaire, J.A, B.J. Kreakie, T. Keitt, and E. Minor. 2014. Predicting and Mapping Potential Whooping Crane Stopover Habitat to Guide Site Selection for Wind Energy Projects. Conservation Biology 28(2):541-550.

Berthold, P. 2001. Bird migration: a general survey. Oxford University Press, New York, 253 pp

Binkley, C.S., and R.S. Miller. 1983. Population characteristics of the whooping crane, *Grus americana*. Canadian Journal of Zoology 61:2768–2776.

Bryce, S.A., J.M. Omernik, D.A. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S.H. Azevedo. 1996. Ecoregions of North Dakota and South Dakota, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

CWS and USFWS (Canadian Wildlife Service and U.S. Fish and Wildlife Service). 2007. International recovery plan for the whooping crane. Ottawa: Recover of the Nationally Endangered Wildlife (RENEW), and U.S. Fish and Wildlife Service, Albuquerque, NM.

Hahn, P. 1963. Where is that vanished bird? Royal Ontario Museum, Univ. Toronto, Canada.

Howe, M.A. 1989. Migration of radio-marked whooping cranes from the Aransas-Wood Buffalo population: patterns of habitat use, behavior, and survival. U.S. Fish & Wildlife Service Technical Report 21. Washington, D.C.

Jin, S., L. Yang, P. Danielson, C. Homer, J. Fry, and G. Xian. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. *Remote Sensing of Environment*, 132: 159 – 175.

Johns, B.W. 1992. Preliminary identification of whooping crane staging areas in prairie Canada. Proceedings of the 1988 North American Crane Workshop. Pgs. 61–66.

Johns, B.W., E.J. Woodsworth, and E.A. Driver. 1997. Proceedings of the North American Crane Workshop 7:123–131

Kyut, E. 1992. Aerial radio-tracking of whooping cranes migrating between Wood Buffalo National Park and Aransas National Wildlife Refuge, 1981-84. Occasional Paper 74, Canadian Wildlife Service, 53 pp.

Morkill, A.E. and S.H. Anderson. 1991. Effectiveness of marking powerlines to reduce sandhill crane collisions. Wildlife Society Bulletin 19: 442-449.

Nagy, L., B. Gibson, K.L. Kosciuch, J. Jones, and J. Taylor. 2012. Whooping and Sandhill Crane Behavior at an Operating Wind Farm. Poster presented at National Wind Coordinating Committee Annual Research Meeting, Denver, CO.

North Dakota Game and Fish Department (NDGF). 2012. Threatened and Endangered Species. Available online at: http://gf.nd.gov/wildlife/fish-wildlife/threatened-and-endangered-species.

NDGF. 2013. Whooping Crane. Available online at: http://gf.nd.gov/wildlife/fish-wildlife/id/birds/grassland-birds/whooping-crane. Accessed November 2015.

Pearse, A.T., D.A. Brandt, W.C. Harrell, K.L Metzger, D.M. Baasch, and T.J. Hefley. 2015, Whooping crane stopover site use intensity within the Great Plains: U.S. Geological Survey Open-File Report 2015–1166, 12 p., http://dx.doi.org/10.3133/ofr20151166.

Stahl, J.T. and M.K. Oli. 2006. Relative importance of avian life-history variables to population growth rate. Ecological Modeling 198:23-39.

Stahlecker, D.A. 1992. Using National Wetlands Inventory maps to quantify whooping crane stopover habitat in Oklahoma. Proceedings of the North American Crane Workshop 6:62–68.

Stehn, T.V. 1997. Pair formation by color-marked whooping cranes on the wintering grounds. Proceedings of the North American Crane Workshop 7:24–28.

Stehn, T.V. and T. Wassenich. 2008. Whooping crane collisions with power lines: an issue paper. Proceedings of the North American Crane Workshop 10:25–36.

Tacha, M, A. Bishop, and J. Brei. 2010. Development of the whooping crane tracking project geographic information system: Proceedings of the North American Crane Workshop, v. 11, p. 98–109.

USFWS (U.S. Fish and Wildlife Service). 2015a. Winter 2014-2015 Whooping Crane Survey Results. Available online at: http://www.fws.gov/uploadedFiles/Region_2/NWRS/Zone_1/Aransas-Matagorda_Island_Complex/Aransas/Sections/What_We_Do/Science/Whooping_Crane_Updates_2013/WHCR_Update_Winter_2014-2015.pdf.

USFWS. 2015b. Fall Migration Update: September 15, 2015. Available online at: http://www.fws.gov/nwrs/threecolumn.aspx?id=2147578614.

USFWS. 2014. National Wetlands Inventory: Classification of Wetlands and Deepwater Habitats of the United States, May 2014. Available online at: http://www.fws.gov/wetlands/.

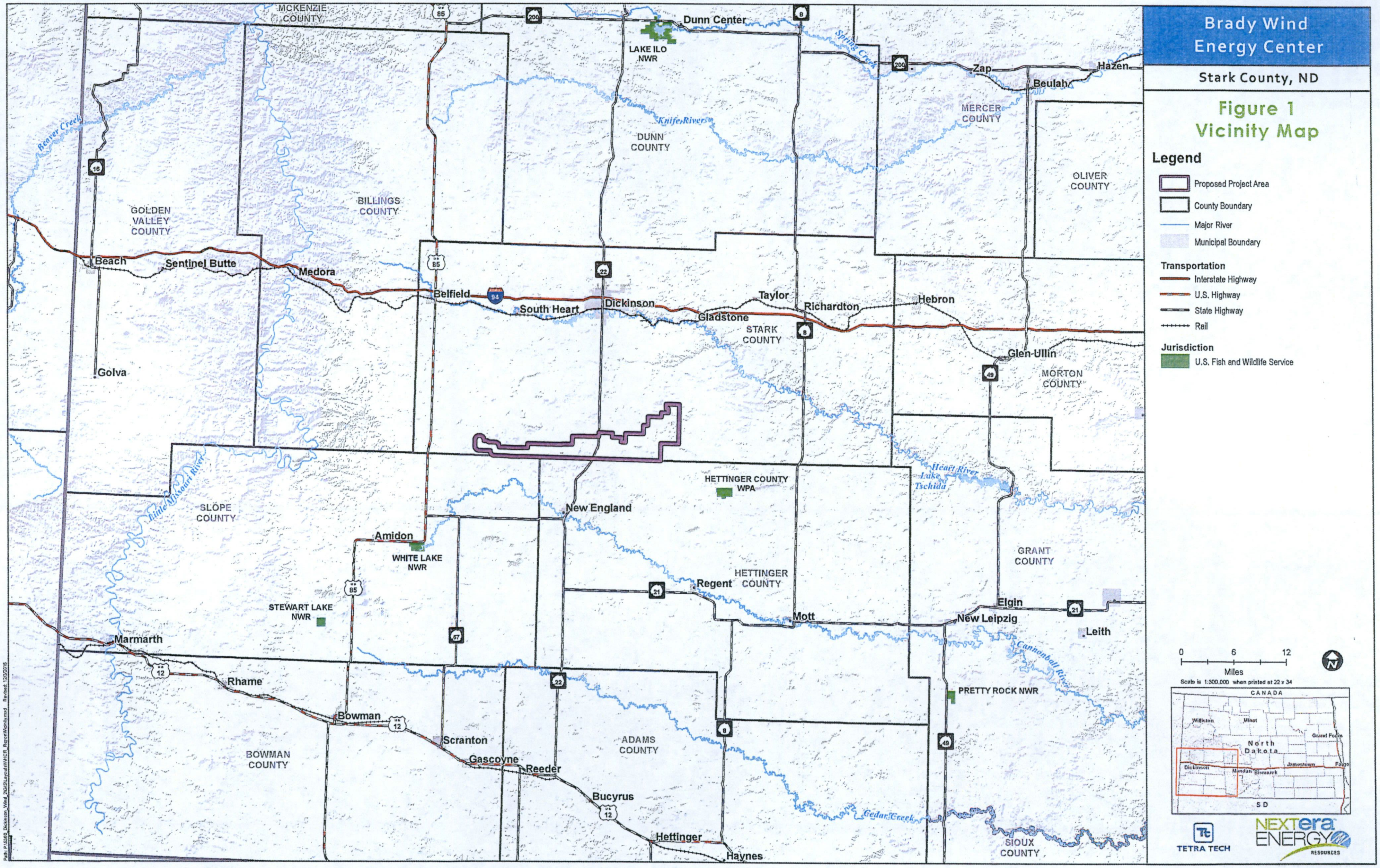
USFWS. 2010. Whooping crane migration corridor in the United States.

USFWS. 2009. Whooping cranes and wind development – An issues paper. USFWS Regions 2 and 6. Available at: http://www.fws.gov/southwest/es/library/

USFWS. 2008. Biological Opinion for the Wessington Springs Wind Project, Jerauld County, South Dakota. USFWS Ecological Services, Bismarck, ND. March 2008.

USGS (U.S. Geological Survey). 2014. National Land Cover Database 2011. Available online at http://www.mrlc.gov/nlcd11_data.php.

FIGURES



Brady Wind Energy Center
Stark County, ND
Figure 1
Vicinity Map
Legend
Proposed Project Area
County Boundary
Major River
Municipal Boundary
Transportation
Interstate Highway
U.S. Highway
State Highway
Rail
Jurisdiction
U.S. Fish and Wildlife Service
0 6 12
Miles
Scale is 1:300,000 when printed at 22 x 34
CANADA
North Dakota
SD
TETRA TECH
NEXTera ENERGY RESOURCES
MCKENZIE COUNTY
GOLDEN VALLEY COUNTY
BILLINGS COUNTY
DUNN COUNTY
MERCER COUNTY
OLIVER COUNTY
STARK COUNTY
MORTON COUNTY
SLOPE COUNTY
HETTINGER COUNTY
GRANT COUNTY
BOWMAN COUNTY
ADAMS COUNTY
SIOUX COUNTY
Dunn Center
LAKE ILO NWR
Zap
Beulah
Hazen
Beach
Sentinel Butte
Medora
Belfield
South Heart
Dickinson
Gladstone
Taylor
Richardton
Hebron
Glen Ullin
Golva
HETTINGER COUNTY WPA
New England
Amidon
WHITE LAKE NWR
STEWART LAKE NWR
Regent
Mott
Elgin
New Leipzig
Leith
PRETTY ROCK NWR
Marmarth
Rhame
Bowman
Scranton
Gascoyne
Reeder
Bucyrus
Hettinger
Haynes
Knife River
Spring Creek
Beaver Creek
Little Missouri River
Heart River
Lake Tschida
Cannonball River
Cedar Creek

Legend

Whooping Crane Critical Habitat

State Border

County Border

Percentage of Sightings Within the Whooping Crane Migration Corridor

75%

80%

85%

90%

95%

0 90 180 Miles

Scale is 1:13,000,000 when printed at 8.5x11"

Path: P:\5360_Dickinson_Wind_2\GIS\Layouts\WHCR_Report\Migration_Corridor.mxd Source: ESRI, BTS, NWI, NLCD, USFWS Last modified: 11/12/2015

