BW Exhibit 10

Plains Sharp-Tailed Grouse Conservation Strategy

Badger Wind Farm

Prepared for:

Ørsted
Onshore North America, LLC
401 N. Michigan Ave., STE 501
Chicago, IL 60611

Prepared by:

Chad LeBeau, Grant Gardner, and Kurt Smith

Western EcoSystems Technology, Inc.
1610 East Reynolds Street
Laramie, Wyoming 82072

February 11, 2022

32 PU-22-86 Filed 06/08/2022 Pages: 26
Proposed Exhibit 10 - Plains Sharp-Tailed Grouse Conservation Strategy
Badger Wind, LLC
Mollie Smith, Fredrikson&Byron, P.A.

BW Exhibit 10

EXECUTIVE SUMMARY

Ørsted is considering the development of the Badger Wind Farm (Project) in Logan and McIntosh counties, North Dakota. The Project falls within the range of plains sharp-tailed grouse (STGR) and Ørsted is interested in understanding the potential impacts the Project may have on local STGR population. We evaluated potential impacts to the local STGR population at both landscape and site-specific levels using various available resources and existing literature. This information was used to determine the extent of potential suitable habitat within and near the Project which can be used in siting.

At the landscape level, STGR are most likely to occur in suitable habitat located in the northern portion of the Project. The majority of habitat outside of this area is highly fragmented by agriculture and not likely to support STGR; however, the Project has the potential to impact the connectivity between habitats where STGR are predicted to occur. The proportion of grassland, agricultural development, and existing levels of anthropogenic disturbances all suggest suitable habitat is limited to the northern portion of the Project overlapping the majority of known lek locations. It is currently unknown how STGR respond to wind energy development. However, assuming that STGR respond to wind energy development similar to other prairie grouse species, infrastructure located in suitable habitats identified through this assessment has the potential to impact the local population through habitat loss, avoidance behaviors and reduce connectivity between key habitats. However, the extent and magnitude of these potential impacts are dependent on infrastructure location.

At the site-specific level, the Project’s wind turbines are sited in previously fragmented areas, and areas not identified as suitable habitat through this assessment. Placing turbines in previously fragmented areas and considering turbine spacing in the northern portion of the Project where suitable habitat exists has minimize impacts to the local breeding population based on our current understanding of grouse behavior relative to turbines. Nonetheless, even with implementation of described minimization measures, STGR may avoid previously used habitats in close proximity to turbines; however, based on our current understanding this avoidance behavior is not expected to result in population level declines.

BW Exhibit 10

REPORT REFERENCE

LeBeau, C., G. Gardner, and K. Smith. 2022. DRAFT Plains Sharp-Tailed Grouse Conservation Strategy for the Badger Wind Farm. Prepared for Ørsted Onshore North America, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Laramie, Wyoming. February 11, 2022.

BW Exhibit 10

TABLE OF CONTENTS

LIST OF FIGURES

BW Exhibit 10

INTRODUCTION

Ørsted is considering the development of the Badger Wind Farm (Project) in Logan and McIntosh counties, North Dakota (Figure 1). The Project falls within the range of plains sharp-tailed grouse (STGR; *Tympanuchus phasianellus jamesi*). Ørsted recognizes the need to conserve STGR populations and understands the potential for the Project to adversely affect the local STGR population. The purpose of this assessment is to evaluate the potential impacts the Project may have on the local STGR population.

The objective of this assessment was to determine if and how the construction and operation of the Project would affect the local STGR population. Mortality of STGR is an unlikely result of the Project due to STGR flight behavior; however, the direct habitat loss and potential indirect effects of the Project's construction and operation could affect STGR through displacement from otherwise suitable habitat (Coppes et al. 2020, LeBeau et al. 2020a). More specifically, we used the best available information to evaluate the potential impacts of the Project on the local STGR population based on local data, best available science, existing landscape features, and existing anthropogenic disturbances.

BW Exhibit 10

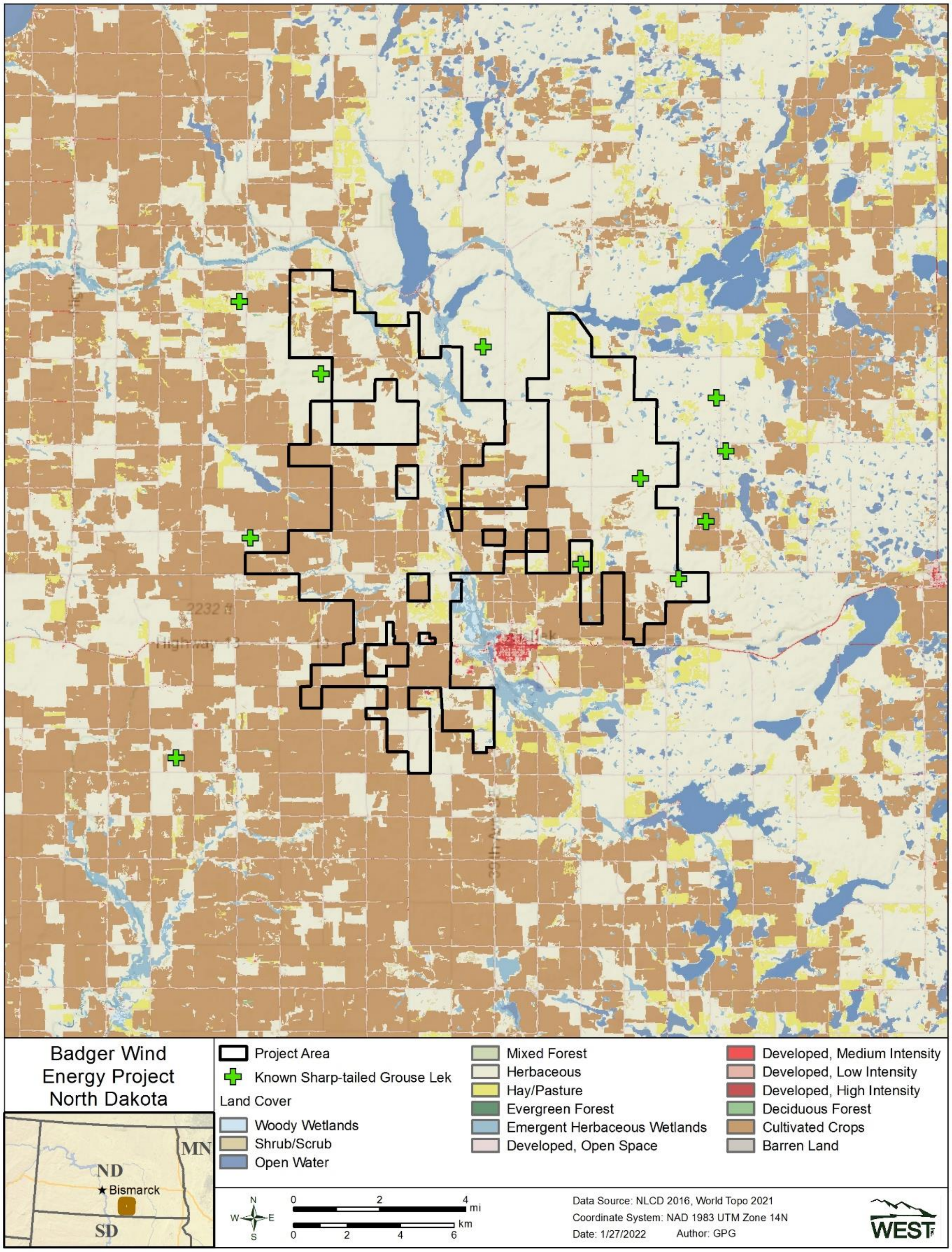

Figure 1. The Badger Wind Farm relative to known plains sharp-tailed grouse (STGR) leks in Logan and McIntosh counties, North Dakota.

