Eagle Conservation Plan for the Mountain Breeze/Panorama Wind Energy Project

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Appendix A. Baseline Wildlife Studies Conducted for the Mountain Breeze/Panorama Wind Project

1.0 INTRODUCTION

Mountain Breeze Wind, LLC and Panorama Wind, LLC, individually and collectively referred to herein as the "Project" or "Projects", have developed this Eagle Conservation Plan (ECP) in compliance with the regulatory requirements to support the issuance of an Eagle Take Permit (ETP) covering non-purposeful take of bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos*, respectively) from activities at the Projects. There will be two energy off-takers, with Public Service Company of Colorado purchasing energy from Mountain Breeze, and another local utility purchasing the power from Panorama Wind; but Mountain Breeze and Panorama will be constructed and operated as part of one large Project. An application for a 30-year programmatic ETP, along with this ECP for the Project was submitted on October 11, 2019.

This ECP follows U.S. Fish and Wildlife Service (USFWS) Region 6 Migratory Bird Management Office guidance for ECPs, dated July 23, 2019. This ECP documents The Projects coordination with USFWS to identify potential risks to bald and golden eagles from Project construction and operations, and reduction of those risks through implementation of conservation measures designed to avoid or reduce risk to eagles to the maximum degree practicable relative to the magnitude of impacts to eagles. This ECP also describes alternate sites, layout configurations, construction methods, and operational practices evaluated by The Project and the USFWS during the avoidance and minimization process. Finally, the ECP documents compensatory mitigation for remaining unavoidable eagle take, and monitoring procedures for impacts to eagles during operation of the Project.

In addition to this ECP, The Project also intends to work with the USFWS to develop a Bird and Bat Conservation Strategy (BBCS) for the Project based on the Land-Based Wind Energy Guidelines (USFWS 2012).

1.1 Project Background

The Project is located in northern Weld County, Colorado, approximately 9 miles (mi; 14 kilometers [km]) northeast of the town of Grover (Figure 1.1). Wind data collection and land agreements were obtained during 2016-2018. The Project layout is located mostly on private land, though there are some parcels of state land managed by the State Land Board (Figure 1.1). While the Project is located within the nominal boundary of the Pawnee National Grassland, no federal lands occur within the Project area or along transmission routes. The Project is adjacent to the Cedar Creek Wind Project along its western, southern and southeastern sides. The nearest turbines and infrastructure of the Cedar Creek Wind Project are within 800 meters (1/2 mile) of the Project.

The nameplate capacity of the Project is approximately 370 megawatts produced by up to 128 wind turbine generators, with 62 turbines in the Mountain Breeze portion of the Project, and 66 turbines in the Panorama portion of the Project (Figure 1.2). Turbines for the Mountain Breeze portion of the Project will have hub heights of 80-89 meters (m; 262-292 feet [ft]), and the rotor diameter will be 116-127 m (380-417 ft). Turbines for the Panorama Wind portion of the Project

will have hub heights of 80-110 m (262-361 ft), and rotor diameters will range between 116 and 140 m (380-459 ft). Additionally, the Mountain Breeze Project will include the construction of an approximately 10-mile generation tie-in (gen-tie line; 230-kilovolt [kV] transmission line) to deliver power from the Project to the existing gen-tie line that begins at the Cedar Creek Wind Project and maintenance facility. The Panorama Wind Project will include the construction of an approximately 13-mile 115-kV gen-tie line to connect to the Tri-State Redtail substation approximately 10 mi to the south. The Project as a whole also will include associated infrastructure consisting of access roads, underground collector lines, a meteorological (MET) tower, and substations at the beginning of the gen-tie lines. The Project will be supported by the existing operation and maintenance facility located at the existing Cedar Creek Wind Project pursuant to separate agreements between The Project and the owners of that facility.

The Project will result in both permanent and temporary loss of vegetation communities and associated wildlife habitat. This ECP defines permanent direct habitat loss as acres of lost habitat that will be removed for the operating life of the Project, and temporary direct habitat loss as acres of lost habitat that will be removed during construction but will be reclaimed and/or allowed to rejuvenate following the construction period. Estimates of permanent and temporary acres of direct habitat loss for major Project components are provided in Table 1.1.

Another direct potential impact from the Project will be mortality or injury to eagles and other birds or bats due to collision with infrastructure and possibly electrocution, although the latter is expected to be minimized by burying collection lines and following Avian Power Line Interaction Committee (APLIC) guidelines for minimizing electrocution and collision risk associated above-ground power transmission (APLIC 2006, 2012; see Section 5.0 below for additional discussion of other types of impacts beyond temporary and permanent habitat loss).

Indirect impacts associated with the Project include habitat fragmentation, species displacement, and avoidance. Construction of the Mountain Breeze portion of the Project is anticipated to begin in mid-late 2019 with an estimated in-service date in the third or fourth quarter of 2020. For the Panorama portion of the Project, construction is expected to start in mid-2021 and with an in-service date in the fourth quarter of 2021.

Table 1.1. Estimated permanent and temporary acres of direct impacts associated with the Mountain Breeze/Panorama Wind Energy Project features, Weld County, Colorado.

Project Feature	Number or Miles	Temporary Impact Acres	Permanent Impact Acres
Wind Turbine Generators	128	320.89	38.24
Access Roads	61.10	16.40	53.10
Collection Lines	73.70	58.41	0
MET Tower (unguyed)	1	0.04	0.01
Substations	2	0	5.79
Laydown Yard	2	38.65	0
230-kV Gen-tie Line[1]	10 miles	121.21	0
115-kV Gen-tie Line	13.4 miles	162.42	0
Total		**718.02**	**391.90**

[1]Due to the low vegetation height, the right of way for gen-tie lines will not be mowed or maintained.