Brady Wind Energy Center

Stark County, ND

Figure 2
Whooping Crane Migration Corridor

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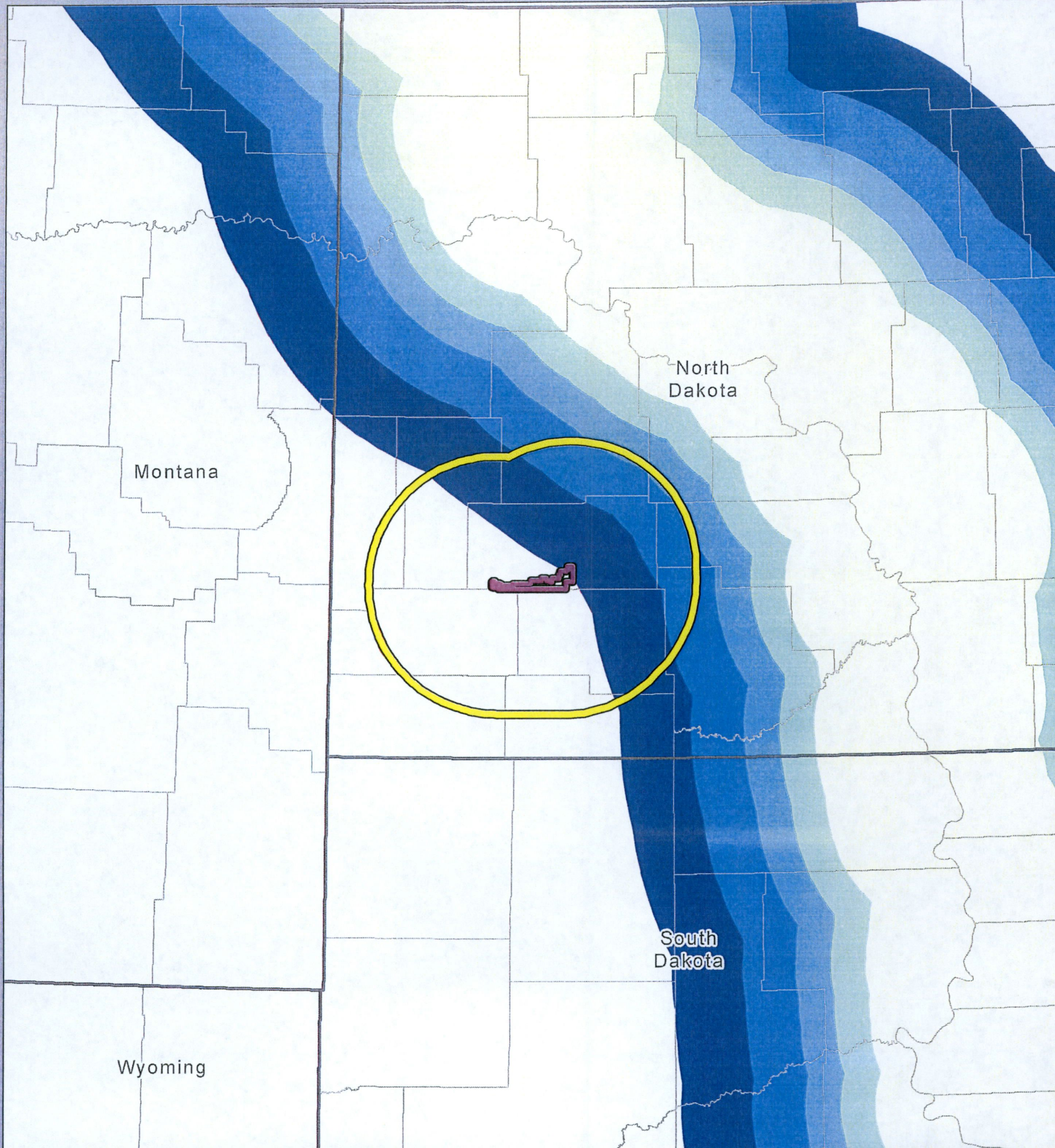

Legend

Proposed Project Area
35-mile Buffer Area
State Border
County Border

Percentage of Sightings Within the Whooping Crane Migration Corridor

75%
80%
85%
90%
95%

0 20 40 Miles
Scale is 1:2,500,000 when printed at 8.5x11"

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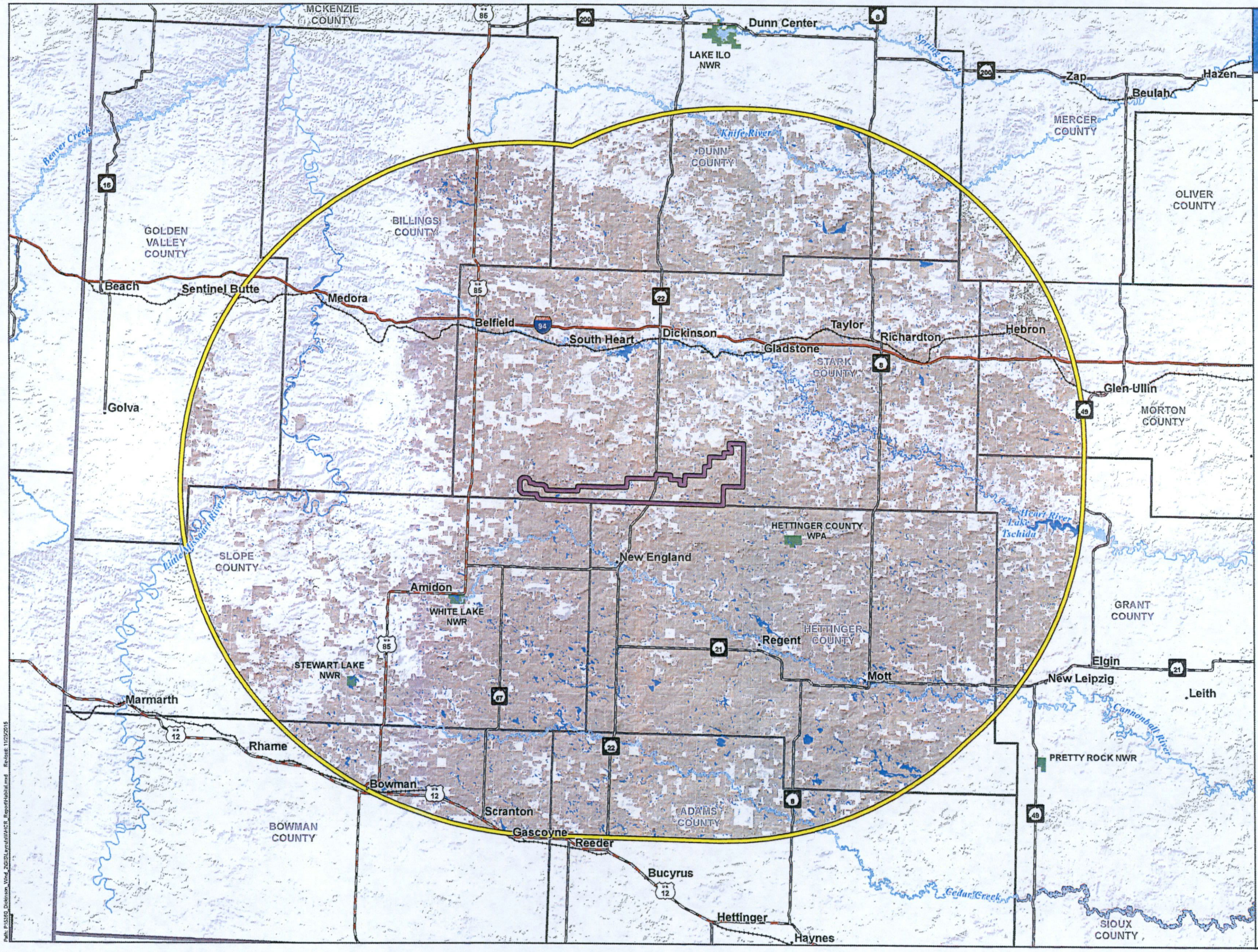
Brady Wind Energy Center

Stark County, ND

Figure 3
Whooping Crane Migration: North Dakota

TETRA TECH

NEXTera ENERGY RESOURCES



Brady Wind Energy Center

Stark County, ND

Figure 4
Whooping Crane Habitat Map

Legend

- Proposed Project Area
- 35-mile Buffer Area
- County Boundary
- Major River
- Wetland
- Wetland/Agricultural Matrix

Transportation

- Interstate Highway
- U.S. Highway
- State Highway
- Rail

Jurisdiction

- U.S. Fish and Wildlife Service

0 6 12
Miles
Scale is 1:300,000 when printed at 22 x 34

CANADA
North Dakota
SD

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Bat Habitat Assessment

Brady Wind Energy Center
Stark County, North Dakota

Prepared for:

Brady Wind, LLC

NEXTera ENERGY RESOURCES

February 2016

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1.0 INTRODUCTION

Brady Wind, LLC (Brady Wind), a wholly-owned, indirect subsidiary of NextEra Energy Resources, LLC (NextEra), is proposing to develop the Brady Wind Energy Center (Project) in Stark County, located in southwestern North Dakota approximately 15 miles south of the City of Dickinson (Figure 1). The Project has a proposed nameplate capacity of approximately 150 megawatts (MW), anticipated to consist of 80 GE 1.7-MW Xle wind turbine generators and 7 GE 1.79-MW Xle wind turbine generators. The Project also includes a planned approximately 19-mile, 230-kilovolt (kV) overhead transmission line. Additional Project facilities include access roads, electrical collection systems and cabling, a collection substation, an operation and maintenance (O&M) building, meteorological towers, a construction laydown area, and a temporary turbine storage area.

Brady Wind contracted Tetra Tech, Inc. (Tetra Tech) to evaluate the suitability of habitat within the Project for bats, with a focus on the federally listed threatened species, northern long-eared bat (*Myotis septentrionalis*; NLEB). We evaluated the area where wind turbines are proposed (Project Area; Figure 2) as well as a 1.5-mile buffer of the Project Area (Project Buffer; Figure 3)

The objectives of the habitat assessments were to:

- Evaluate habitat features within the Project Area and Project Buffer for bats using a desktop approach, focusing specifically on NLEB;
- Assess the likelihood of NLEB and other bat species occurring within the Project Area and Project Buffer based on known distributions and habitat requirements of bat species in the region.

In October 2013, the NLEB was proposed for listing as endangered under the federal ESA and was listed as threatened with an interim 4d rule in April 2015 (USFWS 2013, USFWS 2015b). Under the final Section 4(d) rule, incidental take of NLEB is prohibited within the U.S. Fish and Wildlife Service (USFWS) White-Nose Syndrome (WNS) zone, which includes all counties affected by WNS and an additional 150-mile (241-km) buffer around these counties (USFWS 2016b). Lethal take by operating wind turbines is specifically excluded from this prohibition. Take incidental to otherwise lawful activities is not prohibited outside of the WNS zone designated by USFWS. The Project Area is outside of the area in which incidental take due to hibernacula disturbance or tree removal is prohibited under the final 4d rule. Tetra Tech prepared this bat habitat assessment in accordance with USFWS recommendations for NLEB impact assessments (USFWS 2014b) and as part of Brady Wind's environmental due diligence for the Project. Tetra Tech examined publically available information and habitat requirements of NLEB and other bat species that may occur in the vicinity of the Project Area, the results of which are summarized in Section 3.0. Sections are subdivided into habitat suitability for NLEB and all bat species.

Letters were sent to USFWS and North Dakota Game and Fish (NDGF) on August 14, 2015 introducing the Project and requesting information on sensitive biological resources. NDGF responded in a letter dated September 25, 2015, with no specific mention of bats. No response from USFWS has been received to date.

2.0 BACKGROUND

This section describes the Project Area and includes background information on bats in the region, a summary of current information regarding bat interactions with wind energy projects, and a discussion of the legal and regulatory framework applicable to bats and wind energy.

2.1 Project Area Description

The 23,983-acre Project Area is located on privately owned lands in southwestern North Dakota and is approximately 15 miles south of Dickinson, less than 2 miles west of Lefor, and approximately 6 miles north of New England (Figure 1). The Project Area is located in the Missouri Plateau subregion of the Northwestern Great Plains Ecoregion (Bryce et al. 1996). Bedrock geology in the ecoregion is primarily sandstone and shale and geology within the vicinity of the Project Area is sandstone and siltstone (Bryce et al. 1996, NDGS and NDDH 2001; Figure 4). Due to the local geology and topography, caves do not form regularly in the sandstone and siltstone of the Project Area and there no known caves within the Project Area. The closest known caves are Bear Cave (11.5 miles to the southwest) and Snow Cave (28 miles to the southwest) (Murphy 2007; Figure 4).

Land use within the ecoregion is primarily dryland farming and cattle grazing. Coal mining in western North Dakota for lignite coal deposits is common and primarily done through surface mining although underground mines are also used (Figure 4; Murphy no date; NDPSC 2013). The topography of the region is a semiarid rolling plain (Bryce et al. 1996). Vegetation in the region was historically mixed-grass prairie with blue grama (*Bouteloua gracilis*), little bluestem (*Schizachyrium scoparium*), prairie sandreed (*Calamovilfa longifolia*), and a wheatgrass-needlegrass association (Bryce et al. 1996). Native grasslands occur in areas of steep topography.

Based upon the National Land Cover Database (NLCD) information for the Project Area, the current land use in the Project Area is primarily cultivated crops (54.8 percent) and grassland/herbaceous, which includes native prairie (24.8 percent) (Figure 2; Jin et al. 2013). There are no major rivers or lakes within the Project Area; however, the Project Area contains numerous small streams and wetlands that vary from shallow vegetated depressions, man-made cattle ponds, and intermittent creeks. The closest major river is the Cannonball River located approximately five miles to the southwest of the Project (Figure 1). There are few wetlands evident that are not associated with a stream system. Trees and forested areas are restricted mainly to riparian areas and windbreaks for fields and for residences scattered throughout the Project Area. The topography within the Project Area is primarily rolling plains and lacks prominent landscape features (e.g., hills, valleys); the elevation ranges from 2,527 to 2,920 feet above mean sea level.