BW Exhibit 10

BACKGROUND

Prairie-grouse have experienced range-wide population declines as a result of habitat loss, degradation, and fragmentation of grasslands over the last century (Aldridge et al. 2004). Conversion of grassland to agricultural development is a primary cause of prairie-grouse population declines (Kirsch et al. 1973, Fuhlendorf et al. 2002). This is unsurprising given the strong association with mixed grassland habitats, in which they rely to meet their life history requirements (Hanowski et al. 2000, Roersma 2001). STGR are one of six subspecies of sharp-tailed grouse in North American (Johnsgard 1983), and occupy subclimax brush-grassland communities in the Great Plains region east of the Rocky Mountains from Alberta, Canada south to Nebraska and Colorado (NRCS 2007). There is currently no special status associated with STGR in the United States and the species is considered a species of ‘Least Concern’ by the International Union for Conservation of Nature Red List (BirdLife International 2016). Within North Dakota’s State Wildlife Action Plan (Dyke et al. 2015) however, STGR are assigned a species of conservation priority level II, which indicates a species of moderate conservation priority (Dyke et al. 2015). Primary threats to STGR in North Dakota include “Conversion of grassland to cropland, energy development and urban expansion. Degradation of grasslands from invasive plants, woody encroachment, succession, and loss of diversity. The expiration of CRP grasslands is also of concern and will result in population declines. Degradation due to livestock overuse can also reduce habitat quality” (Dyke et al. 2015).

Conserving large intact native habitats is an important step in reducing threats to STGR populations. For example, STGR lek occurrence is positively related to the amount of available grassland habitats (Grossman and Stavne 2005, Runia et al. 2021). In Alberta, Grossman and Stavne (2005) compared habitat characteristics around active and inactive STGR leks and found that active leks contained less cultivated land (and more intact grassland) within a 0.25 square mile (mi^2; 0.64 square kilometer [km^2]) area (37% compared to 50% cultivated lands). At a larger, 2.2-mi^2 (5.8-km^2) scale (0.8-mi [1.3-km] radius), the proportion of cultivated land was also lower at active compared to inactive leks (31% compared to 46%; Grossman and Stavne 2005). The percent of grassland and pasture hay within a 0.7-mi (1.2-km) radius was also a strong positive predictor of STGR occurrence and density in North and South Dakota (Runia et al. 2021). Both predicted probability of occurrence and predicted density of STGR approximately doubled when the percentage of grass increased from 53% to 90% within 0.7 mi (Runia et al. 2021). Resource selection and reproductive success of STGR are also positively correlated with grassland habitats. In Montana and Western North Dakota, female STGR selected a greater proportion of grassland habitats within their home ranges during the breeding season (Milligan et al. 2020). STGR nest site selection and brood survival was positively correlated with visual obstruction and grassland vegetation height (Prose et al. 2002, Geumont and Graham 2020), and nest survival was negatively impacted by landscapes with greater than 10% cropland and low grass cover (Manzer and Hannon 2005). These examples suggest larger intact grasslands are necessary for STGR to satisfy their life history requirements.

Large patches of grassland habitat must also be characterized with low densities of anthropogenic disturbances to support STGR populations. Anthropogenic disturbances may impact prairie

BW Exhibit 10

grouse populations directly through habitat loss and indirectly by avoidance of otherwise suitable habitats (Hovick et al. 2014). Research specific to anthropogenic disturbances and STGR populations are generally lacking, but current literature suggests that STGR may be more tolerant of oil and gas development compared to other grouse species (Williamson 2009, Burr et al. 2017), which may be partially explained by a shift in STGR predator communities in landscapes impacted by development (Burr et al. 2017). Nonetheless, it is well understood that higher densities of anthropogenic disturbance impacts STGR populations (Hovick et al. 2014, Runia et al. 2021).

Although no studies have directly measured potential impacts to STGR from renewable energy development, there is an increasing body of literature evaluating the response of other prairie grouse to wind energy infrastructure (LeBeau et al. 2020a). In Wyoming, LeBeau et al. (2014) reported lower Greater sage-grouse (GRSG; *Centrocercus urophasianus*) nest and brood survival in habitats closer to wind turbines two years following development. However, over a 6-year period after development, LeBeau et al. (2017b) failed to detect negative effects on GRSG nest, brood, or summer female survival, suggesting variability in survival was better explained by temporal variability than wind energy infrastructure. In Idaho, Columbian sharp-tailed grouse (CSTG; *Tympanuchus phasianellus columbianus*) nest survival was not influenced by proximity to turbines (Proett et al. 2019). Greater prairie chicken (GRPC; *Tympanuchus cupido*) nest and female survival was also reportedly not influenced by proximity to wind turbines in Nebraska or Kansas (Winder et al. 2014a, Harrison et al. 2017, Smith et al. 2017).

In general, studies have failed to detect demographic impacts associated with wind energy development, but avoidance behaviors associated with wind energy infrastructure could possibly mask the ability to detect any potential survival consequences. LeBeau et al. (2017b) did find GRSG selection for brood-rearing and summer habitats was negatively correlated with surface disturbance associated with wind energy infrastructure. Similar displacement behaviors have also been documented for GRPC, with avoidance of wind turbines in Kansas (Winder et al. 2014b). These results suggest there is some level of indirect loss of potentially suitable habitat as a result of wind energy infrastructure. However, our current understanding does not suggest these avoidance behaviors translate to population level effects (LeBeau et al. 2017a). LeBeau et al. (2020a) reviewed studies and conducted a meta-analysis that evaluated the effect of wind energy development on prairie grouse, with the main objective to determine the magnitude of effects of distance to wind turbines on prairie grouse habitat selection, lek attendance, and survival. The body of evidence suggested that impacts to prairie grouse did not extend beyond 1.4 mi (2.2 km) from wind turbines (Winder et al. 2014), and all 10 studies evaluated investigated the effects of wind turbines along a gradient where the impact was expected to be greatest in close proximity to wind turbines, but dissipated as distance from wind turbines increased.

Power lines (transmission and distribution lines) often associated with wind energy infrastructure also have the potential to directly and indirectly negatively affect grouse populations. Direct mortality caused by collision with power lines has been documented in Idaho (Beck et al. 2006) and indirect effects could include displacement and survival consequences similar to wind energy infrastructure. In Nevada, GRSG resource selection and demography was negatively associated with a 345-kilovolt (kV) transmission line (Gibson et al. 2018). At the same study site, population growth rates were lower for leks near power lines (Gibson et al. 2018). GRSG resource selection and demography was also negatively associated with power lines, but transmission lines did not affect lek persistence in a multi-state study (Kohl et al. 2019). In Wyoming, LeBeau et al. (2019) also found that transmission lines had a negative effect on GRSG habitat selection and survival. However, the authors determined the effect varied by proximity to occupied leks and habitat suitability, suggesting the magnitude of effects may be minimized when placing transmission lines in unsuitable habitats when they occur within 1.9 mi (3.1 km) from an occupied lek (LeBeau et al. 2019). LeBeau et al. (2020b) found little evidence that a wind energy facility influenced lesser prairie chicken (LEPC; *T. pallidicinctus*) in a landscape that was already fragmented by agricultural development, providing additional support that placement of infrastructure in previously disturbed landscapes may minimize additional deleterious effects of fragmentation. While we are unaware of any studies directly evaluating the effects of transmission lines on STGR, we expect STGR populations would respond similarly as other prairie grouse species.

Considering the effects of anthropogenic features on STGR populations and given the lack of research specific to wind energy infrastructure, surface disturbance, or any vegetation removal resulting in bare ground, may be a useful metric for understanding and regulating impacts to grouse populations regardless of infrastructure type. Runia et al. (2021) found that the percent of developed landscape was negatively associated with STGR occurrence and density. Predicted probability of STGR occurrence declined by approximately 66% when development within 0.7 mi increased from zero to 10% and predicted STGR density declined by 53% when development increased from zero to 3.78% (Runia et al. 2021). It appears that development exceeding 4% within 0.7 mi represents a potential threshold where both STGR occurrence and density become low (See figures 2 and 3 in Runia et al. 2021). Surface disturbance has also been negatively associated with GRSG brood and nest survival (e.g., Kirol et al. 2020) and displacement of GRSG during winter (Smith et al. 2014). Kirol et al. (2020) determined successful GRSG nests were negatively correlated with the amount of surface disturbance within 1.0 mi (1.6 km), and greater than 90% of nest and brood rearing locations occurred in habitats with less than 3% surface disturbance within 0.6 mi (1.0 km). In addition, the proportion of disturbance associated with wind turbine pads and roads consistently out-performed models with distance to wind turbines in a GRSG study in Wyoming (LeBeau et al. 2017b), and turbine density was included in a set of competing models of nest survival and habitat selection models for CSTG in Idaho (Proett et al. 2019). This suggests density of infrastructure, including wind energy facilities as indexed by surface disturbance, may be a useful predictor of responses compared to distance to infrastructure alone.