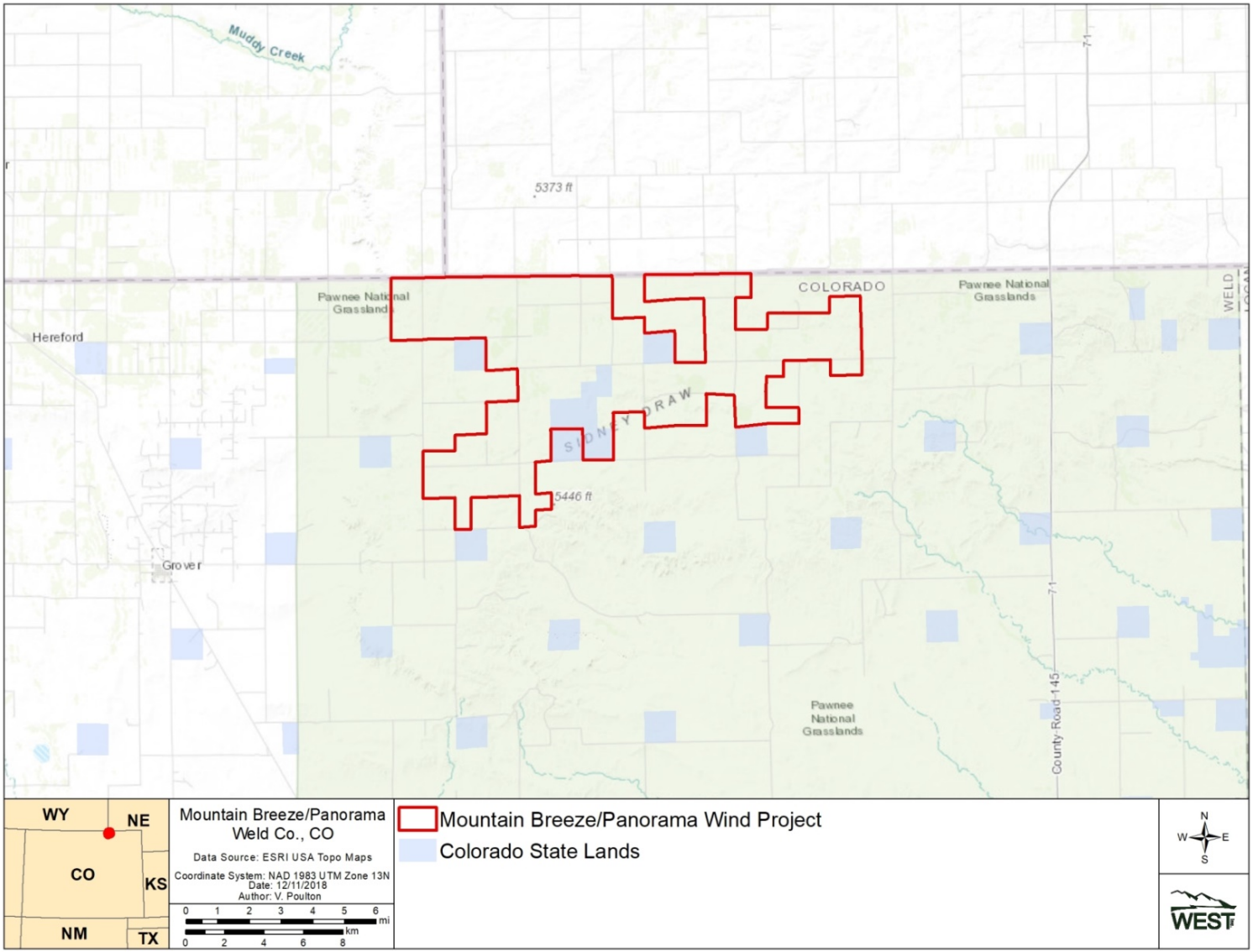


Figure 1.1. General location of the Mountain Breeze/Panorama Wind Energy Project in Weld County, Colorado.