2.2 Wind Energy and Bats

Bat mortality associated with wind turbine operations has been reported at locations around the world, including wind energy facilities in the United States (Kunz et al. 2007, Arnett et al. 2008, Rydell et al. 2010, Hayes 2013). Rates of overall bat mortality from wind turbines vary by region (Arnett et al. 2008, Baerwald and Barclay 2009, Cryan 2011, Hein et al. 2013). The highest numbers of fatalities reported in the United States are from wind energy facilities in the eastern U.S., particularly those located along forested ridges in the Appalachian region where annual mortality estimates have ranged from 20.8 to 69.6 bats per turbine per year, or 14.9 to 53.3 bats per MW per year (Arnett et al. 2008, Strickland et al. 2011). However, relatively high fatality estimates for bats also have been reported at wind energy facilities in agricultural settings in the central and Midwestern U.S. (Table 1; Jain 2005, Gruver et al. 2009, Poulton 2010).

Bat mortality at wind energy facilities is caused primarily by direct collision with moving turbine blades (Horn et al. 2008). There is little information about the indirect causal factors that influence bat mortality at wind energy facilities, although several hypotheses have been proposed (Kunz et al. 2007, Arnett et al. 2008, Cryan and Barclay 2009, Rydell et al. 2010). The current leading hypotheses are that bats are attracted to turbines for several reasons including as potential roosting locations (Kunz et al. 2007), potential pairing or mating sites (Cryan and Barclay 2009), or the potential accumulation of migratory insects around turbine rotors (Rydell et al. 2010). Thus, variables that may contribute to bat fatalities from wind turbines include, but are not limited to: the biology of the bat species, season, region, and turbine design (Kunz et al. 2007). Regardless of the specific causes of bat fatalities, two general patterns of fatalities are consistent across nearly all wind energy facilities:

1. Migratory tree-roosting bats represent the majority of fatalities; and
2. The majority of bat fatalities occur during late summer and early fall, coinciding with the fall migratory movements of bats (Arnett et al. 2008, Cryan 2011).

Some migratory bats travel long distances at altitudes that may overlap with the height of wind turbine blades, making them more susceptible to collisions. The probability of mortality events may also increase during periods of low wind speeds or low barometric pressure, which are conditions associated with increased bat activity (Arnett et al. 2008).

Tree bats, such as eastern red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), make long latitudinal migrations to warmer climates, and peaks in fatality rates appear to coincide with increasing bat activity levels associated with the southward migration of these species (Cryan 2003, Arnett et al. 2008). *Myotis* species are not considered particularly susceptible to direct mortality from wind turbines, but individuals, mostly little brown bat (*Myotis lucifugus*), have been found during mortality searches (Arnett et al. 2008, BHE Environmental 2011, Grodsky and Drake 2011).

NLEB may be most susceptible to impacts during the summer residency period if they are present and roosting habitat is cleared during wind project construction, as well as during the spring and fall periods when migrating bats, more likely to be flying within the rotor swept area (RSA), could collide with operational turbines. There are only 41 confirmed records of NLEB fatalities at wind energy facilities (USFWS 2015d). With the exception of the fatalities in Missouri, all known NLEB fatalities from wind energy facilities are located east of the Mississippi River (USFWS 2015b). The greatest numbers of NLEB have been found at wind energy facilities on forested ridge tops in West Virginia, where a total of seven fatalities have been documented (Kerns and Kerlinger 2004, Young et al. 2009). NLEB mortality has also been documented in New York, Pennsylvania, and Ontario, Canada (Arnett et al. 2005, Jacques Whitford 2009, Stantec 2011). Recently, WNS has caused large declines in populations of cave-hibernating species throughout eastern North America. WNS has been especially devastating to populations of species in the *Myotis* genus, including NLEB, prompting federal protection under the ESA for this species by USFWS (USFWS 2013, USFWS 2015b). In the final 4d rule, based on the small number of NLEB affected annually, USFWS concluded that adverse effects from wind energy and other activities will not lead to population-level declines of NLEB (USFWS 2016a).

Table 1. Estimates of Mean Bat Fatalities per Megawatt per Year at Wind Facilities in the northern Great Plains and Midwest Regions from Publicly Available Data.

Wind Facility[1]	State	Habitat	Turbine Model (turbine rotor-swept area)[2]	Estimated mean fatalities/MW/year	Bat Species Recorded as Fatalities (in order of decreasing frequency)	Source
Cedar Ridge	Wisconsin	Agricultural cropland	Unknown, 1.6MW (5,281 m^2)	30.40 (per 169 days)	hoary, silver-haired, big brown, eastern red, little brown	Poulton 2010
Blue Sky Green Field	Wisconsin	Agricultural cropland	Vestas V-82, 1.65MW (5,281 m^2)	24.57	little brown, silver-haired, big brown, hoary, eastern red, unidentified	Gruver et al. 2009
Forward Energy Center	Wisconsin	Agricultural cropland	GE 1.5MW (5,027 m^2)	15.63	hoary, silver-haired, eastern red, unidentified, little brown, big brown	Grodsky and Drake 2011
Top of Iowa (2004)	Iowa	Agricultural cropland	NEG Micon 52 (2,107.69 m^2)	7.94	hoary, little brown, eastern red , big brown, silver-haired	Jain 2005, Jain et al. 2011
Kewaunee County	Wisconsin	Agricultural cropland	Vestas 0.66MW (1,734 m^2)	6.45	eastern red bat, hoary bat	Howe et al. 2002
Top of Iowa (2003)	Iowa	Agricultural cropland	NEG Micon 52 (2,107.69 m^2)	4.94	hoary bat, little brown bat, eastern red bat, big brown bat, silver-haired bat	Jain 2005, Jain et al. 2011
Ainsworth	Nebraska	Mixed grass prairie	Vestas V82 (5,281 m^2)	1.16	hoary bat, unidentified bat species, big brown bat, eastern red bat	Derby et al. 2007
Oklahoma	Oklahoma	Mixed grass prairie	Unknown (4,657m^2)	0.79-1.06	Brazilian free-tailed, hoary bat, eastern red bat, eastern pipistrelle, cave myotis, silver-haired bat, big brown bat	Piorkowski and O'Connell 2010
Buffalo Gap II	Texas	Juniper-oak woodlands	1.5MW (Unknown)	0.14	Hoary bat, Brazilian free-tailed bat, unidentified	Tierney 2009

[1] Facilities arranged by estimated mean fatality/MW/year

[2]. If varying models were used in the Project, the largest rotor-swept area is given.

2.3 Regulatory Framework

Although the majority of bird species in the U.S. are protected under the federal Migratory Bird Treaty Act, and selected bird species or groups of species are protected under other statutes, there are relatively few laws or regulations that protect bats. At the federal level, there are no laws or regulations specific to bats; existing environmental laws primarily address the protection of habitat favored by bats, such as caves, and prohibit wanton destruction of wildlife. Bat species determined to be at risk are listed under the federal ESA or at the state level.

Federal Protection

Of the 45 species of bats known to occur in the continental U.S., six species and two subspecies are currently federally listed as endangered or threatened and protected under the ESA (USFWS 2015a): gray bat (*Myotis grisescens*), Indiana bat (M. *sodalis*), Florida bonneted bat (*Eumops floridanus*), Ozark big-eared bat (*Corynorhinus townsendii ingens*), Virginia big-eared bat (*C. t. virginianus*), lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae)*, Mexican long-nosed bat (L. *nivalis*), and NLEB. Of these species, only the NLEB is known to occur in North Dakota, although many areas of the state do not support suitable habitat for this species.

Northern Long-eared Bat

On April 2, 2015, the U.S. Fish and Wildlife Service (USFWS) announced that the NLEB was listed as threatened with an interim Section 4(d) rule. The intent of the 4(d) rule is to provide the USFWS flexibility in implementing the ESA by modifying regulations necessary to provide for the conservation of a threatened species while not overburdening private landowners, state agencies, and others with blanket regulations that do not further the conservation of the species. The 4(d) rule underwent a 60-day comment period when the proposed rule was first published on January 16, 2015, and a second 90-day public comment period on the interim rule to engage with stakeholders on whether additional exemptions should be included under the rule (USFWS 2015b). Comments were incorporated in a complete review pursuant to the National Environmental Policy Act (NEPA) leading to the final 4(d) rule released on January 14, 2016 (USFWS 2016a). The Service determined that White-Nose Syndrome (WNS) is the primary threat to NLEB and regulating other sources of mortality or harm, such as from habitat loss, will not effectively conserve this species. The final rule reduces the scope of incidental take of NLEB (USFWS 2016a), but protocols for implementing the rule are still being developed by USFWS Field Offices.

The final 4(d) rule prohibits all *purposeful take*[1] within the range of NLEB except: removal of NLEB from human structures, defense of human health (disease monitoring), or removal of hazardous trees for the protection of human life and property. All take incidental to otherwise lawful activities

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[1] "Purposeful take is when the reason for the activity or action is to conduct some form of take. For instance, conducting a research project that includes collecting and putting bands on bats is a form of purposeful take. Intentionally killing or harming bats is also purposeful take and is prohibited" (USFWS 2016c).

is allowed outside of the WNS zone designated by USFWS. The WNS zone includes all counties affected by WNS and an additional 150-mile buffer around these counties (Figure 5; USFWS 2016b).

For areas within the WNS zone, *incidental take*[2] is prohibited only if it occurs within a hibernaculum, if tree removal activities occur within a quarter-mile of a known, occupied hibernaculum at any time of year or within 150 feet of a known, occupied maternity roost tree from June 1 through July 31 (USFWS 2016a).

Under the final 4(d) rule, incidental take by wind turbines is not prohibited. Regulatory mechanisms for wind energy facilities were not included in the final 4(d) rule because the primary factor causing the rapid population decline in NLEB is WNS and the best available information suggests that NLEB fatalities caused by wind facilities are not contributing significantly to the species' decline. However, because harm to individual bats by turbines may occur, the USFWS recommends adopting voluntary protocols for best management practices, such as limiting operations of turbines in low-wind speed conditions during the fall bat migration season, to reduce impacts to bats (USFWS 2016a). The Project Area is outside of the WNS zone and therefore no forms of incidental take are prohibited; however, this area may change in the future if new occurrences of WNS are discovered. The USFWS database and WNS Zone Map is updated on a monthly basis[3] (Figure 5).

State Protection

The protection and regulation of bat species not listed under the federal ESA is typically at the discretion of state wildlife agencies. North Dakota does not have a state endangered or threatened species list, but NDGF has identified 100 species of conservation priority, or those in greatest need of conservation in the State (Dyke 2014) to aid in managing these species and prioritizing their conservation; however, these species are not afforded regulatory protection.

Species are categorized into three levels according to conservation need:

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

There are four bat species on the conservation priority list categorized as Level I: Townsend's big-eared bat (*Corynorhinus townsendii*), big brown bat (*Eptesicus fuscus*), little brown bat, and NLEB. Townsend's big-eared bat is rare and most suitable habitat in the state exists in the Little Missouri breaks, approximately 18.6 miles (30 km) west of the Project Area. Big brown bat and

[2] "Incidental take is defined by the Endangered Species Act as take that is incidental to, and not the purpose of the carrying out of an otherwise lawful activity. For example, harvesting trees can kill bats that are roosting in the trees, but the purpose of the activity is not to kill bats" (USFWS 2016c).
[3] http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf

little brown bat are common throughout the state while the northern long-eared bat is considered to be near the western edge of its range and rare in the state.

There are no bat species on the conservation priority list categorized as Level II.

There are three bat species on the conservation priority list categorized as Level III: western small-footed bat (*Myotis ciliolabrum)*, long-eared bat (*Myotis evotis)*, and long-legged bat (*Myotis volans*). These species are known to occur in western North Dakota.

Voluntary Guidelines for Wind Power Projects

The USFWS has developed Land-Based Wind Energy Guidelines (WEG; USFWS 2012), a non-regulatory, tiered framework for assessing risk and collecting data on wildlife for wind energy projects. These guidelines are voluntary. This bat habitat assessment is consistent with the USFWS recommendations for Tier 2 – Site Characterization in the voluntary WEG. North Dakota has not developed state-specific siting guidelines for wind power developers and other stakeholders for the consideration of potential wind power projects located in North Dakota but defers to the USFWS guidelines (ASFWA 2010).