Overall there is concern that additional habitat loss through land conversion or anthropogenic influences will lead to STGR population declines. Future impacts to large intact habitats could exacerbate these declines. The Project is located within the range of STGR and has the potential to impact various life stages but the extent and magnitude of such impact will likely vary based on the location of infrastructure. Using available data sources and our current understanding of the effects of wind energy development on grouse populations, we evaluated the Project's potential impact on the local STGR population.

BW Exhibit 10

METHODS

Based on the current understanding of STGR habitat requirements and responses to anthropogenic development, we evaluated potential effects of the Project on STGR by evaluating the landscape level impacts as well as the site-specific impacts to the local population. The landscape level assessment was necessary to place the Project in context with the surrounding habitat and population density. The site-specific assessment considered the Project's impacts to the local breeding population and focused on turbine placement.

Landscape Level Assessment

We used the best available information to evaluate the Project in context with surrounding habitat and extent of the STGR population. For instance, we relied on data supporting STGR life history needs and breeding and nonbreeding habitat requirements (Manzer and Hannon 2005, Manzer and Hannon 2008, Milligan et al. 2020, Runia et al. 2021). We relied on a combination of datasets to evaluate potential impacts at the landscape level rather than relying on one dataset. While we reviewed these datasets, we considered how the Project could increase habitat fragmentation, impact connectivity between important habitats, and impact the local breeding population.

While considering the Project's impacts to the local population, it is important to understand habitat needs during various life-cycles, especially during the breeding period. STGR habitat consists of breeding, nesting, brood, and autumn/winter habitat. Each of these components must occur in close proximity to each other in order to support a viable population of STGR, given that the birds are not typically considered migratory (Prose 1987). STGR require relatively large parcels of intact native grassland to maintain self-sustaining populations (Milligan et al. 2020, Runia et al. 2021) but these parcel sizes appear to be smaller than other prairie grouse that are more sensitive to landscape change (e.g., lesser prairie-chicken; USFWS 2021). In addition, grassland parcels with higher amounts of existing anthropogenic features have the potential to decrease habitat suitability for STGR (Runia et al. 2021), thus, we evaluated patch sizes and levels of existing fragmentation during the landscape level assessment.

STGR are not known to migrate, but have been observed making large movements (~30 miles [~ 48 km]) between seasonal ranges (Klett 1957); in autumn and winter, the birds assemble in mixed-gender flocks. Loss of habitat and avoidance of anthropogenic features could impact large movements to seasonal habitat, which could have adverse effects on population viability (Peterson et al. 2020). We identified the Project's location on the landscape and evaluated how the Project could impact movements between key habitats and between lek locations.

Considering the potential effects of the Project on various population characteristics, a qualitative assessment was conducted by considering characteristics that influence population viability in a Geographic Information System (GIS) framework assessment and included:

- Project Area and surrounding area
- Two potential turbine layouts provided by Ørsted
- Modelled occurrence and density of STGR (Runia et al. 2021)

- Land Use and Land Cover and landfire National Land Cover Data (NLCD 2016) grass land and cultivated lands
- Aerial imagery
- Lek survey data

As discussed, habitat fragmentation and loss is a primary threat to STGR populations. Part of this landscape assessment is to understand how the Project could affect habitat fragmentation and loss in areas important for conservation of the species. NDGF conservation priority is to maintain native intact grasslands which STGR depend upon. Determining the extent of these areas within the Project and surrounding areas provided additional information on how the Project could impact STGR populations.

Site-specific Evaluation

It is currently unknown how STGR will respond to wind energy facilities. We documented the extent of available habitat within 2 mi of a lek to identify potential habitat used by STGR. STGR use habitats outside of a 2-mi buffer of leks to satisfy various life history requirements (Prose 1987) so habitats outside this 2-mi buffer were also evaluated. In addition, prairie grouse lek locations may vary year to year (Hovick et al. 2015), making management decisions specific to lek locations difficult. Thus, to determine site-specific impacts, we relied on various existing GIS layers to determine where suitable habitat exists within the Project and our understanding of how wind turbines affect behaviors of other grouse species to predict impacts.

We utilized three components of STGR habitat to determine existing suitability within the Project:

- Grassland: Milligan et al. (2020) found that female STGR selected home ranges (average home range size of 489 ha or a circle with radius of 0.7 mi) during the breeding season with a greater portion of grassland habitat. The relative probability of selection of grassland by females during the breeding season suggested that 60% grassland within seasonal home ranges represents a potential selection threshold (See Figure 3 in Milligan et al. 2020). Similarly, both predicted probability of STGR occurrence and predicted density of STGR doubled when the percentage of grassland increased from approximately 53% to 90% within 0.7 mi (Runia et al. 2021).
- Agricultural development: Grossman and Stavne (2005) found that active STGR leks contained on average 31% cultivated lands within 0.8 mi (1.3 km) of the lek location compared to 46% cultivated lands at inactive lek locations.
- Development: Runia et al. (2021) found that the percent of developed landscape was negatively associated with STGR occurrence and density. Predicted probability of STGR occurrence declined by approximately 66% when development within 0.7 mi increased from zero to 10% and predicted STGR density declined by 53% when development increased from zero to 3.78% (Runia et al. 2021). It appears that development exceeding 4% within 0.7 mi represents a potential threshold where both STGR occurrence and density declines precipitously (See figures 2 and 3 in Runia et al. 2021).

BW Exhibit 10

We quantified the amount of grassland, cultivated cropland, and development within the Project area, by calculating focal statistics for each layer within 0.7-mi radii to identify potentially suitable STGR habitats. Grassland and cultivated cropland were derived from the National Land Cover Database (NLCD 2016). Development including buildings, roads, railroads, oil and gas wells, pipelines, transmission lines, and other tall structures were manually digitized within the Project area. We considered habitats to be suitable for STGR when any of the following conditions were met: at least 60% grassland within 1.2 km, less than 46% cultivated land within 0.7 mi, or less than 4% development within 0.7 mi.

Following the identification of available STGR habitat, we evaluated how wind energy infrastructure would impact STGR that use those habitats. The state of the science related to the effects of wind energy facilities on grouse is developing, and our understanding from the 15 studies that have evaluated the impacts of wind energy on grouse is that wind energy infrastructure has the ability to adversely affect grouse behavior similar to other forms of development (Winder et al. 2014, LeBeau et al. 2017b, 2020a, b). In addition, the magnitude of impact likely varies based on the characteristics of the facility and the facilities placement on the landscape as evident at a LEPC study site in Kansas (LeBeau et al. 2020b); however, management recommendations for siting wind energy projects that minimize impacts to STGR are limited.

In absence of management recommendations outside of lek avoidance measures, we reviewed studies and conducted a meta-analysis that evaluated the effect of wind energy infrastructure on grouse, with the main objective to determine the magnitude of effects of distance to wind turbines on grouse habitat selection, lek attendance, and survival (LeBeau et al. 2020a). We used 10 studies, resulting in 22 study-result combinations. Based on our review of the literature, impacts to grouse did not extend beyond 1.4 mi (2.2 km) from wind turbines (Winder et al. 2014b), and all 10 studies we evaluated investigated the effects of wind turbines along a gradient from wind turbines where the impact was expected to be greatest in close proximity to wind turbines, but dissipated as distance from wind turbine increased.

We focused on results from studies that evaluated habitat selection and provided selection coefficients related to the effect of distance to wind turbines as that was the largest effect size documented in LeBeau et al. (2020a). We modeled coefficients from each study using a generalized linear random-effects model to determine the average effect of wind turbines on grouse displacement. Overall, the authors found evidence for grouse displacement associated with distance to wind turbines but this effect did not result in population level declines. The results of this analysis were used to interpret the potential impacts of the facility on the local STGR population. Spatially, we identified areas within the Project that may displace STGR or where turbines have the potential to impact connectivity.

RESULTS

The Project is located within the Northwestern Glaciated Plains Level III Ecoregion (US Environmental Protection Agency 2017). The Northwestern Glaciated Plains is described as an

BW Exhibit 10

area with semi-arid climate and a mix of rangeland and agriculture interspersed with seasonal wetlands (Tollerud et al. 2018). The primary land use within the Project area is agricultural production including cattle grazing.