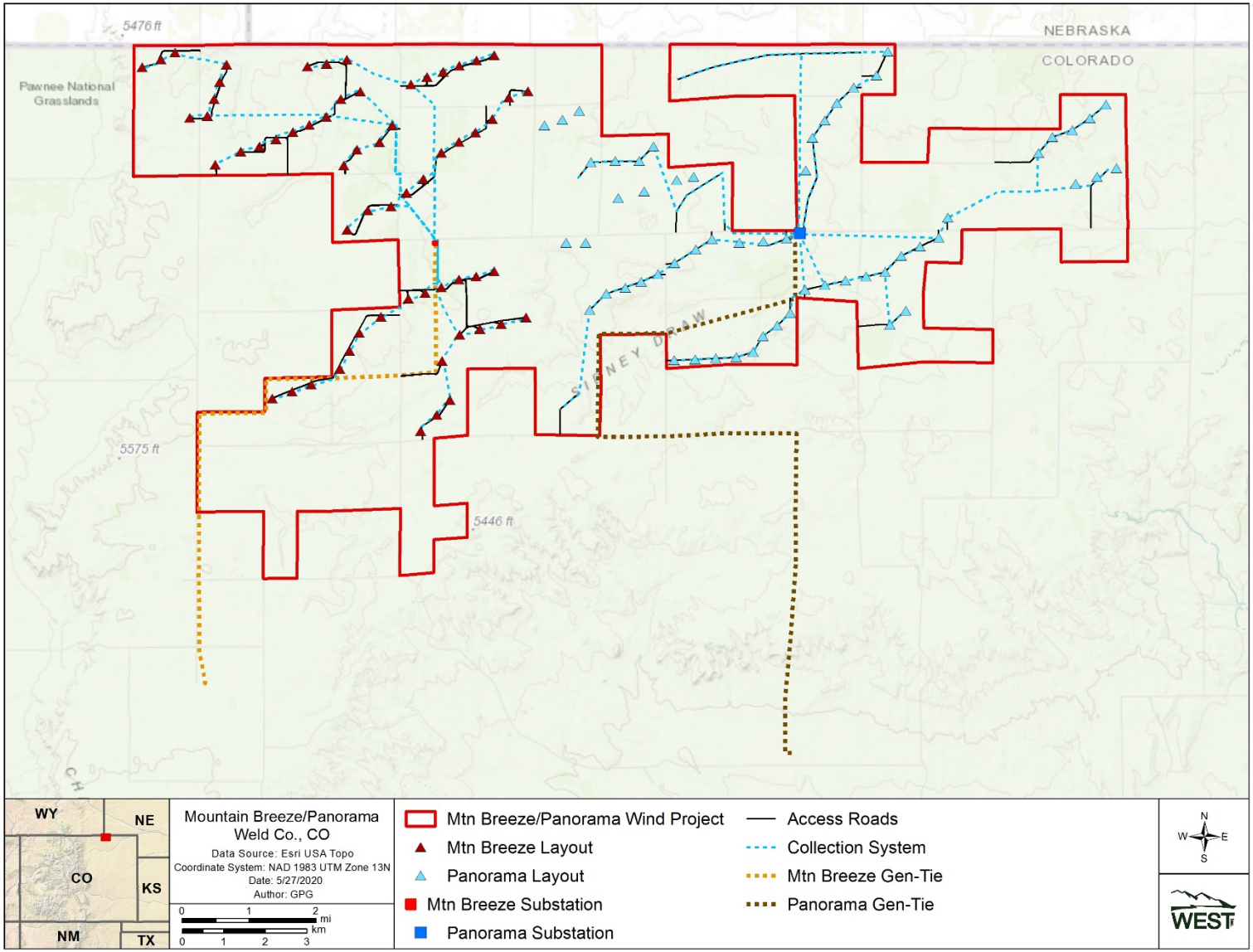


Figure 1.2. Proposed layout for the Mountain Breeze/Panorama Wind Energy Project.

1.2 Environmental Setting

The Project, including the gen-tie lines, is located on approximately 43,000.0 acres (ac; 67.2 square miles) in the high-altitude plains east of the Rocky Mountains. The Project boundary encompasses 34,455.87 ac, exclusive of the gen-tie lines. Elevations within the Project boundary range from approximately 1,561 to 1,675 m (5,120 to 5,494 ft; Figures 1.2 and 1.3). The Project area has rolling to hilly topography, with more rugged topography outside of the Project boundary along an escarpment to the south and west (Figures 1.2 and 1.3). The dominant land use within the Project area is livestock (mostly cattle) grazing, although there are also some cultivated lands within the Project area (Figure 1.4). Of the 128 turbines, there are 10 proposed on state-owned and 118 on privately owned land.

There is one intermittent drainage feature (Sidney Draw) that flows to the northeast through the Project area. Sidney Draw joins with Lodgepole Creek, which is a tributary to the South Platte River. According to the National Land Cover Database (NLCD; 2016), land cover in the Project area is dominated by grassland/herbaceous (22,183 ac, 64.4%), while cultivated crops are the next most common cover type (11,069 ac, 32.1%; Table 1.2, Figure 1.4). In addition to the grassland and cultivated crop cover types, approximately 3.4% of land cover within the Project area is developed open space, hay/pasture, deciduous forest, woody wetlands, and open water (Table 1.2, Figure 1.4). Developed low intensity, barren land, shrub/scrub, emergent herbaceous wetlands, and evergreen forest together represent about 0.1% of land cover (Table 1.2, Figure 1.4). The density of human habitation in the vicinity of the Project is very low, consisting primarily of homesteads or buildings for ranching and farming operations.

Table 1.2 illustrates the major land cover types present within the Project area. As illustrated above in Table 1.1, Project impacts are estimated affect a relatively small portion of the total Project area. The Project is estimated to permanently impact approximately 392 ac and temporarily impact approximately 718 ac. An estimate of the major land-use types, based on the NLCD (2016) which will be impacted by the Project is provided in Table 1.3. The estimates are provided to give a very general idea of land cover types that may be impacted (i.e., primarily grassland and cropland). It is important to note that this dataset is fairly coarse in nature and may not accurately reflect conditions within the Project area. For example, examination of aerial imagery indicates that areas labeled as deciduous forest and open water do not actually contain those features and are mostly used for cultivated agriculture. Determination of the potential for wetland impacts should be based on wetland delineations conducted within the Project.

Table 1.2. Land cover types in the Mountain Breeze/Panorama Wind Energy Project, excluding the generation tie-line routes, in Weld County, Colorado, from the National Land Cover Database (2016).

Land Cover	Acres	% Composition
Grassland/Herbaceous – *areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.*	22,182.72	64.4

Table 1.2. Land cover types in the Mountain Breeze/Panorama Wind Energy Project, excluding the generation tie-line routes, in Weld County, Colorado, from the National Land Cover Database (2016).

Land Cover	Acres	% Composition
Cultivated Crops – *areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.*	11,069.00	32.1
Developed, Open Space – *areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.*	665.64	1.9
Hay/Pasture – *areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.*	262.05	0.8
Deciduous Forest - *areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.*	90.54	0.3
Woody Wetlands – *areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.*	81.60	0.2
Open Water – *areas of open water, generally with less than 25% cover of vegetation or soil.*	61.12	0.2
Developed, Low Intensity – *areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.*	13.25	<0.1
Barren Land (Rock/Sand/Clay) - *areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.*	10.62	<0.1
Shrub/Scrub - *areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.*	8.89	<0.1
Emergent Herbaceous Wetlands – *areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.*	7.11	<0.1
Evergreen Forest – *areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.*	3.33	<0.1
Total	**34,455.87**	**100**

Table 1.3. Estimated temporary and permanent acres of impact by major land-use/habitat types associated with Mountain Breeze/Panorama Wind Energy Project features. Data were obtained the National Land Cover Database (2016). Due to rounding, sums may not equal totals reflected on Table 1.1.