3.0 SPECIES EXPECTED TO OCCUR IN THE PROJECT VICINITY

Tetra Tech evaluated the potential for all bats known to occur in North Dakota to use the Project Area, but with a focus on NLEB. Tetra Tech considered the suitability of the Project Area's habitat and habitats within a 1.5-mile buffer around the Project Area to develop the list of species expected to occur in the Project Area and vicinity. The 1.5-mile buffer is based upon the NLEB Interim Conference and Planning Guidance from the USFWS, and is the foraging range from roosts used to estimate home ranges for NLEB (USFWS 2014b).

Identifying if a species' constituent habitat elements for roosting and foraging occur in an area is key to determining habitat suitability (Duchamp et al. 2004). Habitat variables evaluated in this assessment included the amount of suitable foraging and roosting habitat, as well as potential migration and movement corridors in and near the Project Area. Habitat variables reviewed in the assessment included identification of the bat species known to occur in the region surrounding the Project Area and their behavioral characteristics relative to roosting, foraging, and migratory activity. This information was used to derive a high, moderate, or low likelihood of occurrence in the Project Area for each species with ranges overlapping the Project Area, and specifically the NLEB (see Table 2 for likelihood of occurrence criteria).

All Bat Species

A total of 11 bat species are known to occur in North Dakota (Table 2; BCI 2016, Gullickson *n.d.*). Of these 11 species, available information about species-specific suitable habitat, known distribution ranges, and documented occurrences indicate that five species (big brown bat, little brown bat, red bat, hoary bat, and silver-haired bat) are expected to have a moderate or high potential to occur within, and in the vicinity of the Project Area, and the remaining six species (Townsend's big-eared bat, fringed bat [*Myotis thysanodes*], long-eared bat, long-legged bat, western small-footed bat, and NLEB) are expected to have a low potential of occurrence.

Roosting colonies of big brown bat and little brown bat have a high probability of occurring within the Project Area because of their known association with edge habitats and human-made structures (Table 2). Little brown bats are thought to be the most common bat in North Dakota (Gullickson *n.d.*). In addition, big brown bats are known to forage in agricultural lands (Whitaker 1995; Rogers et al. 2006). Both species have been documented as fatalities at wind energy projects (Arnett et al. 2008).

Eastern red bat, hoary bat, and silver-haired bat have a moderate likelihood of occurring in the Project Area, primarily during migration. These species have been the predominant species found during post-construction mortality studies at operational wind energy facilities in North America (Arnett et al. 2008). The eastern red bat, hoary bat, and silver-haired bat are all associated with forested habitats and would most likely occur in small woodlots while moving through the Project Area during migration (Table 2). Each of these species are found in North Dakota from May through September (Cryan 2003, Cryan and Veilleux 2007).

The remaining species found in North Dakota (Townsend's big-eared bat, fringed bat, long-eared bat, long-legged bat, western small-footed bat, and NLEB) are expected to have a low likelihood of occurrence in the Project Area based upon species range, known habitat associations, and occurrence of similar habitats within the Project Area.

Northern Long-eared Bat

NLEB are expected to have a low likelihood of occurrence within the Project Area and Project Buffer during the summer residency period and during migration due to lack of suitable habitat and distance to known occurrences. The species' range includes Stark County (USFWS 2013, USFWS2015b, BCI 2016; Figure 5). Few data are available on NLEB in North Dakota; however, the species is believed to occur statewide in suitable habitats (Harvey et al. 2011; Gullickson *n.d.*). Surveys conducted in the summers of 2009, 2010, and 2011, confirmed the presence of NLEB in the Turtle Mountains (approximately 200 miles northeast of the Project), Missouri River Valley (approximately 50 miles northeast of the Project), and in the Badlands regions (approximately 200 miles south of the Project; Gilliam and Barnhart 2011). The species has recently been detected in Billings and Hettinger counties (Gilliam and Barnhart 2011, WAPA and USFWS 2015), and could occur in the Project Area during seasonal movements to and from hibernacula; however, no hibernacula are known to occur in the state.

Table 2. Bat Species Known to Occur in North Dakota and their Likelihood of Occurrence at the Brady Wind Energy Center, Stark County, North Dakota.

Likelihood of Occurrence[1]	Common Name	Scientific Name	Habitat Association[2]	Wind-energy Fatalities
High	Little brown bat	*Myotis lucifugus*	Found in close proximity to a water source for foraging and in close proximity to human-made structures. Roosts in tree cavities, caves and human-occupied structures.	Relatively few fatalities documented in North America (Arnett et al. 2008)
High	Big brown bat	*Eptesicus fuscus*	Habitat generalist found in deciduous forests, urban development, and agricultural croplands. Roosts in tree cavities, under loose bark, buildings, mines, bridges, caves, and crevices in cliff faces.	Relatively few fatalities documented in North America (Arnett et al. 2008).
Moderate	Eastern red bat	*Lasiurus borealis*	Migratory Species. Found in hardwood deciduous forests. Generally found in close association with riparian areas. Roosts in foliage of trees.	One of most common fatalities documented in North America; fatalities assumed to be migratory individuals (Johnson et al. 2002, Kunz et al. 2007)
Moderate	Hoary bat	*Lasiurus cinereus*	Migratory Species. Forested upland habitats, including bottomland hardwoods. Roosts in foliage of trees along the edge of clearings.	Most common fatality documented in North America; fatalities assumed to be migratory individuals (Kunz et al. 2007, Arnett et al. 2008)
Moderate	Silver-haired bat	*Lasionycteris noctivagans*	Migratory Species. Closely associated with conifer and mixed hardwood forests; Generally found in association with riparian areas. Roosts in foliage of trees.	One of most common fatalities in North America; fatalities assumed to be migratory individuals (Johnson et al. 2002, Kunz et al. 2007)
Low	Fringed bat	*Myotis thysanodes*	Found in a variety of habitats. Oak and pinyon woodlands are the most commonly used. Roosts in caves, mines, and buildings.	None documented
Low	Long-eared bat	Myotis evotis	Found associated with caves and mines, and closely associated with human-made structures	None documented
Low	Long-legged bat	*Myotis volans*	Found in rugged, rocky terrain in variety of habitats. Roosts in trees, rock crevices, and buildings.	None documented
Low	Northern long-eared bat	*Myotis septentrionalis*	Forages along forested hillsides and ridges. Roosts in cavities, caves and mines, underneath bark, or in crevices of trees and snags; rarely roosting in barns. Hibernate in caves and mines.	Relatively few fatalities documented in North America (Arnett et al. 2008)
Low	Townsend's big-eared bat	*Corynorhinus townsendii*	Typically found in arid western desert scrub and pine forest regions. In spring and summer, females form maternity colonies and males roost individually. Hibernates in caves and abandoned mines.	None documented
Low	Western small-footed bat	*Myotis ciliolabrum*	Found in rugged, rocky terrain in variety of habitats. Roosts in rock crevices, caves, tunnels, buildings, and underneath bark.	None documented

[1] Likelihood of Occurrence: **High** = Suitable habitat, species range overlaps with the Project Area, and known occurrences within and/or near the Project Area. **Moderate** = Species known to occur in habitat similar to the Project Area, species' range overlaps with Project Area, and known occurrences near the Project Area. **Low** = Marginally suitable habitat in the Project Area, species' range does not overlap with the Project Area, no known occurrences within and/or near the Project Area, and/or known as migratory species during spring and fall migration.

[2] Sources: Gullickson *n.d.*, Western Bat Working Group 2005, Harvey et al. 2011, Bat Conservation International (BCI) 2016, American Society of Mammologists 2015.

4.0 HABITAT ASSESSMENT

The habitat assessment was conducted via a desktop evaluation of land cover and land uses within the Project Area and a 1.5-mile buffer (Figures 2 and 3). Identification of suitable habitats in the Project Area, and the bat species that may use these habitats, may prove helpful when designing the Project to minimize interactions between wind turbines and bats (Duchamp et al. 2004). Habitat variables evaluated in this assessment included the amount of suitable foraging and roosting habitat, as well as potential migration and movement corridors in and near the Project Area.

Although there are still substantive information gaps on bat migration patterns across North America, there is speculation that bats migrate in a similar manner to some birds (i.e. possibly as broad-frontal migration; Cryan 2003). Migratory bats moving through the Project Area during migration may be at risk of colliding with wind turbines regardless of habitat conditions. The likelihood of mortality or other impacts during migration on NLEB, and other bats, is difficult to determine based on available data.

4.1 Land Use and Land Cover

Land use and land cover types in the Project Area and Project Buffer were characterized using the National Land Cover Database in Geographic Information System software (Jin et al. 2013). Habitats were compared between the Project Area and Project Buffer to understand if bats would be likely to select habitat within the Project Area in the context of the surrounding landscape. For example, if the Project Area supported a relatively higher concentration of suitable habitat areas than the Project Buffer, it is possible the site would concentrate bats in densities slightly higher than the surrounding areas.

The Project Area and Project Buffer contain the same land uses and cover types and based on the percentage of cover types available in the Project Area versus the Project Buffer. It is unlikely that bats would use the Project Area disproportionately for roosting or foraging over other areas in the vicinity. The percentage of suitable bat habitat cover types (shown in bold in Table 3) are similar between the Project Area and the Project Buffer. Although the Project Buffer is larger than the Project Area, both are dominated (≥80 percent) by cultivated crops and grassland/herbaceous cover types. The majority of cover within the Project Area is cultivated crops (54.8 percent) and grassland/herbaceous (24.8 percent), as is the majority of cover within the Buffer Area (59.0 percent cultivated crops and 26.9 percent grassland/herbaceous). Suitable bat habitat (open water, emergent herbaceous wetlands, deciduous forest, evergreen forest, mixed forest, shrub/scrub, and woody wetlands) comprises 2.0 percent of the total Project Area and 1.8 percent of the Project Buffer.

Table 3. Land Use and Land Cover Present in the Project Area and Project Buffer, Stark County, North Dakota.

Land Use/Land Cover Description	Acres in Project Area	Percent of Project Area	Acres in Project Buffer	Percent of Project Buffer
Cultivated Crops	16,447	54.8	28,585	59.0
Grassland/Herbaceous	7,452	24.8	13,026	26.9
Pasture/Hay	4,296	14.3	4,045	8.4
Developed, Open Space	1,195	3.9	1,814	3.7
Developed, Low Intensity	20	Less than 0.1	140	0.3
Developed, Medium Intensity	2	Less than 0.1	1	Less than 0.1
Shrub/Scrub	**273**	**0.9**	**349**	**0.7**
Woody Wetlands	**213**	**0.7**	**343**	**0.7**
Deciduous Forest	**29**	**Less than 0.1**	**67**	**0.1**
Emergent Herbaceous Wetlands	**21**	**Less than 0.1**	**6**	**Less than 0.1**
Evergreen Forest	**2**	**Less than 0.1**	**3**	**Less than 0.1**
Open Water	**30**	**Less than 0.1**	**26**	**Less than 0.1**
Barren Land (Rock/Sand/Clay)	4	Less than 0.1	5	Less than 0.1
Total	29,983		48,410	

Note: **Bold** text indicates habitat types that are most suitable for bat foraging and roosting habitat.

4.2 Roosting Habitat

Non-migratory bats use caves or similar habitat for winter hibernacula, and then disperse onto the landscape for the active period (typically April 15 – November 15) and shelter in "summer roosts". Similarly, migratory bats migrate north from wintering areas and use some of the same habitat features (e.g., tree cavities and bark) as non-migratory species during the summer. This section describes summer roosting habitat in the Project Area; winter hibernacula are discussed in Section 4.3. Summer roosts provide important shelter from the environment and adverse weather, resting places during migration or regional movements, protection from predators, and are used for social interaction and rearing of young. Due to bats' dependence on roost structures during all stages of their life cycle; the preservation of summer roosting habitat, as well as winter hibernacula, has been identified as critical for the conservation of bats in North America (Kunz 1982, Kunz and Fenton 2003).

All Bat Species

Bats may roost in rock formations, caves, human-made structures, live trees (often in the foliage), dead trees (snags), and partially dead trees (partial snags) with cavities and loose bark. North Dakota's species can be broadly classified as tree-roosting bats (those that roost in live trees, snags, and partial snags) and species adapted to roosting in multiple habitats (generalists that roost in natural habitat, but also frequently roost in human-made structures such as barns) (Harvey et al. 2011).