Landscape Level Assessment

The Project is located within a range of habitats predicted to have low to high probability of STGR occurrence (Runia et al. 2021; Figure 2). Areas with the highest predicted STGR occurrence occur in the northern portion of the Project and largely coincide with the 11 known leks located within or near the Project. At the landscape level, the Project has the potential to impact the connectivity between habitats where STGR are predicted to occur. Occurrence models are valuable when placing the Project in context with the larger population and species conservation efforts, but are less effective at evaluating local populations within the Project. Nonetheless, the occurrence model does provide some context in the overall conservation of the species.

BW Exhibit 10

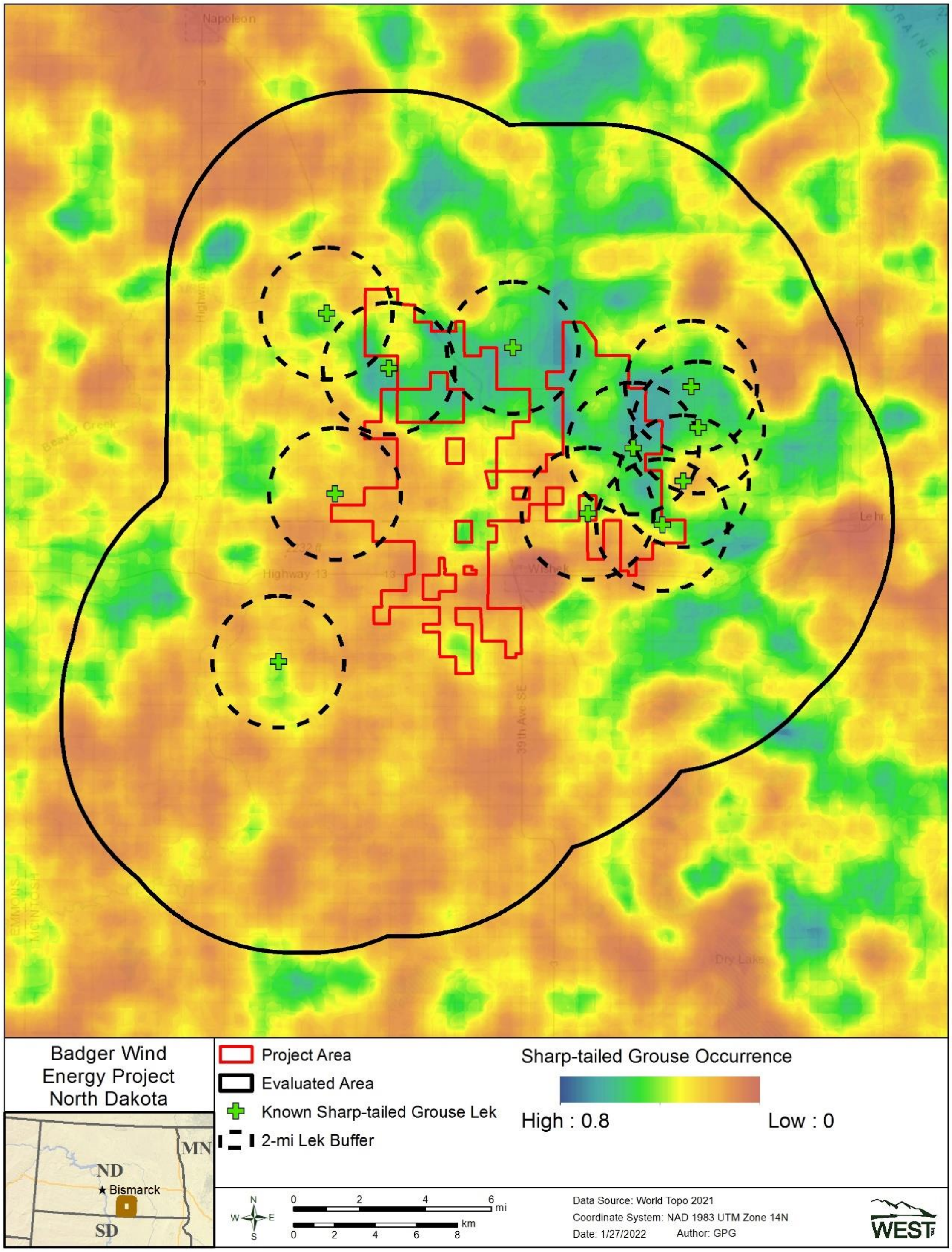

Figure 2. Predicted plains sharp-tailed grouse occurrence developed from Runia et al. (2021) at the Badger Wind Farm project and surrounding region.

BW Exhibit 10

Site-specific Evaluation

The proportion of grassland within 0.7 mi that exceeds 60% is largely restricted to the northern portion of the Project (Figure 3). The proportion of cropland that is less than 46% within 0.7 mi is also generally restricted to the northern portion of the project (Figure 4). Development exceeding 4% within 0.7 mi is largely absent from the northern portion of the Project (Figure 5). Combining these layers to identify areas potentially suitable for STGR (Figure 6) largely coincides with the location of known leks at and near the Project. Two leks, located near the western and southwestern borders of the Project occur in areas that are primarily agriculture with little grassland habitats.

BW Exhibit 10

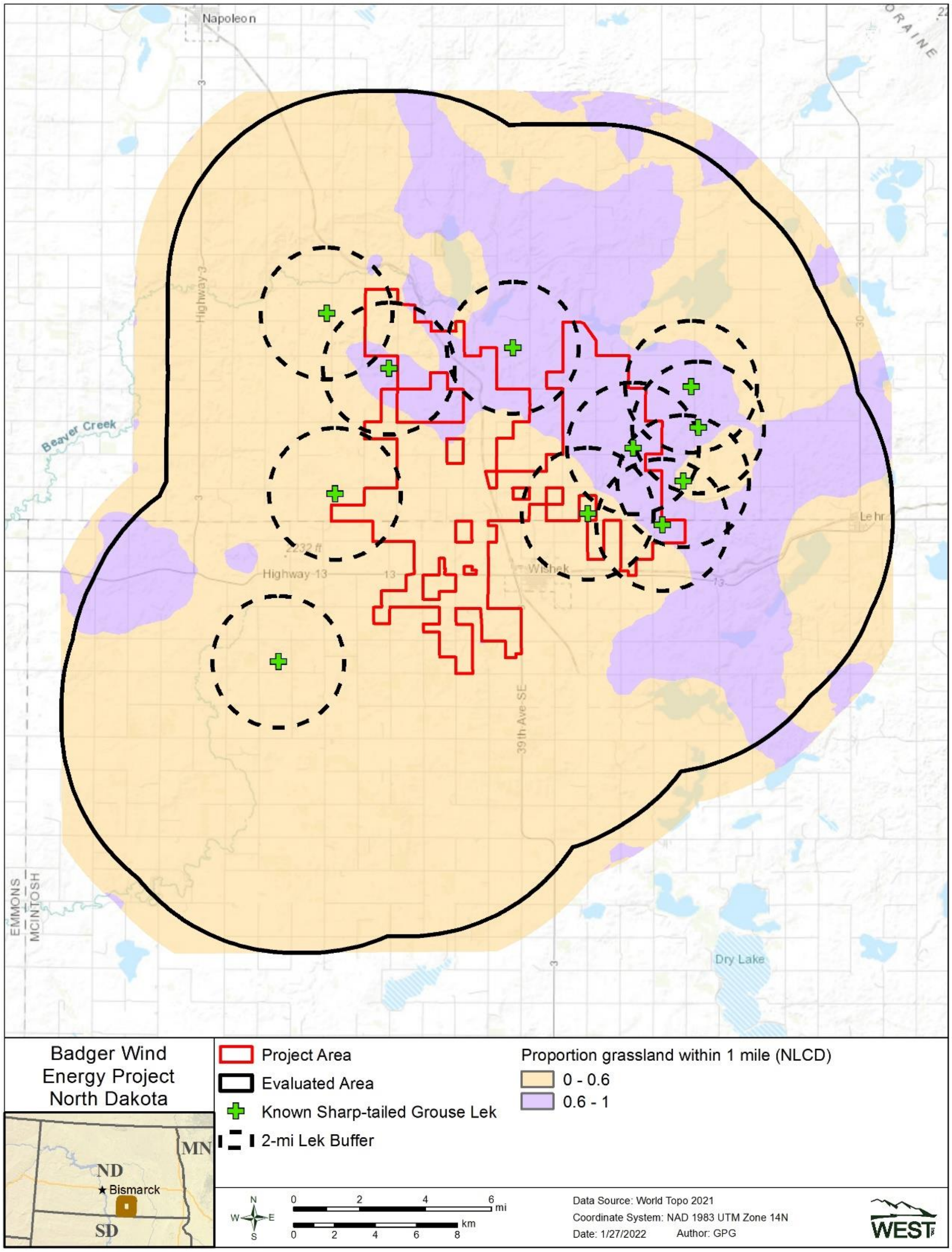

Figure 3. Suitable grassland habitats (areas with greater than 60% grassland within 0.7 mi (1.2 km) at the Badger Wind Farm in Logan and McIntosh counties, North Dakota.