	Disturbance Acres per Land Cover Class							
	Grassland/ Herbaceous	**Cultivated Crops**	**Developed, Open Space**	**Developed, Low Intensity**	**Pasture/Hay**	**Barren Land**	**Deciduous Forest**	**Open Water**
Permanent Impacts								
Turbine	27.94	9.79	0	0	0	0	0.21	0.30
Access Roads	38.25	13.33	0.86	0	0.24	0.02	0.07	0.32
Collection Lines	0	0	0	0	0	0	0	0
Substation	10.99	4.32	1.57	0	0	0	0	0
Laydown Yard*	0	0	0	0	0	0	0	0
230-kV Gen-tie Line	0	0	0	0	0	0	0	0
115-kV Gen-tie Line	0	0	0	0	0	0	0	0
Total Permanent	**77.19**	**27.44**	**2.44**	0	**0.24**	**0.02**	**0.28**	**0.63**
Temporary Impacts								
Turbine	236.17	81.26	0	0	0	0	0.87	2.58
Access Roads	11.87	4.03	0.30	0	0.08	0.01	<0.01	0.11
Collection Lines	38.75	16.80	1.07	0.02	0.19	0.01	0.10	0
Substation	0	0	0	0	0	0	0	0
Laydown Yard*	1.15	37.50	0	0	0	0	0	0
230-kV Gen-tie Line	121.21	0	0	0	0	0	0	0
115-kV Gen-tie Line	162.42	0	0	0	0	0	0	0
Total Temporary	**571.57**	**139.59**	**1.37**	**0.02**	**0.26**	**0.02**	**0.97**	**2.69**

* Locations not yet determined for Panorama Wind.

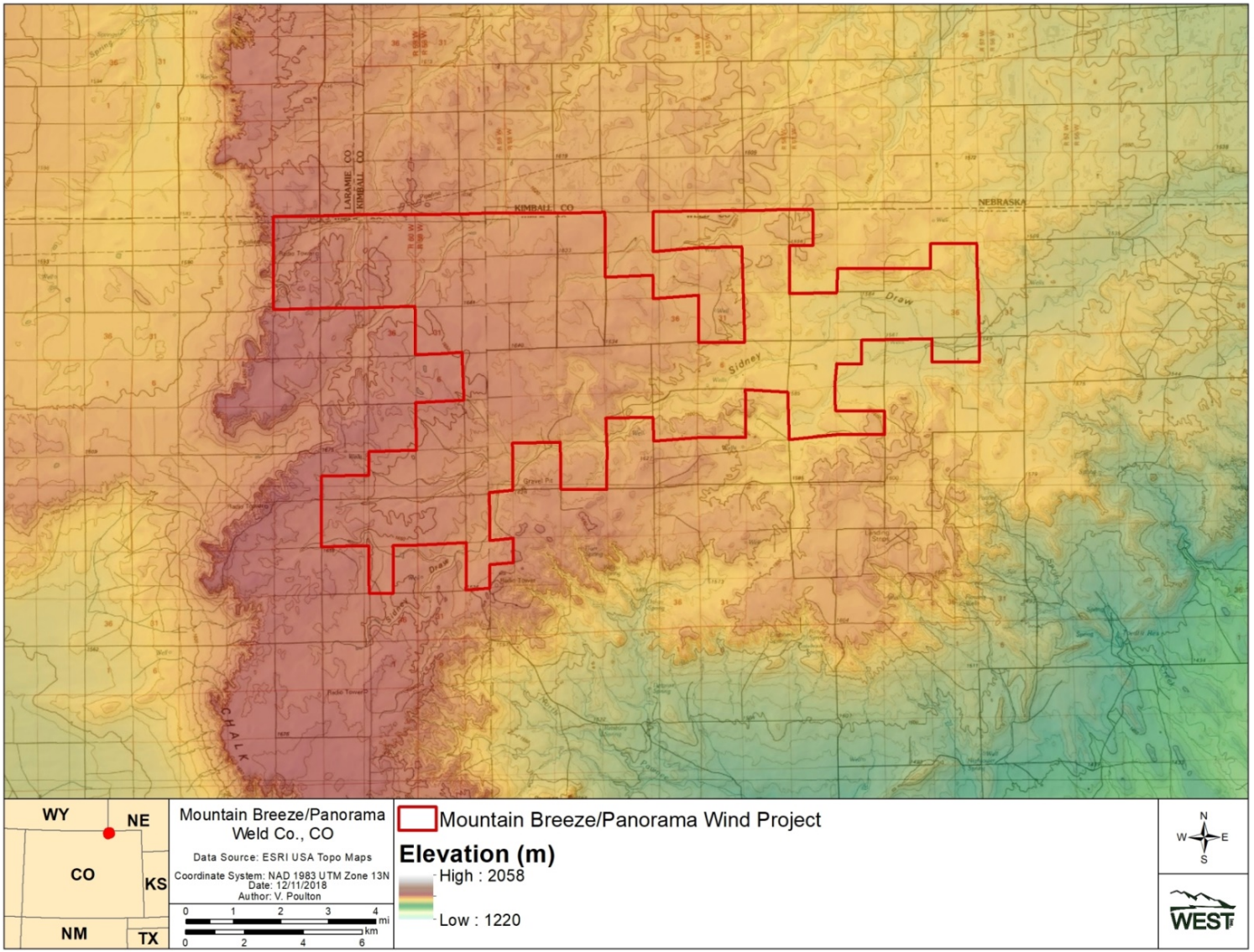


Figure 1.3. Digital elevation map of the Mountain Breeze/Panorama Wind Energy Project.