Most tree-roosting species (including silver-haired bat) prefer trees that are large enough to contain colonies and sustain adequate temperatures, which are often found in older forest stands

(Crampton and Barclay 1998, Barclay and Brigham 1996). Migratory tree bats (hoary bat and eastern red bat) often prefer to roost in the foliage of live trees (Kunz 1982, Harvey et al. 2011), and NLEB may also roost in live trees that contain cavities. Suitable natural roosting habitats in the Project Area are limited to individual trees, windrows, woodlots, and riparian zones. These wooded locations are generally near homes, along riparian corridors, or are planted windbreaks. The availability of tree-roosting habitat in the Project Area is limited due to the small size and fragmented nature of the wooded habitat and accounts for less than 1 percent of the Project Area. Therefore, roost tree availability is almost certainly a limiting factor to the occurrence of bats in the Project Area (Carter and Menzel 2007).

In addition to trees, potential roosting locations are also available in farmstead buildings (houses, barns, etc.). The suitability of these man-made structures has not been evaluated. However, they are present in the Project Area and Project Buffer and could potentially be used by roosting bats. There are no known abandoned mines within the Project Area that bats could use for roosting (Figure 4; NDPSC 2013).

Northern Long-eared Bat

During the spring, summer, and early fall, NLEB roost in suitable forest habitat typically within 50 miles of wintering sites (USFWS 2013). Like other North American forest bats, reproductive NLEB females will roost colonially during the late-spring and summer maternity period (approximately May to July). Maternity colonies (averaging 30–60 individuals) are most frequently found in mature forests, with a higher abundance of standing dead trees (snags), but the species also may roost in partially live or live mature trees. NLEB typically roost in the bark or cavities of trees, versus foliage like other tree bats (USFWS 2015b). Both male and female NLEB generally prefer dead trees or live trees in early stages of decline (USFWS 2015b). Less commonly, NLEB summer day roost sites may also include human-made structures, including a variety of shelters such as buildings, behind shutters, under live tree bark, and in small tree cavities (Harvey et al. 2011). Roosts are often used for a period of 2–11 nights, but maternity colonies may be occupied for longer. Because of NLEBs' preference for switching roosts, multiple suitable roosting locations in a given forested patch may be indicative of higher quality summer habitat. Summer home ranges for females are estimated to be between 47 and 425 acres (USFWS 2013).

There is no interior forest habitat (wooded habitat at least 300 feet from non-forest land cover) among 17 forested areas in the Project Area and none within the Project Buffer. The majority of forests within the Project Area are associated with riparian areas rather than ridges, which are preferred by NLEB (USFWS 2014b). The only potentially suitable NLEB roosting habitat in the Project Area consists of trees associated with riparian features and small woodlots or windbreaks near homesteads. Although these sites do contain suitable roost trees, they are isolated and not connected with or contiguous to other forest patches and account for less than 0.3 percent of the Project Area. Average forest patch size in the Project Area is approximately 1.1 acres and the average forest patch size in the Buffer Area is approximately 1.0 acres. There is evidence suggesting that NLEB select forest patches with greater connectivity to other patches and larger forest patches with a closed canopy (mature forests) than those available in the Project Area (USFWS 2015b, USFWS 2013).

4.3 Winter Habitat

Of the bat species with a moderate or high likelihood of occurring in the Project Area, silver-haired bat, hoary bat, and eastern red bat migrate to southern latitudes during winters. The remaining species, big brown bat and little brown bat, hibernate locally or regionally. The northern long-eared bat also hibernates locally. This section focuses on winter habitat for NLEB in the Project Area vicinity, and briefly touches on the suitability of winter habitat for other species as well.

Northern Long-eared Bat

NLEB do not undertake long-distance seasonal migrations between summer and winter ranges but do undertake shorter distance movements between summer roosts and winter hibernacula. These seasonal movements are generally between 35 miles and 55 miles, but may be substantially longer in some areas, perhaps as great as 168 miles (USFWS 2013). Information on habitat use during migration is limited, but individuals in transit are likely to use foraging habitats at least part of the time.

NLEB arrive at hibernacula in August or September, begin hibernation in October and November, and exit hibernacula in March or April (USFWS 2013). NLEB prefers hibernacula with large entrances such as caves and mines, as well as less traditional hibernacula including dams, dry wells, and other human-made structures. Individuals may hibernate in cracks and crevices in hibernacula walls, and as such, may be overlooked during winter surveys. Although NLEB are often found with other congeneric species (i.e. *Myotis* spp.), they generally prefer cooler temperatures and higher humidity (USFWS 2013). Hibernacula where NLEB occur may also be used by big brown bat and little brown bat, and possibly western small-footed bat (*Myotis ciliolabrum*; Brack et al. 2010).

There were no caves or other natural rock or crevice formations in the Project Area or Project Buffer that would be suitable hibernacula (Murphy 2007, NDGS and NDDH 2001). All known caves are greater than 11 miles from the Project Area. The closest caves are Bear Cave, approximately 11.5 miles to the southwest, and Snow Cave, approximately 28 miles to the southwest (Figure 4). Bear Cave extends only 12 feet into the rock and Snow Cave has been destroyed by falling rock and erosion (Murphy 2007). There are no abandoned mines within the Project Area; the closest mines that could provide potential roosting habitat for bats are approximately five miles south of the Project Area (Figure 4; NDPSC 2013). The suitability of these mines for roosting bats is unknown. No known hibernacula for NLEB have been documented in North Dakota, although a thorough assessment of potential hibernacula in western North Dakota has not been completed (USFWS 2013). The closest known hibernacula occur in the Black Hills of Wyoming and South Dakota over 150 miles to the southwest (USFWS 2013).

4.4 Foraging Habitat

Foraging habitats are not necessarily exclusive of roosting or migrating habitat. However, there are notable preferences among species for different foraging habitats, which are often different from preferred roosting locations (Harvey et al. 2011).

All Bat Species

All bats known to occur in North Dakota are insectivorous, and feed on a variety of prey, including moths, beetles, flies, and mosquitoes (Kunz and Fenton 2003). Bats typically forage in areas with high prey concentrations (i.e. high nocturnal insect densities) in riparian areas (Waldien and Hayes 2001), over waterbodies (Henry et al. 2002, Lacki et al. 2007), and along forest edges (Hayes and Gruver 2000, Rogers et al. 2006). Non-developed and non-agricultural types of habitats (open water, forested, wetlands, and scrub/shrub) provide the best foraging opportunities for bats and account for less than 2.0 percent of the Project Area. Although there is some evidence to indicate that some species, such as the big brown bat, prefer foraging over agricultural lands (Rogers et al. 2006, BCI 2016), agricultural lands (cultivated crops and pasture/hay) within the Project Area are typically the least suitable locations for foraging and account for approximately 69 percent of the Project Area.

Northern Long-eared Bats

Unlike other *Myotis* in the region that typically forage along streams and within floodplains, NLEB are adapted to gleaning and hawking for insects in the sub-canopy of deciduous and mixed forests and therefore typically forage along ridge tops and forested hillsides (Harvey et al. 2011). However, foraging may also occur in forest clearings, above roadways, and along trails or near water (USFWS 2013). Agricultural lands within the Project Area (approximately 55 percent of the land cover) are the least suitable locations for NLEB foraging. Suitable foraging habitat for NLEB includes forested areas, wind breaks, riparian corridors, and open water areas in the Project Area. This suitable foraging habitat accounts for 1.3 percent of the Project Area, which is a small percentage of overall land cover.

4.5 Bat Migration and Movement Characteristics

Bat migration includes seasonal movement from summer residency areas to wintering areas. Wintering areas for long-distance migrants are typically in southern latitudes (Fleming and Eby 2003). Long-distance migratory bats such as the eastern red bat, silver-haired bat, and hoary bat undertake seasonal movements greater than 62 miles and less than 1,200 miles (Cryan 2003, Cryan 2011). Wintering areas for other species include natural or man-made hibernacula (Fleming and Eby 2003). NLEB, little brown bat, and others migrate short distances from summer colonies to winter hibernacula (i.e. partial or short-distance migration) (Fleming and Eby 2003). Most species, including NLEB, are thought to move along linear landscape features that connect habitats, such as horizontal forest features, (e.g., forest edges), vertical forest features (e.g., between forest canopy structures), or riparian corridors (Hayes and Gruver 2000, Downs and Racey 2006, Furmankiewicz and Kucharska 2009). Beyond these generalities, the current understanding of bat migration is limited (Baerwald and Barclay 2009, Cryan 2011).

NLEB and other species may fly thorough the Project Area during spring and fall migration en route to hibernacula. The Project Area contains small forested riparian corridors that bats could follow or use as day roosting sites, although these are not significant features from a regional perspective. The limited roosting habitat within the Project Area is a major limiting factor for use of the Project Area by migrating bats. Therefore, bat migration through the Project Area is likely low in magnitude.

5.0 NORTHERN LONG-EARED BAT HABITAT SUITABILITY CONCLUSION

The NLEB Guidance (USFWS 2014b) includes a stepwise assessment approach with specific questions intended to facilitate review of potential impacts to the species. The following questions (in bold) and responses are based on our current knowledge of the Project Area and the results of the 2015 desktop habitat assessment. Sections 4.1 – 4.5 provide information requested by USFWS for habitat assessments, as part of the NLEB interim guidance (USFWS 2014b, USFWS 2015e).

Is the project within the range of NLEB?

Yes. The Project Area is within the range of NLEB (Gullickson *n.d.*, Harvey et al. 2011, USFWS 2014a, USFWS 2016b).

Is suitable summer or winter habitat present?

The proposed Project Area is located in the Northern Great Plains ecoregion, which has been intensively cultivated but historically consisted of prairie habitat. In this ecoregion forested habitat is almost exclusively associated with human development (e.g., wind breaks), lakesides, and riparian areas.

Approximately 1 percent of the 23,983-acre Project Area is forested. Forested habitat in the Project Area (woody wetlands, evergreen forest, mixed forest, deciduous forest) is relegated to small woodlots that are disconnectedly distributed along riparian areas, as woody wetlands, and as windbreaks along fields or at homesteads. Large, contiguous tracks of upland forested habitat, preferred by NLEB, are not present in the Project Area.

Based on the desktop habitat assessment, the NLEB has a low likelihood to occur in the Project Area during the summer residency period (approximately May 15–August 15) because of the lack of large contiguous woodlots and due to the species being uncommon in the far western extent of its range, which includes the Project Area. The species could occur in the Project Area during seasonal movements to hibernacula. Although we have not assessed the Project Area for potential winter hibernacula, Tetra Tech is not aware of any available data that indicate the occurrence of NLEB hibernacula in western North Dakota and no hibernacula are known in the state (USFWS 2013).

Is lethal take during migration possible?

NLEB have been found during mortality searches at wind energy facilities (e.g., Arnett et al. 2005, Jacques Whitford 2009), so lethal take is possible if NLEB migrate through the

Project. However, the occurrence of the species in North Dakota, including potential winter hibernacula, is poorly understood and NLEB are expected to be uncommon or rare in western North Dakota (USFWS 2013). Therefore, the likelihood of NLEB occurring in the Project Area during the summer residency period is low. No clear migratory pathways, or known hibernacula are in the Project Area or vicinity; however, migration patterns are poorly understood. The likelihood of the species occurring during the migration period (spring and fall) is expected to be low because of distance to known hibernacula and low availability of suitable foraging or roosting habitat in the Project Area and Project Buffer. With the exception of fatalities in Missouri, records of NLEB mortalities at wind energy facilities are from projects east of the Mississippi River.

Is there an existing summer or winter occurrence record near the Project Area (e.g., within 1.5 miles of a known roost tree, 3 miles of capture location, or 5 miles of a hibernaculum)?

Tetra Tech is not aware of any existing summer or winter occurrence records within 5 miles of the Project Area.

Was the presence of NLEB documented during surveys?

Bat acoustic surveys for NLEB were not included in this scope of work.

Is this an existing or ongoing project within the range of the Indiana bat with a prior determination for Indiana bat?

No. The Project Area is outside of the range of the Indiana bat.

5.1 Critical Habitat for Listed Species

At the time this report was prepared, the USFWS has not designated or proposed any critical habitat for NLEB and no bats with designated critical habitat occur within the Project Area (USFWS 2013, USFWS 2015b). If USFWS designates critical habitat for NLEB, designated areas would likely consist of large well-known hibernacula, similar to critical habitat designated for the Indiana bat.

6.0 SUMMARY

There is little suitable roosting or foraging habitat in the Project Area or within the Project Buffer for the NLEB. There is slightly more suitable roosting and foraging habitat for other bat species, primarily big brown bat and little brown bat, in the Project Area and the Project Buffer. The small size and small number of wooded parcels in the Project Area and the Project Buffer likely limits the density and diversity of bats in the Project Area. Because of this lack of forested habitat within the Project Area and Project Buffer and the location of the Project Area at the edge of the species' range, NLEB have a low likelihood of occurring in the Project Area. There are no known NLEB hibernacula in North Dakota and the NLEB is considered to be rare in the state (USFWS 2013, Dyke 2014).