BW Exhibit 10

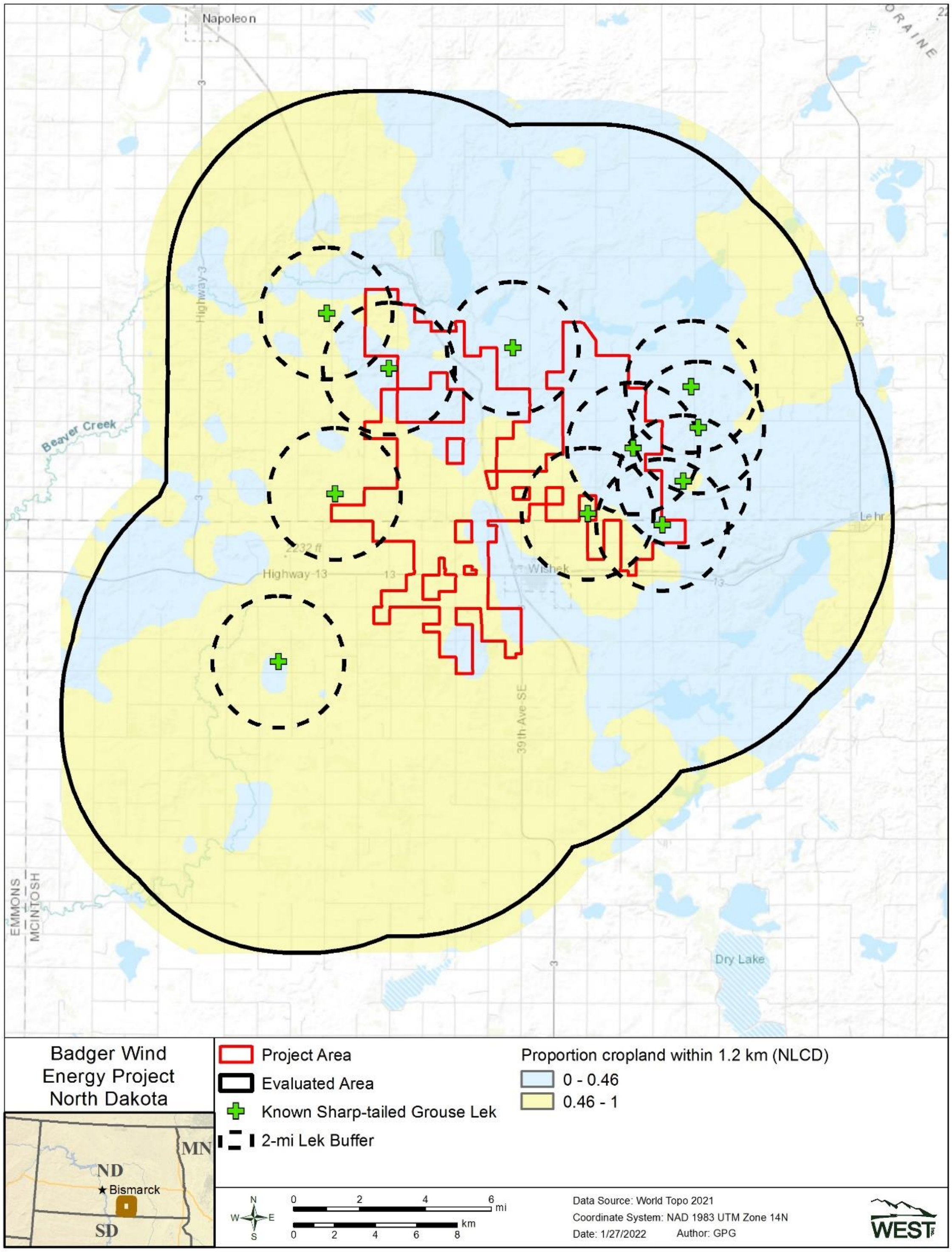

Figure 4. Suitable areas that have less than 46% Cropland within 0.7 mi (1.2 km) at Badger Wind Farm in Logan and McIntosh counties, North Dakota.

BW Exhibit 10

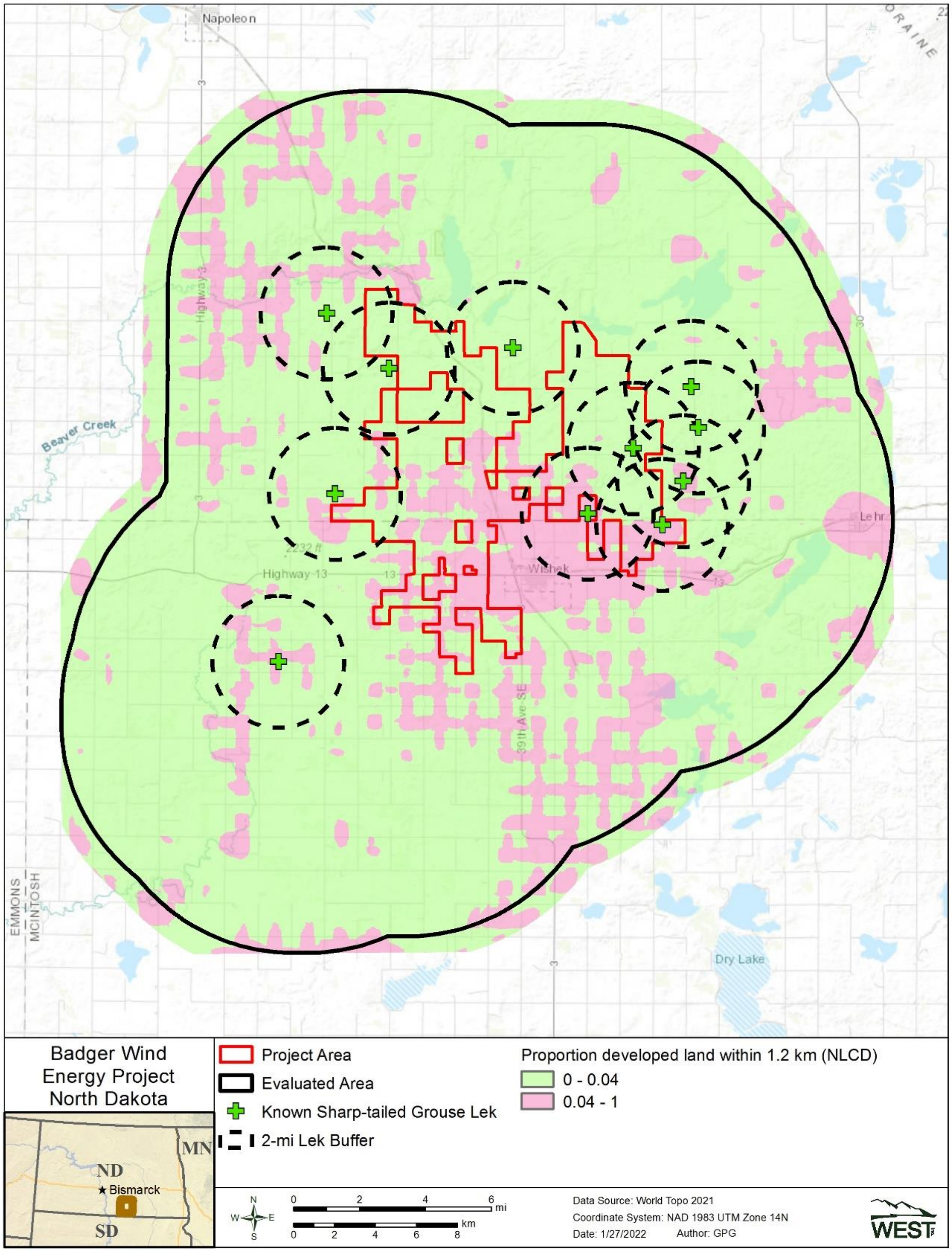

Figure 5. Suitable areas that have less than 4% development within 0.7 mi (1.2 km) at the Badger Wind Farm in Logan and McIntosh counties, North Dakota.