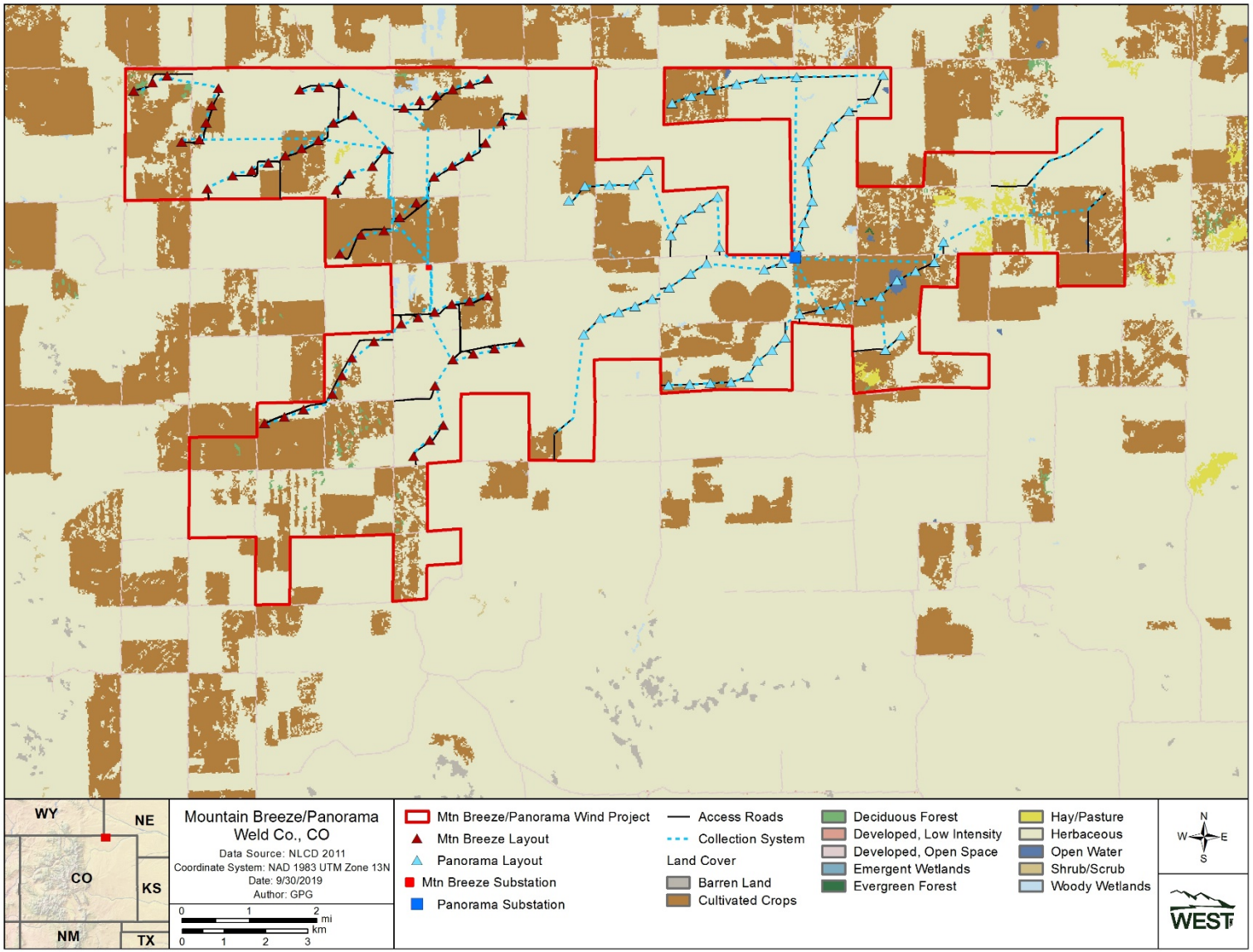


Figure 1.4. Land cover for the Mountain Breeze/Panorama Wind Energy Project.

1.3 Agency Communication

The Project has regularly communicated with the USFWS and Colorado Parks and Wildlife (CPW) regarding the Project plans and biological surveys, including phone calls, e-mails, and in-person meetings beginning in August 2017 (Table 1.4). Study plans for aspects of the two years of baseline data collection were developed with input from USFWS and CPW, and study results were shared with USFWS and CPW. The Project coordinated with the USFWS and CPW in determining the final turbine and gen-tie layout for the Project, with the intent of avoiding and minimizing impacts to wildlife including eagles and state-listed species. For example, The Project worked with CPW to site some turbine locations and route the gen-tie line to avoid breeding sites for plains sharp-tailed grouse (PSTG; *Tymphanuchus phasianellus jamesi*), which is state-listed as endangered in Colorado.

The Project coordinated with USFWS throughout the development of the Project's ECP, and intends to continue to coordinate with USFWS throughout the eagle permit process. In addition, The Project intends to continue working with the USFWS to avoid and minimize impacts to migratory birds including eagles (The Project anticipates developing a BBCS in coordination with USFWS).

1.4 Endangered Species Act Compliance

Based on the Project location, baseline wildlife survey observations, available data, and discussions with USFWS, no impacts to federal-listed endangered or threatened species are anticipated. There is no designated critical habitat for federal listed species in the Project. No activities are planned that will affect water sources in the North or South Platte River systems.

1.5 Department of Defense and Federal Aviation Administration Coordination

The Project has communicated plans and coordinated with the Department of Defense (DoD) and Federal Aviation Administration (FAA) to ensure there will be no interference with DoD installations or federal or civil airports. In a letter dated July 31, 2019, DoD confirmed that construction of the Project as proposed would not have an adverse impact on Military operations. In letters dated May 29, 2018, and August 13, 2019, the FAA confirmed that proposed turbine locations would not be a hazard to air navigation, assuming they were marked appropriately.

Table 1.4. Summary of communications with the U.S. Fish and Wildlife Service (USFWS) and Colorado Parks and Wildlife (CPW) regarding the Mountain Breeze/Panorama Project.