7.0 LITERATURE CITED

Arnett, E.B., W.P. Erickson, J. Kerns, and J. Horn. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality and Behavioral Interactions with Turbines. Prepared for Bats and Wind Cooperative. 187 pgs.

Arnett, E.B., W.K. Brown, W.P. Erickson, K.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T.J. O'Connell, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. *Journal of Wildlife Management* 72:61–78.

American Society of Mammologists (ASM). 2015. Mammals of North Dakota. Available online at: http://www.mammalsociety.org/mammals-north-dakota. Accessed January 2015.

Association of Fish and Wildlife Agencies (ASFWA). 2010. Federal and State Wind Energy Siting Guidelines: North Dakota. Available online at: http://www.fishwildlife.org/files/North_Dakota.pdf. Accessed January 2015

Baerwald, E.F. and R.M.R. Barclay. 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. *Journal of Mammalogy* 90:1341–1349.

Barclay, R.M.R. and M.R. Brigham (eds). 1996. Bats and Forests Symposium, October 19–21, 1995, Victoria, British Columbia, Canada. Ministry of Forests Research Program, Victoria, B.C. Work Paper 23.1996.

Bat Conservation International (BCI). 2016. Species profiles. Available online at http://www.batcon.org/index.php/resources/media-education/species-profiles. Accessed February 2016.

BHE Environmental, Inc. 2011. Post-Construction Bird and Bat Mortality Study: Cedar Ridge Wind Farm, Fond Du Lac County, Wisconsin Final Report prepared for Wisconsin Power and Light, Madison, Wisconsin. Prepared by BHE Environmental, Inc. Cincinnati, Ohio. February 2011.

Brack Jr., V., D. W. Sparks, J. O. Whitaker Jr., B. L. Walters, and A. Boyer. 2010. Bats of Ohio. Indiana State University Center for North American Bat Research and Conservation. 92 pp.

Bryce, S.A., J.M. Omernik, D.A. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S.H. Azevedo. 1996. Ecoregions of North Dakota and South Dakota, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Carter, T.C. and J.M. Menzel. 2007. Behavior and day-roosting ecology of North American foliage-roosting bats. Pages 61-82 in J. P. H. M.J. Lacki, and A. Kurta, editor. Bats in Forests: Conservation and Management. The Johns Hopkins University Press, Baltimore, MD.

Crampton, L.H. and R.M.R. Barclay. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12:1347–1358.

Cryan, P.M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. Journal of Mammalogy 84:579–593.

Cryan, P.M. 2011. Wind Turbines as Landscape Impediments to the Migratory Connectivity of Bats. Environmental Law 41: 355-370.

Cryan, P. M. and J. P. Veilleux. 2007. Migration and use of autumn, winter and spring roosts by tree bats. Pages 153–176 *in* Bats in Forests: Conservation and Management, eds. J. P. H. M.J. Lacki, and A. Kurta. Baltimore, MD, The Johns Hopkins University Press.

Cryan, P.M. and R.M.R. Barclay. 2009. Causes of bat fatalities at wind turbines: hypotheses and predictions. Journal of Mammalogy 90:1330–1340.

Derby, C., A. Dahl, W. Erickson, K. Bay, and J. Hoban. 2007. Post-Construction Monitoring Report for Avian and Bat Mortality at the NPPD Ainsworth Wind Farm. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, for the Nebraska Public Power District.

Downs, N.C. and P.A. Racey. 2006. The use by bats of habitat features in mixed farmland in Scotland. Acta Chiropterologica 8:169–185.

Duchamp, J.E., D.W. Sparks, and J.O. Whitaker Jr. 2004. Foraging-habitat selection by bats at an urban-rural interface: comparisons between a successful and a less successful species. Canadian Journal of Zoology 82:1157–1164.

Dyke, S. 2014. North Dakota Species of Conservation Priority: 2014 List Update. Available online at: http://gf.nd.gov/magazines/june-2014/north-dakota-species-conservation-priority.

Fleming, T.H. and P. Eby. 2003. Ecology of bat migration. *In* T.H. Kunz and M.B. Fenton (eds.). Bat Ecology. University of Chicago Press, Chicago, Illinois.

Furmankiewicz, J. and M. Kucharska. 2009. Migration of bats along a large river valley in southwestern Poland. Journal of Mammalogy 90:1310–1317.

Gilliam, E. and P. Barnhart. 2011. Distribution and habitat use of the bats of North Dakota, Final Report prepared for the North Dakota Game and Fish Department.

Grodsky, S.M. and D. Drake. 2011. Assessing Bird and Bat Mortality at the Forward Energy Center. Final Report. Public Service Commission (PSC) of Wisconsin. PSC REF#:152052. Prepared for Forward Energy LLC. Prepared by Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, Wisconsin. August 2011.

Gruver, J., M. Sonnenburg, K. Bay, and W. Erickson. 2009. Post-Construction Bat and Bird Fatality Study at the Blue Sky Green Field Wind Energy Center, Fond Du Lac County, Wisconsin July 21 – October 31, 2008 and March 15 – June 4, 2009. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. December 17, 2009.

Gullickson, G. *no date.* Bats of North Dakota. North Dakota Game and Fish and Bat Conservation International.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 2011. Bats of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD. USA. .

Hayes, J.P., and J.C. Gruver. 2000. Vertical stratification of activity of bats in an old-growth forest in western Washington. Northwest Science 74:102–108.

Hayes, M. A. 2013. Bats Killed in Large Numbers at United States Wind Energy Facilities. *BioScience*: 63(12).

Hein, C. D., J. Gruver, and E.B. Arnett. 2013. Relating Pre-Construction Bat Activity and Post-Construction Bat Fatality to Predict Risk at Wind Energy Facilities: A Synthesis. Prepared for the National Renewable Energy Laboratory, Golden, CO. March 2013.

Henry, M., D. W. Thomas, R. Vaudry, and M. Carrier. 2002. Foraging distances and home range of pregnant and lactating little brown bats (*Myotis lucifugus*). Journal of Mammalogy 83:767–774.

Horn, J.W., E.B. Arnett, and T.H. Kunz. 2008. Behavioral responses of bats to operating wind turbines. Journal of Wildlife Management 72:123-132.

Howe, R.W., W. Evans, and A.T. Wolf. 2002. Effects of wind turbines on birds and bats in northeastern Wisconsin. Prepared by University of Wisconsin-Green Bay, for Wisconsin Public Service Corporation and Madison Gas and Electric Company, Madison, Wisconsin. November 21, 2002.

Jacques Whitford Stantec Limited (Jacques Whitford). 2009. Ripley Wind Power Project Post-construction Monitoring Report. Project No. 1037529.01. Report to Suncor Energy Products Inc., Calgary, Alberta, and Acciona Energy Products Inc., Calgary, Alberta. Prepared for the Ripley Wind Power Project Post-Construction Monitoring Program. Prepared by Jacques Whitford, Markham, Ontario. April 30, 2009.

Jain, A.A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. M.S. Thesis. Iowa State University, Ames, Iowa.

Jain, A.A., R.R. Koford, A.W. Hancock, and G.G. Zenner. 2011. Bat Mortality and Activity at a Northern Iowa Wind Resource Area. American Midland Naturalist 165:185200.

Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., and Xian, G. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment 132:159–175. Available online at http://www.mrlc.gov/nlcd2011.php

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879–887.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collisions at the Mountaineer Wind Energy Facility, Tucker County, West Virginia: Annual Report for 2003. Prepared for FPL Energy and the Mountaineer Wind Energy Center Technical Review Committee. February 14, 2004. Technical report prepared by Curry and Kerlinger, LLC., for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee. Curry and Kerlinger, LLC. 39 pp. http://www.wvhighlands.org/Birds/MountaineerFinalAvianRpt-%203-15-04PKJK.pdf

Kunz, T.H. 1982. Roosting Ecology of Bats. *In* Ecology of Bats. T.H. Kunz (ed.) Plenum Publishing Corporation, New York, New York.

Kunz, T.H. and M.B. Fenton (eds.). 2003. Bat Ecology. The University of Chicago Press. Chicago, Illinois.

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R. P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecological Environments 5:315-324.

Lacki, M.J., Hayes, J.P., and A. Kurta. 2007. Bats in Forests: Conservation and Management. The Johns Hopkins University Press. Baltimore, Maryland.

Murphy, E. 2007. Caves in North Dakota. Available online at: https://www.dmr.nd.gov/ndgs/ndnotes/caves/caves_h.asp. Accessed February 2015.

Murphy, E. no date. Mineral Resources of North Dakota: Coal. North Dakota Geological Survey. Available online at: https://www.dmr.nd.gov/ndgs/mineral/nd_coalnew.asp. Accessed February 2015.

NDPSC (North Dakota Public Service Commission). 2013. Abandoned Mines. Available online at: https://apps.nd.gov/hubdataportal/srv/en/main.home

NDGS and NDDH (North Dakota Geological Survey and North Dakota Department of Health). 2001. Bedrock Geology. Available online at: https://apps.nd.gov/hubdataportal/srv/en/main.home

Piorkowski, M., and T. O'Connell. 2010. Spatial Pattern of Summer Bat Mortality from Collisions with Wind Turbines in Mixed-grass Prairie. American Midland Naturalist 164:260-269.

Poulton, V. 2010. Summary of Post-Construction Monitoring at Wind Projects Relevant to Minnesota, Identification of Data Gaps, and Recommendations for Further Research Regarding Wind-Energy Development in Minnesota. Prepared for State of Minnesota Department of Commerce. 52 Pgs.

Rogers, D.S., M.C. Belk, M.W. Gonzalez, and B.L. Coleman. 2006. Patterns of habitat use by bats along a riparian corridor in northeastern Utah. The Southwestern Naturalist 51:52–58.

Rydell, J., L. Bach, M. Dubourg-Savage, M. Green, L. Rodrigues, and A. Hedenstrom. 2010. Mortality of bats at wind turbines links to nocturnal insect migration? European Journal of Wildlife Research 56:823–827.

Stantec Consulting, Inc. (Stantec). 2011. Cohocton and Dutch Hill Wind Farms Year 2 Post-Construction Monitoring Report, 2010, for the Cohocton and Dutch Hill Wind Farms in Cohocton, New York. Prepared for Canandaigua Power Partners, LLC, Portland Maine. Prepared by Stantec, Topsham, Maine. January 2011.

Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A. Shaffer, and W. Warren-Hicks. 2011. Comprehensive guide to studying wind energy/wildlife interactions. Prepared for the National Wind Coordinating Collaborative. Washington, D.C.

Tierney, R. 2009. Buffalo Gap 2 Wind Farm Avian Mortality Study: July 2007 - December 2008. Final Survey Report. Submitted by TRC, Albuquerque, New Mexico. TRC Report No. 151143-B-01. June 2009

USFWS. 2012. Land-Based Wind Energy Guidelines. Available online at http://www.fws.gov/windenergy.

USFWS. 2013. 12-month Finding on a Petition to List the Eastern Small-footed Bat and the NLEB as Endangered or Threatened; Listing the NLEB as an Endangered Species – Proposed Rule. Federal Register 78(191):61046–61080. Available online at http://www.gpo.gov/fdsys/pkg/FR-2013-10-02/pdf/2013-23753.pdf. Accessed January 2015.

USFWS. 2014a. Endangered and Threatened Wildlife and Plants; 6-month Extension of the Final Determination on the Proposed Endangered Status of the Northern Long-Eared Bat. Available online at: http://www.gpo.gov/fdsys/pkg/FR-2014-06-30/pdf/2014-15213.pdf

USFWS. 2014b. Northern long-eared bat interim conference and planning guidance. USFWS Regions 2, 3, 4, 5, and 6. January 6, 2014. Available online at: http://www.fws.gov/midwest/endangered/mammals/nlba/pdf/NLEBinterimGuidance6Jan2014.pdf

USFWS. 2015a. Endangered species of the United States. Available online at: http://www.fws.gov/endangered/species/us-species.html.

USFWS. 2015b. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat with 4(d) Rule. Federal Register 80(63): 17974-18033. Available online at http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/FRnlebFinalListing02April2015.pdf. Accessed October 2015.