BW Exhibit 10

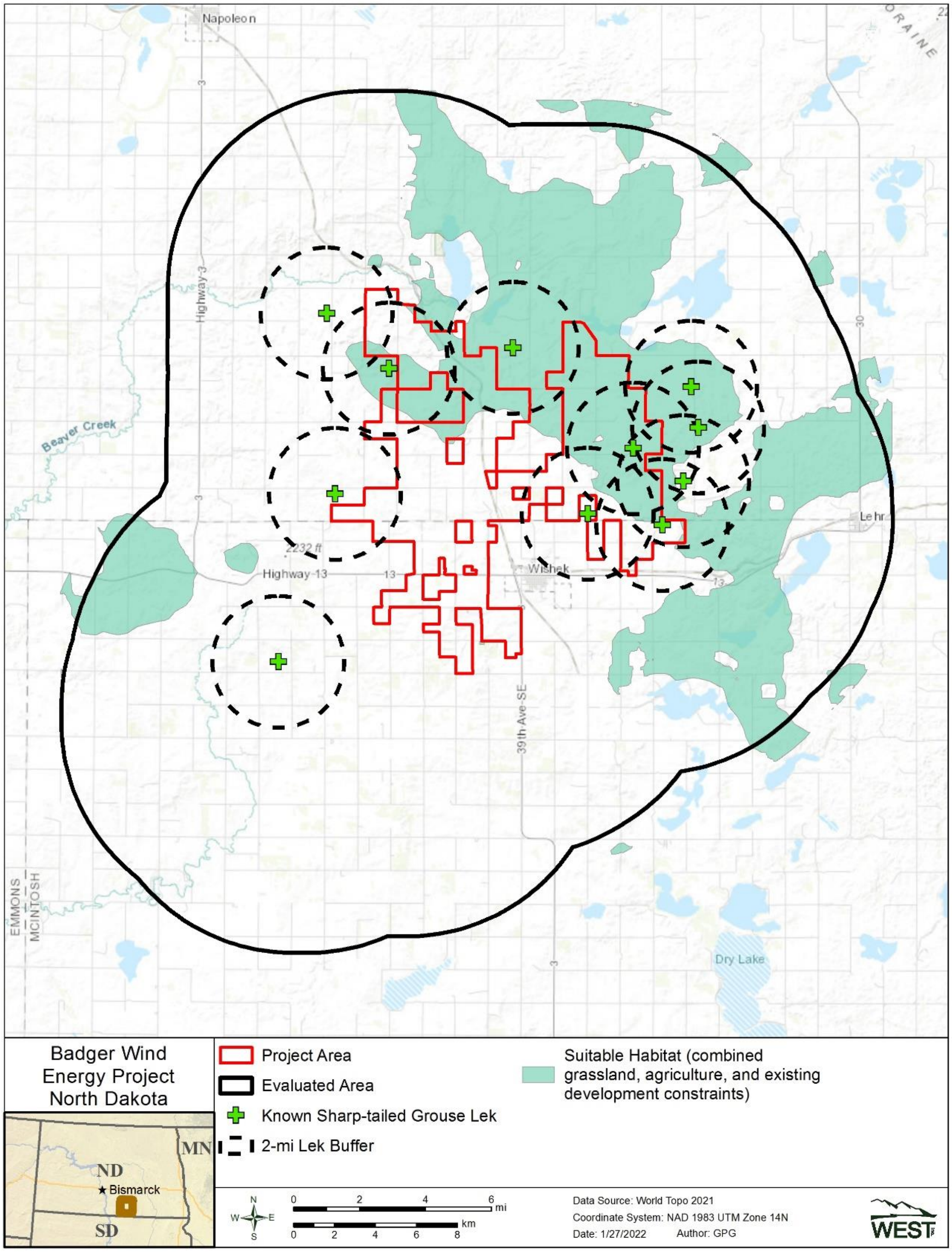

Figure 6. Suitable plains sharp-tailed grouse habitat identified as areas with grassland habitats exceeding 60% within 0.7 mi, less than 46% Cropland within 0.7 mi, or less than 4% development within 0.7 mi at the Badger Wind Farm in Logan and McIntosh counties, North Dakota.

DISCUSSION

The Project occurs within the range of STGR and there is potential for the Project to increase fragmentation of intact grasslands similar to other forms of anthropogenic development. To evaluate the extent and magnitude of this potential impact we evaluated effects at the landscape level and site-specific scales. This was necessary to place the Project in context with the larger STGR population, surrounding habitats, and conservation priorities for the species. By evaluating both in a stepwise process, we were able to compare and contrast landscape level impacts to site-specific impacts. We found the Project is located in an area highly fragmented by agricultural development with the majority of intact grassland habitats located in the northern portion of the Project where lek density is highest. Infrastructure located in suitable habitats identified through this assessment has the potential to impact the local population through habitat loss, avoidance behaviors and reduce connectivity between key habitats (e.g., breeding areas).

Although some information exists on the potential impacts of wind energy development to prairie grouse, little information is known about the potential impacts to STGR. Because of this, managers often assume that impacts to STGR associated with wind turbines are similar to or greater than impacts from other forms of anthropogenic development (e.g., Hagen et al. 2011). However, additional research on the effects of wind energy development on prairie grouse populations, specifically STGR, is needed to better inform siting of future wind projects that minimize impacts to prairie grouse populations. In the absence of additional information, there is potential to minimize potential impacts during siting. Siting wind turbines in previously fragmented areas and outside of areas identified as suitable habitat through this assessment (Milligan et al. 2020, Runia et al. 2021, Grossman and Stavne 2005) would be a good minimization measure to reduce impacts to the local population (LeBeau et al. 2020a).

As discussed however, a lack of understanding about how STGR may respond to wind energy development precludes our ability to make strong conclusions about expected responses. The best available science, assuming STGR respond to wind energy development similarly to other grouse species, suggests that STGR may be displaced from previously used habitats that are in close proximity to wind turbines, but this behavior shift does not appear to result in population level declines (Winder et al. 2014a, LeBeau et al. 2020a). In addition, displacement impacts can be further minimized when infrastructure is located in previously disturbed areas such as non-native areas as the impact to the local population may have already been realized (LeBeau et al. 2020b). All of the turbines located in identified suitable habitat are sited on previously fragmented areas, which is a good measure to minimize impacts to the local STGR population (Figure 7).

In addition to minimizing displacement effects, minimizing impacts to STGR movements and connectivity can be achieved during siting. Recent evidence suggests LEPC may move between turbines that are spaced a minimum of 0.7 mi apart where suitable habitat exists (LeBeau et al. 2020a). This turbine spacing would be most beneficial in areas where leks occur, knowing that STGR use areas near leks throughout the year. Wind turbines located in the northern portion of the Project are spaced on average 0.6 mi (0.93 km) apart which may facilitate movement between key habitats. Some additional minimization measures could be implemented during construction.

BW Exhibit 10

Based on this evaluation, the majority of turbines are located in an area that is not suitable for STGR. There is potential that STGR may use the Project during various seasonal periods but it appears the majority of the area within the Project is not necessary to support a viable breeding population. Placing turbines in previously fragmented areas and considering turbine spacing in the northern portion of the Project where suitable habitat exists has minimize impacts to the local breeding population based on our current understanding of grouse behavior relative to turbines. Nonetheless, even with implementation of the described minimization measures, STGR may avoid previously used habitats in close proximity to turbines; however, based on our current understanding this avoidance behavior is not expected to result in population level declines.