Communication From	Communication To	Type	Date	Regarding
Leeward, K&L Gates	USFWS (S. Vana-Miller, K. Kritz)	In person, Denver	8/28/2017	Discuss Project development options, surveys
Leeward, K&L Gates, Western EcoSystems Technology, Inc. (WEST)	CPW (T. Florian, B. Marette, M. Sherman, W. Figueroa	In person, Cedar Creek Wind Project	9/27/2017	Discuss Project development options, surveys
K&L Gates	CPW (B. Marette)	Email	10/2/2017	Follow up on September meeting action items
CPW (M. Flenner)	WEST (V. Poulton)	Email	11/9/2017	Grouse lek site spatial data
CPW (B. Marette)	K&L Gates, WEST (V. Poulton)	Email	11/7/2017	Data use agreement and sharing of prairie dog mapping info
K&L Gates, WEST (V. Poulton)	CPW (B. Marette)	Email	3/20/2018	Shared grouse lek survey and prairie dog mapping protocol
Leeward, K&L Gates, WEST	CPW (B. Marette)	Phone	3/27/2018	Discuss plains sharp-tailed grouse survey protocol
Leeward, K&L Gates, WEST	CPW (B. Marette)	Phone	3/30/2018	Follow-up on plains sharp-tailed grouse survey protocol
Leeward, K&L Gates, WEST	CPW (T. Florian, B. Marette, W. Figueroa	In person, Barr Lake Nature Center	9/6/2018	Update on Project plans, discuss results from grouse surveys
Leeward, K&L Gates	CPW (T. Florian, B. Marette, W. Figueroa	In person, Barr Lake Nature Center	10/10/2018	Discuss revised turbine and transmission layout, recommendations
Leeward, K&L Gates, WEST	USFWS (C. Clayton, A. Timberman)	In person, Grand Jct FWS office	12/14/2018	Discuss ECP process
Leeward, K&L Gates, WEST	CPW (B. Marette)	Phone	2/21/2019	Discuss plains sharp-tailed grouse conservation measures, county permit process
Leeward, K&L Gates, WEST	USFWS (C. Clayton, A. Timberman)	in person, Grand Jct FWS office	2/25/2019	Discuss ECP process
Leeward, K&L Gates, WEST	CPW (B. Marette, Wendy Figueroa, Mike Sherman, Troy Florian)	Phone	2/28/2019	Follow up on plains sharp-tailed grouse conservation measures, study plan for spring 2019
Leeward, K&L Gates, WEST	CPW (B. Marette, Wendy Figueroa, Mike Sherman, Troy Florian)	Phone	3/7/2019	Follow up on plains sharp-tailed grouse conservation measures, county comment letter
Leeward, K&L Gates, WEST	USFWS (C. Clayton)	Online meeting	3/13/2019	Discuss ECP process

Table 1.4. Summary of communications with the U.S. Fish and Wildlife Service (USFWS) and Colorado Parks and Wildlife (CPW) regarding the Mountain Breeze/Panorama Project.

Communication From	Communication To	Type	Date	Regarding
Leeward, K&L Gates, WEST	USFWS (K. Kritz, E. Duran, L. Ellwood, C. Clayton, D. Suich)	In person and on phone, Lakewood FWS FO	4/23/2019	Discuss ECP process
Leeward, K&L Gates, WEST	USFWS (K. Kritz, E. Duran, C. Clayton, D. Suich)	Phone	5/17/2019	Discuss site specific data, recommendations on avoidance and minimization
USFWS (K. Kritz)	Leeward, K&L Gates	Email	4/13/2020	Comments and recommended edits for the Mountain Breeze/Panorama ECP

2.0 SITE SPECIFIC SURVEYS AND ASSESSMENTS

Western EcoSystems Technology, Inc. (WEST) completed baseline wildlife surveys for the Project. Project surveys of eagle use and potential prey sources for eagles included two years of large bird/eagle use surveys following methods outlined in the USFWS 2013 Eagle Conservation Plan Guidance (ECPG; USFWS 2013) and the 2016 Final Eagle Rule (81 Federal Register [FR] 91494 [December 16, 2016]), two years of small bird use surveys, two years of aerial raptor/eagle nest surveys, mapping of black-tailed prairie dog (BTPD; *Cynomys ludovicianus*) colonies, mapping of waterfowl concentrations, and two seasons of lek surveys for PSTG. Survey reports are included as Appendices A1-A6. Results relevant to eagles are summarized below.

Boundary changes occurred during the baseline wildlife surveys as Project design evolved. Therefore, the Project boundary during 2017 surveys encompassed the Mountain Breeze/Panorama Project as well as the neighboring Cedar Creek Wind Project. In 2018, the Project boundary was just the Mountain Breeze/Panorama Project as defined at that time.

2.1 Large Bird/Eagle Use Surveys

Two years of large bird/eagle use surveys were completed from January 2017 through December 2018. Following the USFWS recommendations cited above, fixed-point eagle use surveys consisted of eagle counts within circular plots centered on fixed observation points. For analytical purposes, the maximum survey radius around each observation point was 800 m; however, observations of eagles beyond 800 m also were recorded (See Appendix A1 for full report).

In 2017, 29 observation points were selected to provide at least 30% coverage of the Project area, which at the time included the existing Cedar Creek Wind Project, and excluded the eastern portion of the current Project (Figure 2.1). By January 2018, the Project area changed by excluding the Cedar Creek Wind Project and including land to the east, which resulted in selecting 17 observation points, including eight from the 2017 study year. The 2018 survey was conducted from January through June 2018 and covered 30% of the current Project area. In July 2018, the Project area was expanded, so five more observation points were added, including one observation point from 2017, for a total of 22 observation points. Point location was randomized to the extent practicable by randomly selecting a land section and finding the nearest public access to the center of the land section. Observation points were adjusted in the field to achieve an adequate view shed. To summarize, large bird/eagle use surveys were completed using a total of 17-29 observation points, which covered at least 30% of the Project area (Table 2.1).

Table 2.1. Description of observation points used for large bird/eagle use surveys during 2017 and 2018 for the Mountain Breeze/Panorama Project.

Survey Period	# Observation Points	Points
Year 1 (January-December)	29	1-29
Year 2 (January-June)	17	18-19, 22, 24-28, 30-38
Year 2 (July-December)	22	14, 18-19, 22, 24-28, 30-38, 39-42