USFWS. 2015c. Northern Long-eared Bat Proposed 4(d) Rule: White-Nose Syndrome Buffer zone Around WNS/Pd Positive Counties/Districts. Available online at: http://www.fws.gov/Midwest/endangered/mammals/nlba/pdf/nlebRangeMapWithWNS150MileBuffer15Jan2015.pdf

USFWS. 2015d. Endangered and Threated Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat With 4(d) Rule. Federal Register 80(63): 17974–18033. Available online at: http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/FRnlebFinalListing02April2015.pdf

USFWS 2015e. 2015 Range-wide Indiana bat summer survey guidelines. April 2015. Available online at: http://www.fws.gov/midwest/endangered/mammals/inba/surveys/pdf/2015IndianaBatSummerSurveyGuidelines01April2015.pdf

USFWS 2016a. Endangered and Threatened Wildlife and Plants; 4(d) Rule for the Northern Long-Eared Bat. Federal Register 81(9): 1900-1922. Available online at http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/FRnlebFinal4dRule14Jan2016.pdf. Accessed January 2016.

USFWS 2016b. Northern Long-Eared Bat final 4 (d) Rule. White-Nose Syndrome Zone Around WNS/Pd Positive Counties/Districts. Available online at http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf. Accessed January 2016.

USFWS 2016c. Key to the Northern Long-Eared Bat 4(d) Rule for Non-Federal Activities. Available online at http://www.fws.gov/midwest/endangered/mammals/nleb/KeyFinal4dNLEB.html. Accessed January 2016.

Waldien, D.L., and J.P. Hayes. 2001. Activity areas of female long-eared myotis in coniferous forests in western Oregon. Northwest Science 75:307–314.

WAPA (Western Area Power Administration) and USFWS. 2015. Programmatic Biological Assessment for the Upper Great Plains Region Wind Energy Program, Final. April 2015.

Western Bat Working Group. 2005. Species Accounts. Available online at: http://www.wbwg.org/speciesinfo/species_accounts/species_accounts.html. Accessed January 2015.

Whitaker, J.O. 1995. Food of the big brown bat *Eptesicus fuscus* from maternity colonies in Indiana and Illinois. The American Midland Naturalist 134:346–360.

Young, D.P. Jr., W.P. Erickson, Bay, K., Nomani, S., and Tidhar, W. 2009. Mount Storm Wind Energy Facility, Phase 1 Post-Construction Avian and Bat Monitoring: July - October 2008. Prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

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FIGURES

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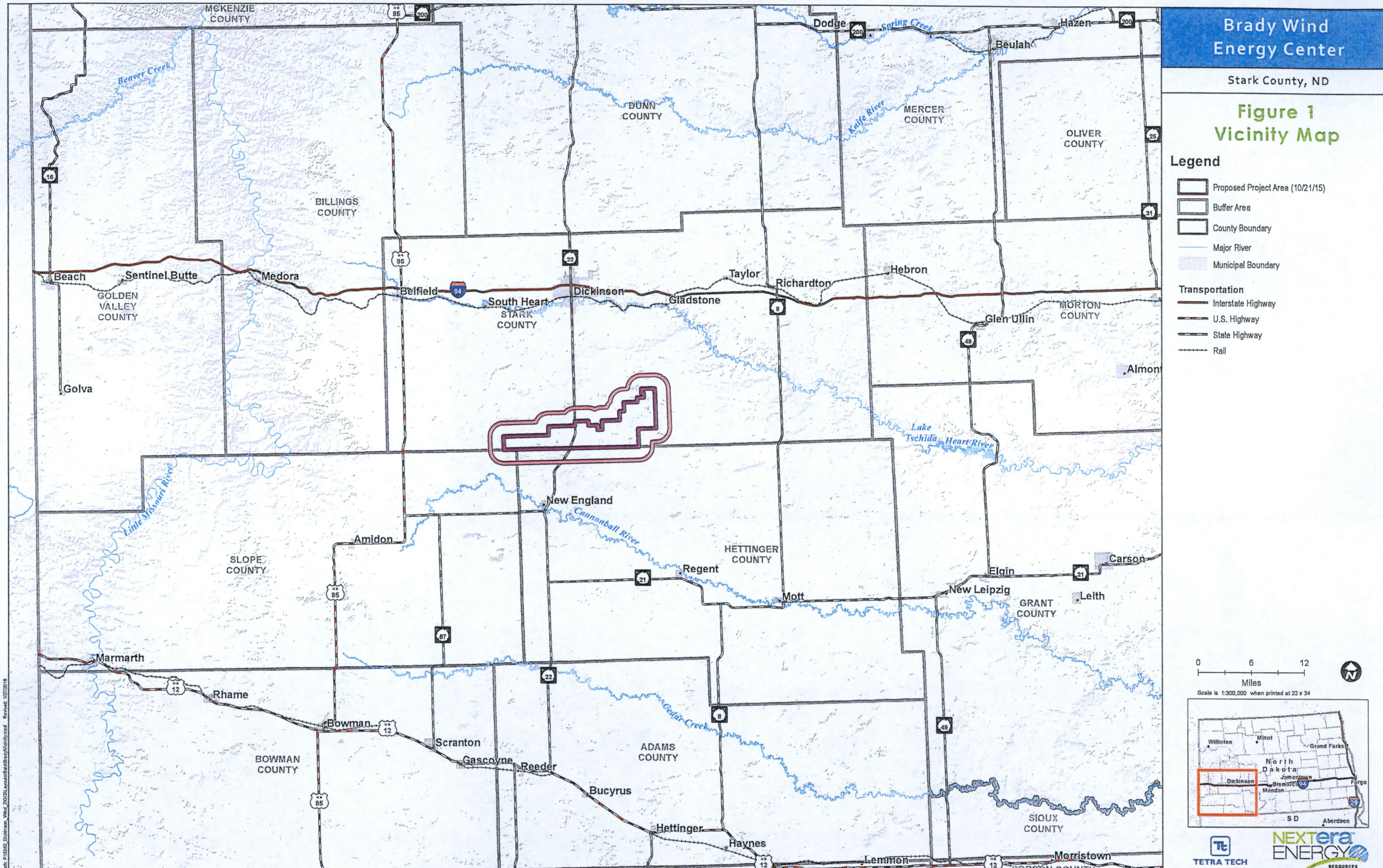
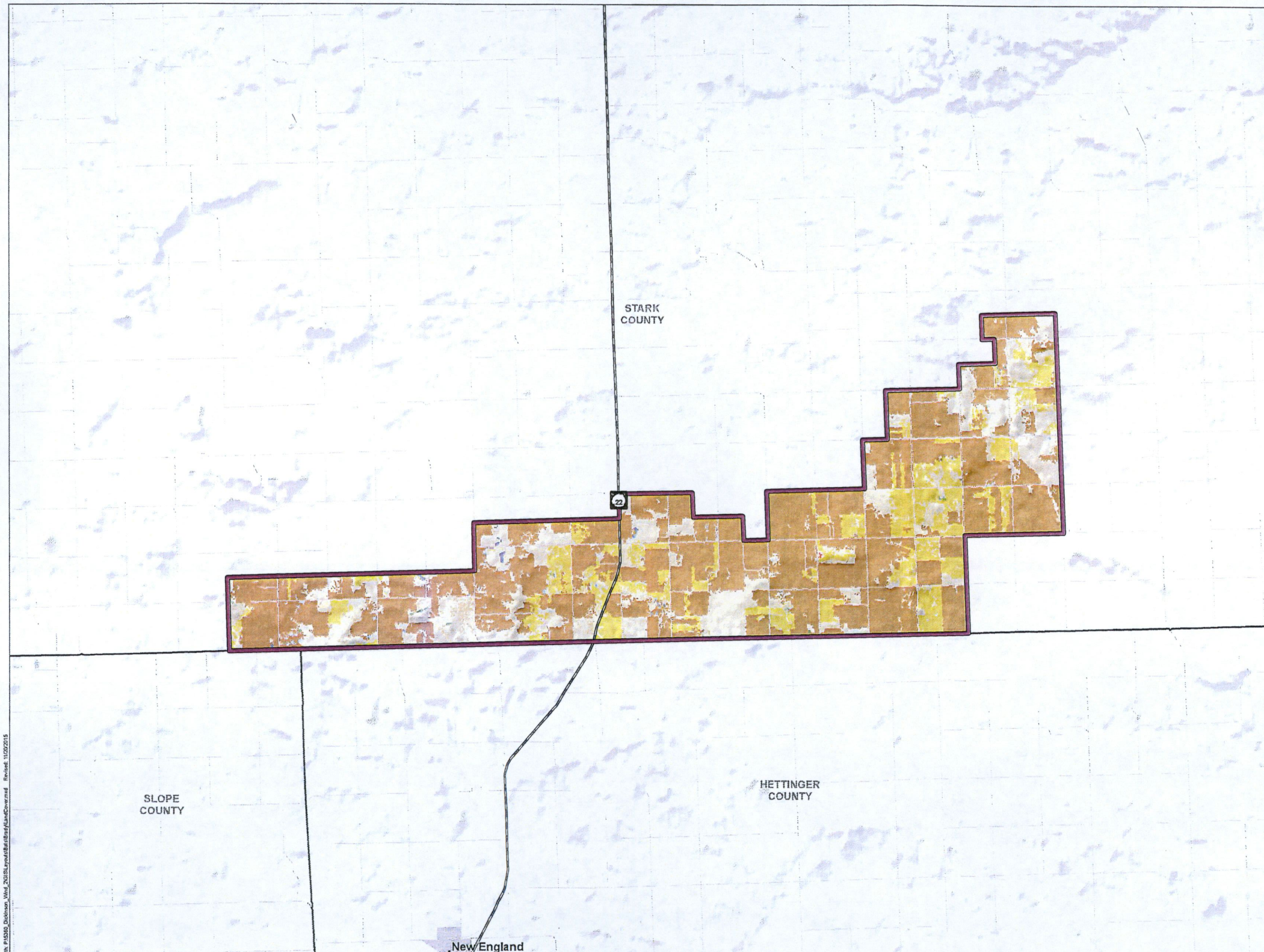


Brady Wind Energy Center
Stark County, ND
Figure 1
Vicinity Map
Legend
Proposed Project Area (10/21/15)
Buffer Area
County Boundary
Major River
Municipal Boundary
Transportation
Interstate Highway
U.S. Highway
State Highway
Rail
0
6
12
Miles
Scale is 1:300,000 when printed at 22 x 34
TETRA TECH
NEXTera ENERGY RESOURCES
MCKENZIE COUNTY
BILLINGS COUNTY
DUNN COUNTY
MERCER COUNTY
OLIVER COUNTY
GOLDEN VALLEY COUNTY
STARK COUNTY
MORTON COUNTY
SLOPE COUNTY
HETTINGER COUNTY
GRANT COUNTY
BOWMAN COUNTY
ADAMS COUNTY
SIOUX COUNTY
CORSON COUNTY
Beach
Sentinel Butte
Medora
Belfield
South Heart
Dickinson
Gladstone
Taylor
Richardton
Hebron
Glen Ullin
Almont
Dodge
Beulah
Hazen
Golva
New England
Amidon
Regent
Mott
New Leipzig
Elgin
Carson
Leith
Marmarth
Rhame
Bowman
Scranton
Gascoyne
Reeder
Bucyrus
Hettinger
Haynes
Lemmon
Morristown
Beaver Creek
Knife River
Spring Creek
Little Missouri River
Cannonball River
Lake Tschida
Heart River
Cedar Creek
Williston
Minot
Grand Forks
North Dakota
Jamestown
Bismarck
Mandan
Fargo
SD
Aberdeen

Brady Wind Energy Center

Stark County, ND

Figure 2
Land Cover



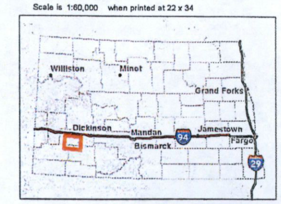
Legend

- Proposed Project Area (10/21/15)
- County Boundary
- Major River
- Municipal Boundary