BW Exhibit 10

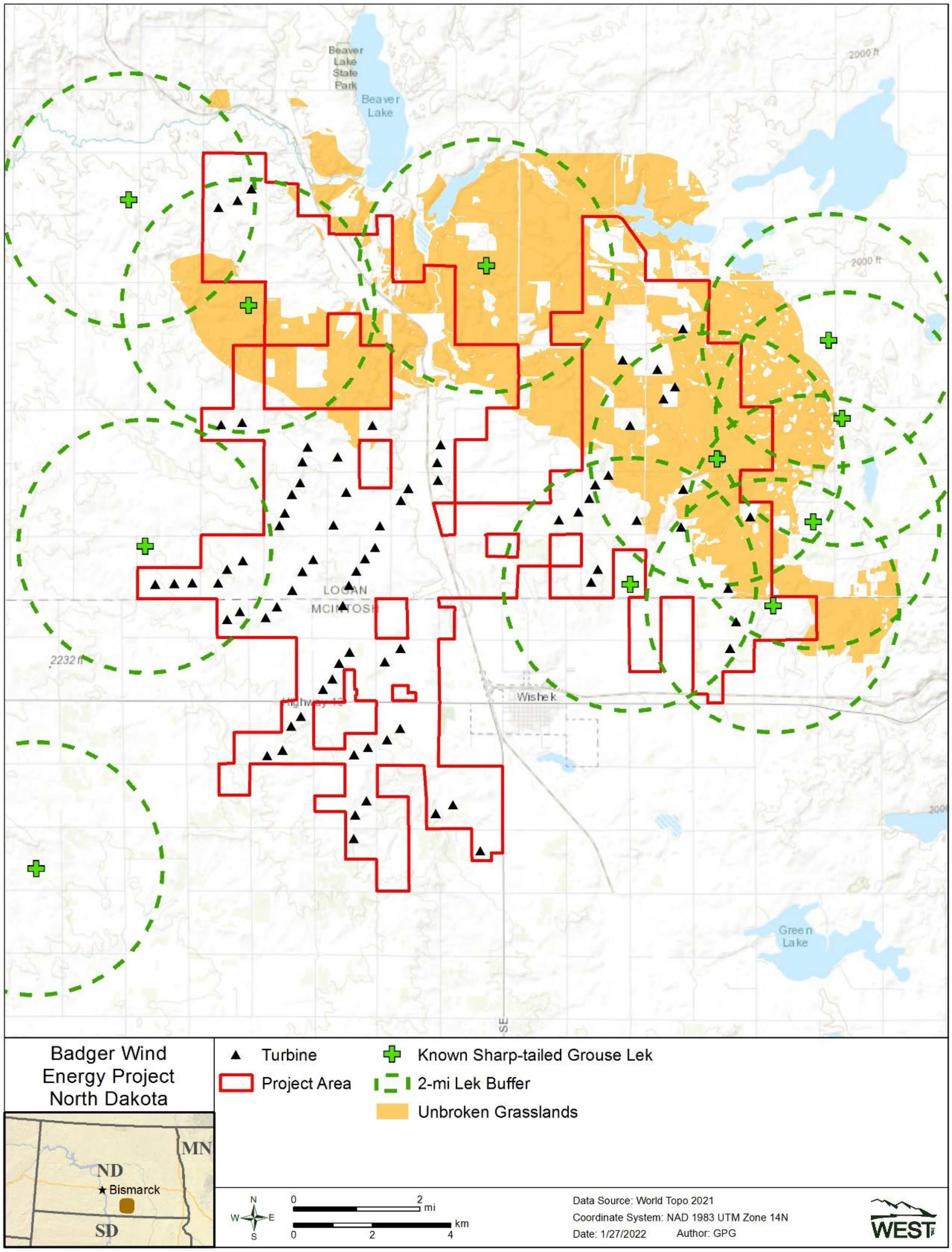

Figure 7. Location of proposed turbines in relation to unbroken grasslands that overlap sharp-tailed grouse suitable habitat at the Badger Wind Farm in Logan and McIntosh counties, North Dakota. Unbroken grassland was restricted to suitable habitat (see Figure 6).

BW Exhibit 10

LITERATURE CITED

Aldridge, C. L., M. S. Boyce, and R. K. Baydack. 2004. Adaptive Management of Prairie Grouse: How Do We Get There? Wildlife Society Bulletin 32:92–103.

Beck, J. L., K. P. Reese, J. W. Connelly, and M. B. Lucia. 2006. Movements and Survival of Juvenile Greater Sage-Grouse in Southeastern Idaho. Wildlife Society Bulletin 34:1070–1078.

BirdLife International. 2016. *Tympanuchus phasianellus*. The IUCN Red List of Threatened Species 2016: e.T22679511A92816912. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22679511A92816912.en. Accessed 08 September 2021.

Burr, P. C., A. C. Robinson, R. T. Larsen, R. A. Newman, and S. N. Ellis-Felege. 2017. Sharp-Tailed Grouse Nest Survival and Nest Predator Habitat Use in North Dakota's Bakken Oil Field. PLoS ONE 12(1): e0170177.

Coppes, J., V. Braunisch, K. Bollmann, I. Storch, P. Mollet, V. Grunschner-Berger, J. Taubmann, R. Suchant, and U. Nopp-Mayr. 2020. The Impact of Wind Energy Facilities on Grouse: A Systematic Review. Journal of Ornithology 161:1–15.

Dyke, S. R., S. K. Johnson, and P. T. Isakson. 2015. North Dakota State Wildlife Action Plan. North Dakota Game and Fish Department, Bismarck, ND. Available online: https://gf.nd.gov/sites/default/files/publications/swap-2015_0.pdf

Esri. 2021. World Imagery and Aerial Photos (World Topo). ArcGIS Resource Center. Environmental Systems Research Institute (Esri), producers of ArcGIS software, Redlands, California. Accessed October 2021. Available online: https://www.arcgis.com/home/webmap/viewer.html?useExisting=1&layers=10df2279f9684e4a9f6a7f08febac2a9

Fuhlendorf, S. D., A. J. W. Woodward, D. M. Leslie, and J. S. Shackford. 2002. Multi-scale Effects of Habitat Loss and Fragmentation on Lesser Prairie-Chicken Populations of the US Southern Great Plains. Landscape Ecology 17:617–628

Geaumont, B. A., and D. L. Graham. 2020. Factors Affecting Sharp-tailed Grouse Brood Habitat Selection and Survival. Wildlife Biology.

Gibson, D., E. J. Blomberg, M. T. Atamian, S. P. Espinosa, and J. S. Sedinger. 2018. Effects of Power Lines on Habitat Use and Demography of Greater Sage-Grouse (*Centrocercus urophasianus*). Wildlife Mongraphs 200:1–41.

Grossman, S.R., and R. B. Stavne. 2005. Use and Habitat Characteristics of Sharp-Tailed Grouse Leks in Northwest Alberta. Technical Report, T-2004-004, produced by Alberta Conservation Association, Peace River, Alberta, Canada. 20pp + App.

Hagen, C. A., J. C. Pitman, T. M. Loughin, B. K. Sandercock, R. J. Robel, and R. D. Applegate. 2011. Impacts of Anthropogenic Features on Habitat Use by Lesser Prairie-Chickens. Pp. 63–75. In: B. K. Sandercock, K. Martin, and G. Segelbacher, eds. Ecology, Conservation, and management of Grouse. University of California Press, Berkeley, California. Vol 39.

Hanowski, J. M., D. P. Christian, and G. J. Niemi. 2000. Landscape requirements of prairie sharp-tailed grouse *Tympanuchus phasianellus campestris* in Minnesota, USA. Wildlife Biology.

Harrison, O. J., M. Bomberger Brown, L. A. Powell, W. H. Schact, and J. A. Smith. 2017. Nest Site Selection and Nest Survival of Greater Prairie-Chickens near a Wind Energy Facility. Condor 119:659–672.

Hovick, T. J., B. W. Allred, R. D. Elmore, S. D. Fuhlendorf, R. G. Hamilton, and A. Breland. 2015. Dynamic Disturbance Processes Create Dynamic Lek Site Selection in a Prairie Grouse. PLoS ONE 10(9):e0157882.

Hovick, T. J., R. D. Elmore, D. K. Dahlgren, S. D. Fuhlendorf, and D. M. Engle. 2014. Evidence of Negative Effects of Anthropogenic Structures on Wildlife: A Review of Grouse Survival and Behaviour. Journal of Applied Ecology 51:1680–1689.

Johnsgard, P. A., 1983. Grouse of the World. University of Nebraska Press, Lincoln, NE.