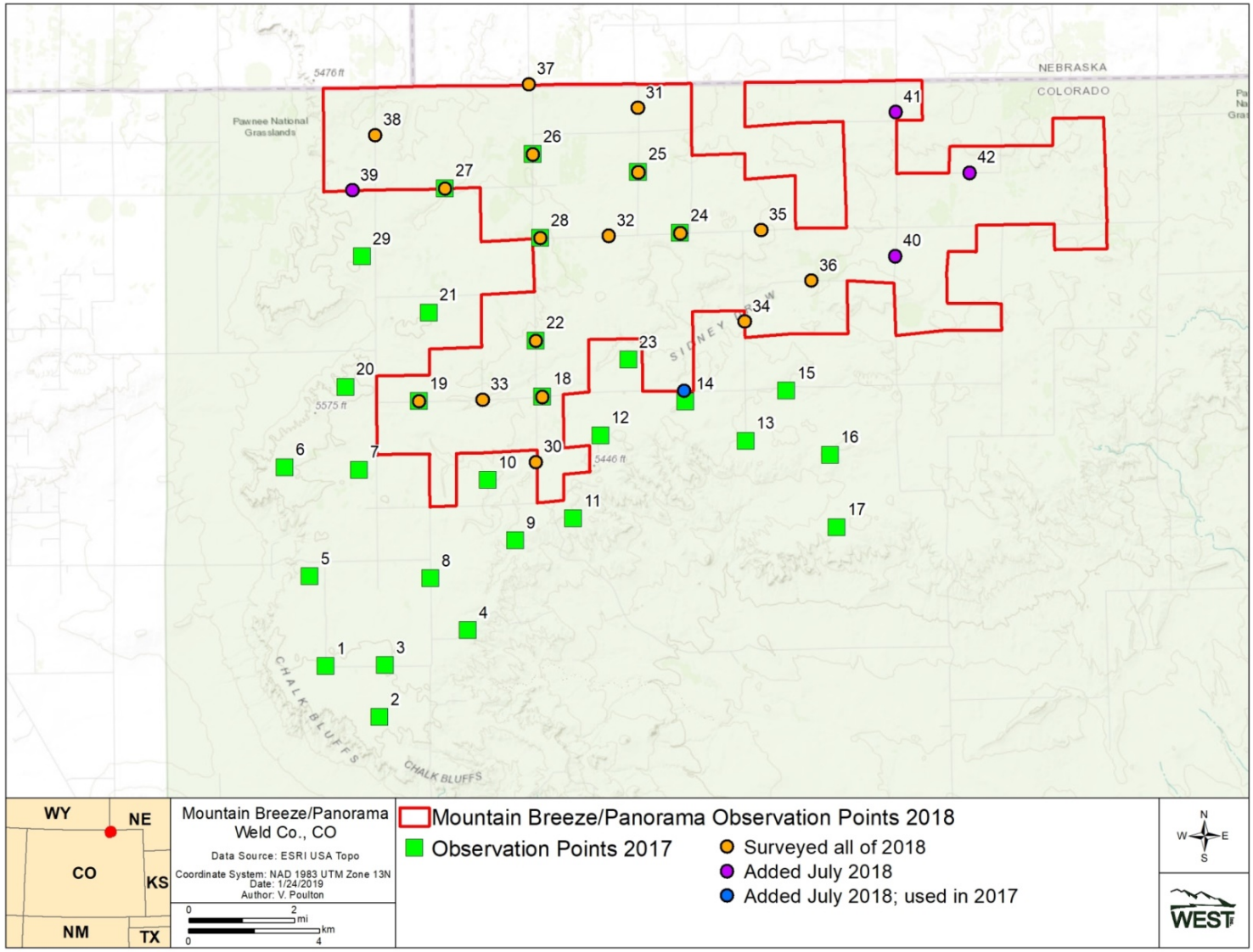


Figure 2.1. Large bird/eagle use survey observation points during 2017 and 2018 for the Mountain Breeze/Panorama Project.

Large bird/eagle use surveys were conducted once per month at each observation point, for a total of 12 survey rounds in the study year. Seasons were defined as: winter (January-February), spring (March-June), summer (July-August), and fall (September-December). Seasons were defined as such so that statistical analyses could accommodate changes in the number of survey points during 2018, and season definitions were used during both survey years to facilitate comparison. Surveys were 60 minutes in duration, and were scheduled to cover all daylight hours. For each observation point, the date, start and end time of each observation period, plot number, species or best possible identification, number of individuals, sex and age class, and location were recorded. The behavior of each eagle observed, flight path and height, and the habitat in which or over which the bird occurred was recorded. Eagle flight paths were recorded on field maps and eagle flight minutes were recorded. Eagles observed outside of use surveys were recorded as incidental wildlife observations.

2.1.1 Eagle Results from Large Bird/Eagle Use Surveys

2017

During 2017, fixed-point large bird/eagle use surveys were conducted for a total of 346.8 hours within the Project between January 25 and December 22. Ten golden eagle observations were recorded. One additional observation was noted; however, due to cloud coverage, positive eagle identification was not accomplished. Of all eagle observations, three were identified as adult birds, one was a subadult, and seven observations were not aged. Individual birds may have been represented by multiple observations. All observations were recorded from four observation points (points 2, 15, 17, 27; Figure 2.2); no eagles were observed from other fixed-point locations. No bald eagles were observed during the 2017 surveys.

For the 10 confirmed golden eagle observations, a total of 40 eagle use minutes were recorded, and a total of 15 eagle risk minutes (i.e., an eagle flying within 800 m of the surveyor and 200 m of ground level) were recorded. An additional risk minute was recorded for the unconfirmed eagle observation. In 2017, the highest number of eagle risk minutes per month was recorded during March (eight eagle risk minutes), followed by October (four eagle risk minutes), January (two eagle risk minutes), and August (one eagle risk minute; Table 2.2). Golden eagles were observed in December, but no risk minutes were recorded; no golden eagle observations were recorded during other months (Table 2.2). Eagle risk minutes per survey hour ranged from 0.08 at Point 2 to 0.75 at Point 27 (Figure 2.2).

Table 2.2. Golden eagle risk minutes documented during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 25 − December 22, 2017.

Month	Survey Hours	Number of Eagle Observations	Number of Eagle Use Minutes	Number of Eagle Risk* Minutes	Eagle Risk Minutes per Survey Hour
January	29.00	1	2	2	0.07
February	29.00	0	0	0	0
March	29.00	2	10	8	0.28
April	25.00	0	0	0	0
May	32.00	0	0	0	0
June	29.00	0	0	0	0
July	29.02	0	0	0	0
August	29.00	1	3	1	0.03
September	28.83	0	0	0	0
October	28.97	3	11	4	0.14
November	29.00	0	0	0	0
December	29.00	3	14	0	0
Total	**346.82**	**10**	**40**	**15**	**0.04**

*Eagles flying within 800 meters (m) of the surveyor and 200 m of ground level.