Land Cover

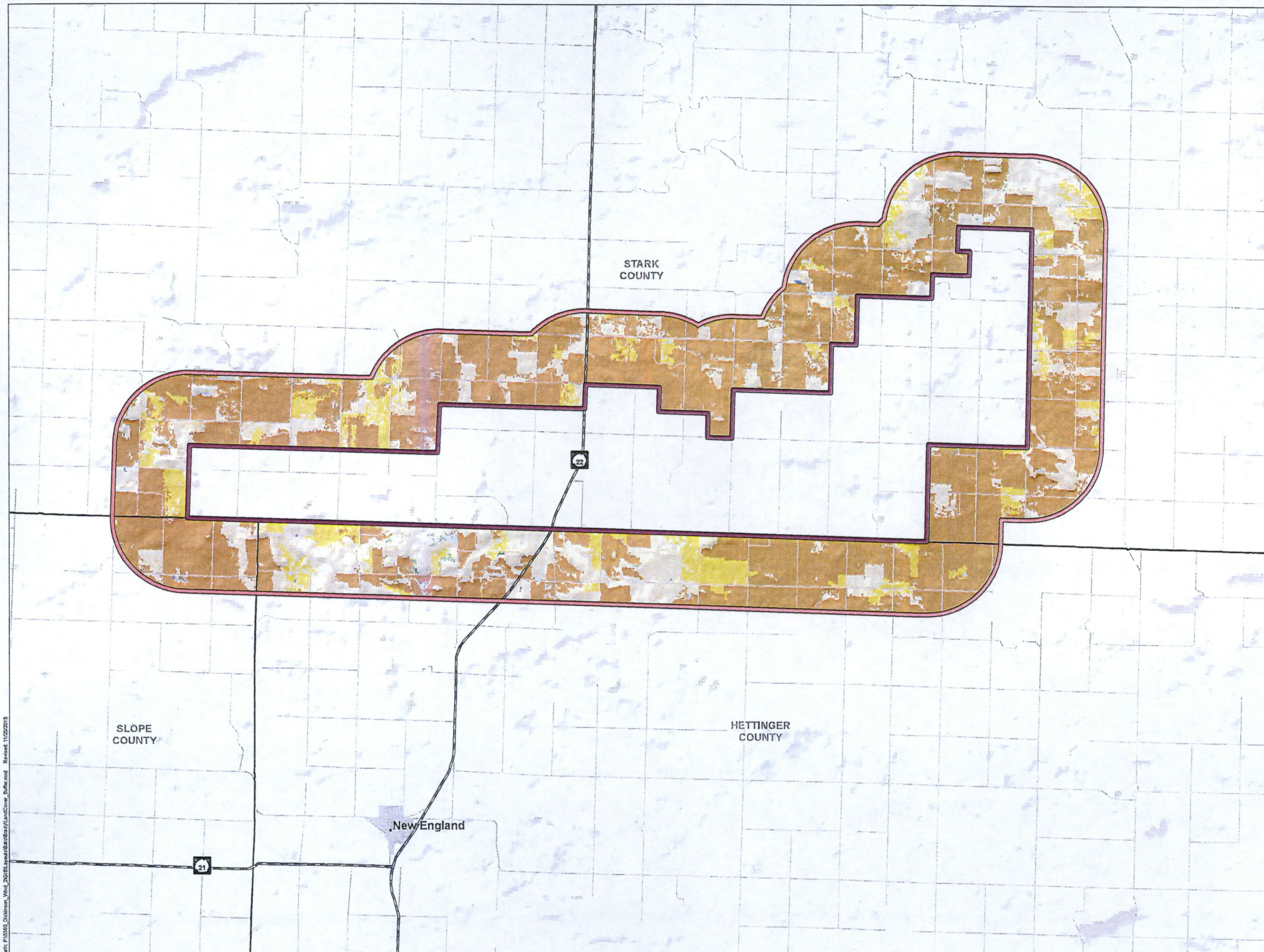
- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

0 1 2
Miles
Scale is 1:60,000 when printed at 22 x 34



TETRA TECH

NEXTera ENERGY RESOURCES



Brady Wind Energy Center

Stark County, ND

Figure 3
Land Cover Buffer

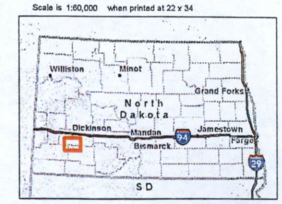
Legend

- Proposed Project Area (10/21/15)
- Buffer Area
- County Boundary
- Major River
- Municipal Boundary

Land Cover

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

0 1 2
Miles
Scale is 1:60,000 when printed at 22 x 34



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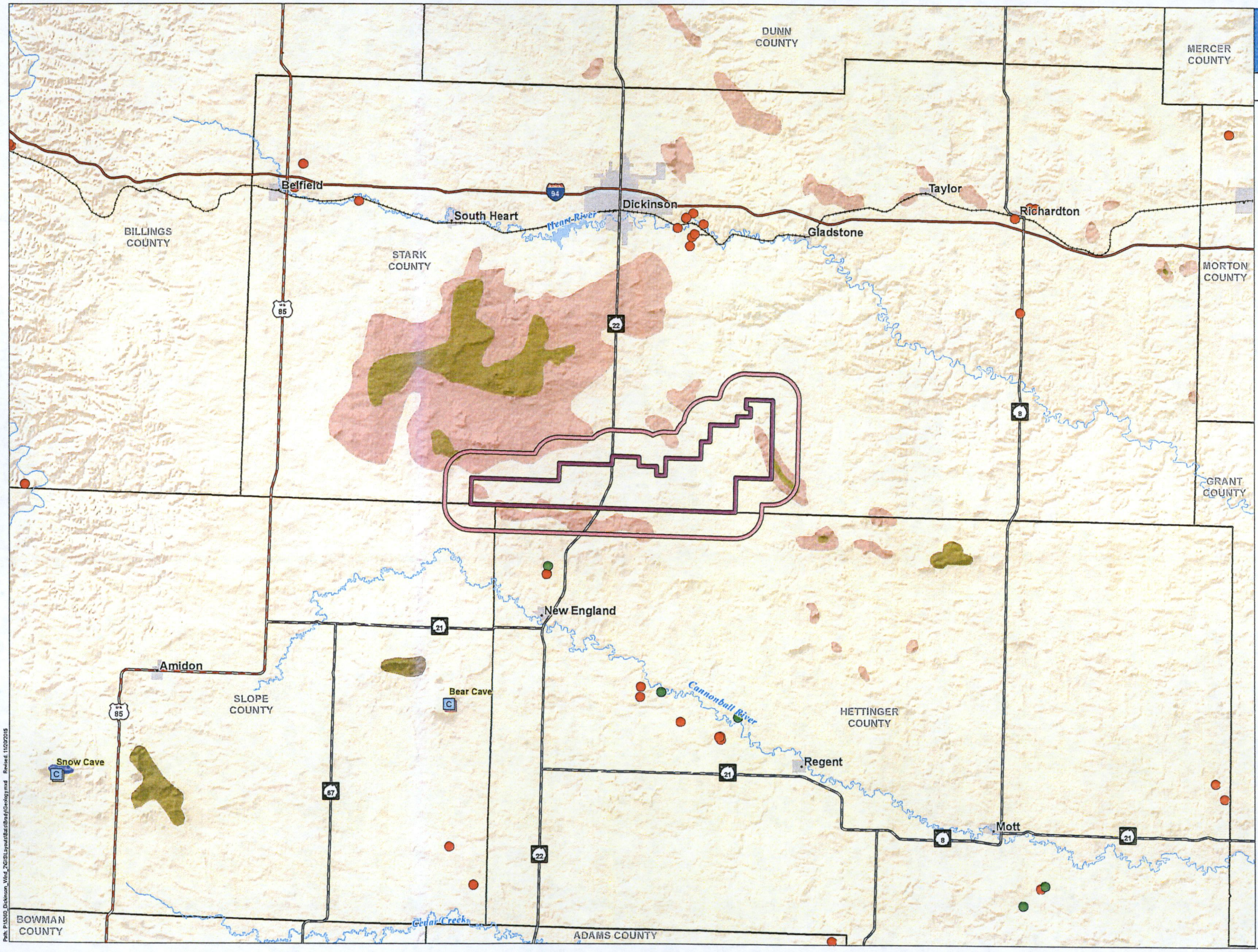

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Figure 4
Geology

Legend

- Proposed Project Area (10/21/15)
- Buffer Area
- County Boundary
- Major River
- Municipal Boundary
- Approximate Cave Location

Abandoned Mines

- Underground
- Underground/Surface

Bedrock Geology

- Micaceous Sandstone, Sand, Silt, Clay
- Sandstone or Limestone, Butte Caprock
- Silt, Sand, Clay, Sandstone, and Lignite
- Siltstone, Clay, Sand

0 5 10
Miles
Scale is 1:165,000 when printed at 22 x 34

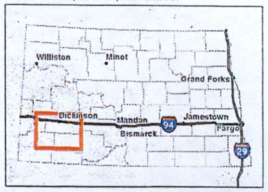

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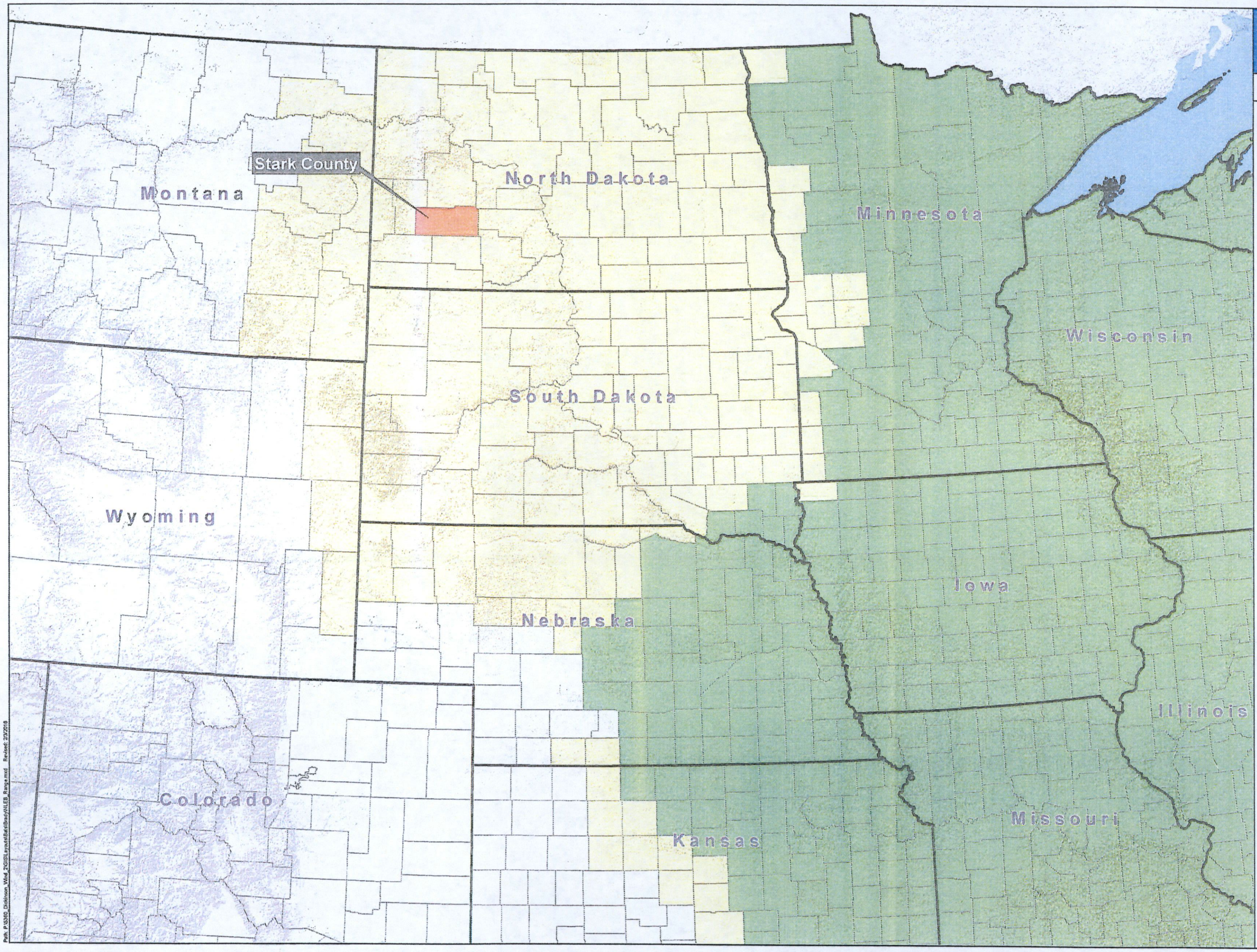
Figure 5
Northern Long-Eared Bat Range and USFWS White-Nose Syndrome Zone



Legend

- USFWS White-Nose Syndrome Zone*
- Northern Long-Eared Bat Range*

*USFWS data updated Jan. 2016

- State Boundary
- County Boundary

0 50 100
Miles

Scale is 1:2,500,000 when printed at 22 x 34

Source: USFWS Bat Range and WNS Buffer, 5/28/15.

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