Kirol, C. P., K. T. Smith, N. E. Graf, J. B. Dinkins, C. W. LeBeau, T. L. Maechtle, A. L. Sutphin, and J. L. Beck. 2020. Greater Sage-Grouse Response to the Physical Footprint of Energy Development. Journal of Wildlife Management 84(5): 989-1001. doi: 10.1002/jwmg.21854.

Kirsch, L. M., A. T. Klett, and H. W. Miller. 1973. Land Use and Prairie Grouse Population Relationships in North Dakota. Journal of Wildlife Management 37:449–453.

Klett, A. T. 1957. Banding and Marking Methods in Studying Seasonal Movements of the Sharp-Tailed Grouse in Morton County, North Dakota. Thesis. Utah State University, Logan, Utah USA.

Kohl, M. T., T. A. Messmer, B. A. Crabb, M. R. Guttery, D. K. Dahlgren, R. T. Larsen, S. N. Frey, S. Lguori, and R. J. Baxter. 2019. The Effects of Electric Power Lines on the Breeding Ecology of Greater Sage-Grouse. PLoS ONE 14(3): e0213668.

LeBeau, C., J. L. Beck, G. D. Johnson, and M. J. Holloran. 2014. Short-Term Impacts of Wind Energy Development on Greater Sage-Grouse Fitness. Journal of Wildlife Management 78(3):522–530.

LeBeau, C., S. Howlin, A. Tredennick, and K. Kosciuch. 2020a. Grouse Behavioral Response to Wind Energy Turbines: A Quantitative Review of Survival, Habitat Selection, and Lek Attendance. Prepared for the National Wind Coordinating Collaborative, Washington, D.C. Prepared by Western EcoSystems Technology, Inc. (WEST).

LeBeau, C., M. Kauffman, K. Smith, J. Haddock, A. Tanner, and K. Kosciuch. 2020b. Placement of Wind Energy Infrastructure Matters: A Quantitative Study Evaluating Response of Lesser Prairie-Chicken to a Wind Energy Facility. AWWI Technical Report. Washington, DC. Available at www.awwi.org. (Copyright) 2020 American Wind Wildlife Institute. This report is the first product of the Wind Wildlife Research Fund. April 13, 2020. Available online: https://awwi.org/wp-content/uploads/2020/04/WWRF-LEPC-Response-to-Wind-Energy.pdf

LeBeau, C. W., J. L. Beck, G. D. Johnson, R. M. Nielson, M. J. Holloran, K. G. Gerow, and T. L. McDonald. 2017a. Greater Sage-Grouse Male Lek Counts Relative to a Wind Energy Development. Wildlife Society Bullen 41(1): 17–26. doi:10.1002/wsb.725.

LeBeau, C. W., G. D. Johnson, M. J. Holloran, J. L. Beck, R. M. Nielson, M. E. Kauffman, E. J. Rodemaker, and T. L. McDonald. 2017b. Greater Sage-Grouse Habitat Selection, Survival, and Wind Energy Infrastructure. Journal of Wildlife Management 81(4):690–711.

LeBeau, C. W., K. T. Smith, M. J. Holloran, J. L. Beck, M. E. Kauffman, and G. D. Johnson. 2019. Greater Sage-Grouse Habitat Function Relative to 230-kV Transmission Lines. Journal of Wildlife Management 83(8):1773–1786.

Manzer, D. L., and S. J. Hannon. 2005. Relating Grouse Nest Success and Corvid Density to Habitat: A Multi-Scale Approach. Journal of Wildlife Management 69:110–123.

Manzer, D. L., and S. J. Hannon. 2008. Survival of Sharp-tailed Grouse Tympanuchus phasianellus Chicks and Hens in a Fragmented Prairie Landscape. Wildlife Biology 14(1):16–25.

BW Exhibit 10

Milligan, M. C., L. I. Berkely, and L. B. McNew. 2020. Effects of Rangeland Management on the Nesting Ecology of Sharp-tailed Grouse. Rangeland Ecology and Management 73:128–137.

North American Datum (NAD). 1983. Nad83 Geodetic Datum.

National Land Cover Database (NLCD). 2016. *As cited includes*:

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S. M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G. C. Liknes, M. Rigge, and G. Xian. 2018. A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies. ISPRS Journal of Photogrammetry and Remote Sensing 146:108–123. doi:10.1016/j.isprsjprs.2018.09.006.

And

Multi-Resolution Land Characteristics (MRLC). 2019. National Land Cover Database (NLCD) 2016. Multi-Resolution Land Characteristics (MRLC) Consortium. US Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, MRLC Project, Sioux Falls, South Dakota. May 10, 2019. Information Online: https://www.mrlc.gov/data.

National Resources Conservation Service (NRCS). 2007. Sharp-tailed Grouse (Tympanuchus phasianellus). Fish and Wildlife Habitat Management Leaflet. No 40. Accessed from: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010110.pdf

Peterson, J. M., J. E. Earl, S. D. Fuhlendorf, R. D. Elmore, D. A. Haukos, A. M. Tanner, and S. A. Carleton. 2020. Estimating Response Distances of Lesser Praire-Chickens to Anthropogenic Features During Long-Distance Movements. Ecosphere 11(9): e03202. doi: 10.1002/ecs2.3202.

Proett, M., S. B. Roberts, J. S. Horne, D. N. Koons, and T. A. Messmer. 2019. Columbian Sharp-Tailed Grouse Nesting Ecology: Wind Energy and Habitat. Journal of Wildlife Management 83:1214–1225.

Prose, B. L. 1987. Habitat Suitability Index Models: Plains Sharp-Tailed Grouse. U.S. Fish and Wildlife Service Biological Report 82(10.142). 31 pp.

Prose, B. L., B. S. Cade, and D. Hein. 2002. Selection of Nesting Habitat by Sharp-Tailed Grouse in the Nebraska Sandhills. The Prairie Naturalist 34:85–105.

Runia, T. J., A. J. Solem, N. D. Niemuth, and K. W. Barnes. 2021. Spatially Explicit Habitat Models for Prairie Grouse: Implications for Improved Population Monitoring and Targeted Conservation. Wildlife Society Bulletin 45:36–54.

Roersma, S. J. 2001. Nesting and brood rearing ecology of plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) in a mixed-grass/fescue ecoregion of southern Alberta. PhD thesis, University of Manitoba, Manitoba, Canada.

Smith, J. A., M. B. Brown, J. O. Harrison, and L. A. Powell. 2017. Predation Risk: A Potential Mechanism for Effects of a Wind Energy Facility on Greater Prairie Chicken Survival. Ecosphere 8(6): doi:10.1002/ecs2.1835.

Smith, K. T., C. P. Kirol, J. L. Beck, and F. C. Blomquist. 2014. Prioritizing Winter Habitat Quality for Greater Sage-Grouse in a Landscape Influenced by Energy Development. Ecosphere 5(2):Article 15.

Tollerud, H. J. Brown, T. Loveland, R. Mahmood, and N. Bliss. 2018. Drought and Land-Cover Conditions in the Great Plains. Earth Interactions: https://doi.org/10.1175/EI-D-17-0025.1

BW Exhibit 10

US Environmental Protection Agency (USEPA). 2017. Level III and Level IV Ecoregions of the Continental United States. Ecosystems Research, USEPA. Last updated June 18, 2020. Accessed September 2021. Information online: https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

US Fish and Wildlife Service (USFWS). 2021. Species Status Assessment Report for the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*). Version 2.2 Prepared by USFWS, Southwest and Mountain-Prairie Regions, Albuquerque, New Mexico, and Denver, Colorado. March 2021. 110 pp. + Appendices.

Williamson, R. M. 2009. Impacts of oil and gas development on sharp-tailed grouse on the Little Missouri National Grasslands, North Dakota. Thesis. South Dakota State University.

Winder, V. L. , L. B. McNew, L. M. Hunt, A. J. Gregory, S. M. Wisely, and B. K. Sandercock. 2014a. Effects of Wind Energy Development on Seasonal Survival of Greater Prairie-Chickens. Journal of Applied Ecology 51:395–405.

Winder, V. L., L. B. McNew, A. J. Gregory, L. M. Hunt, S. M. Wisely, and B. K. Sandercock. 2014b. Space Use by Female Greater Prairie-Chickens in Response to Wind Energy Development. Ecosphere 5(1):1–17.