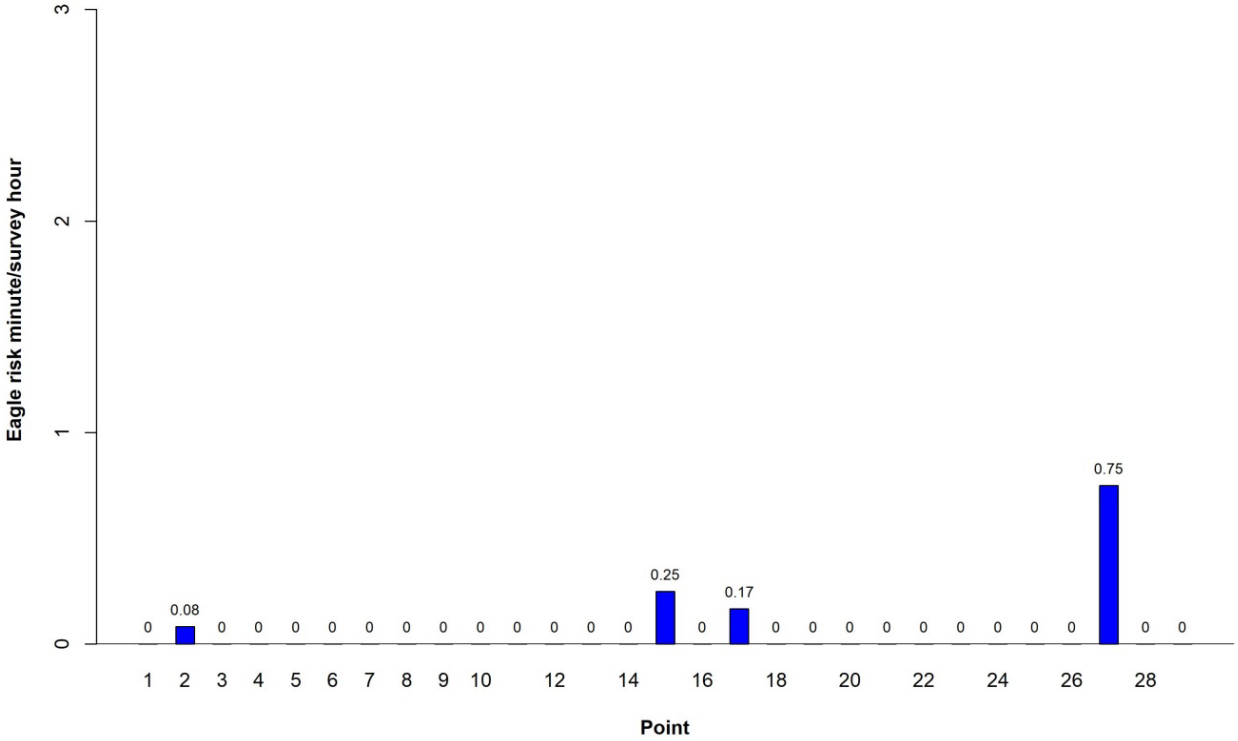


Figure 2.2. Number of golden eagle risk minutes per survey hour by observation point during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 25 − December 22, 2017.

2018

During 2018, large bird/eagle use surveys were conducted within the Project for a total of 234 survey hours between January 29 and December 27. Both golden and bald eagles were observed.

Five golden eagle observations were recorded, of which three were identified as adults, one was a subadult, and one was not aged. For the five golden eagle observations, there were 16 golden eagle use minutes recorded. A total of 14 golden eagle risk minutes were documented. In 2018, the highest number of golden eagle risk minutes per month was recorded during October (12 eagle risk minutes), followed by March 2018 (two eagle risk minutes) (Table 2.3). No golden eagle observations were recorded during other months (Table 2.3). Golden eagle risk minutes per survey hour ranged from 0.17 (Point 35) to 0.33 (points 38 and 40) at the five fixed-point survey locations where they were recorded (Figure 2.3).

Ten bald eagle observations were recorded, including two adults, five subadults, and three observations with birds of mixed ages. Observations did not represent individual birds; nine of the 10 observations were recorded on September 13 at Point 18, and were of one adult and one, possibly two subadults. For bald eagles, the 10 observations were recorded for a total of 25 minutes (Table 2.3). Seventeen risk minutes were recorded for bald eagles, with 15 risk minutes recorded during September 2018, and two risk minutes recorded during November 2018 (Table 2.3). Bald eagles were recorded at two observation points; risk minutes per survey hour were 1.25 at Point 18 and 0.17 at Point 32 (Figure 2.4).

Golden eagles were also recorded as incidental observations in 2018, with four observations in three groups.

Table 2.3. Eagle risk minutes documented during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 29 − December 27, 2018.

Month	Survey Hours	Number of Eagle Observations	Number of Eagle Use Minutes	Number of Eagle Risk* Minutes	Eagle Risk Minutes per Survey Hour
			Golden Eagles		
January	17	0	0	0	0
February	17	0	0	0	0
March	17	1	2	2	0.12
April	17	0	0	0	0
May	17	0	0	0	0
June	17	0	0	0	0
July	22	0	0	0	0
August	22	0	0	0	0
September	22	0	0	0	0
October	22	4	14	12	0.55
November	22	0	0	0	0
December	22	0	0	0	0
Total	**234**	**5**	**16**	**14**	**0.06**
			Bald Eagles		
January	17	0	0	0	0
February	17	0	0	0	0
March	17	0	0	0	0

Table 2.3. Eagle risk minutes documented during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 29 − December 27, 2018.

Month	Survey Hours	Number of Eagle Observations	Number of Eagle Use Minutes	Number of Eagle Risk* Minutes	Eagle Risk Minutes per Survey Hour
April	17	0	0	0	0
May	17	0	0	0	0
June	17	0	0	0	0
July	22	0	0	0	0
August	22	0	0	0	0
September	22	9	21	15	0.68
October	22	0	0	0	0
November	22	1	4	2	0.09
December	22	0	0	0	0
Total	**234**	**10**	**25**	**17**	**0.07**

*Eagles flying within 800 meters (m) of the surveyor and 200 m of ground level.

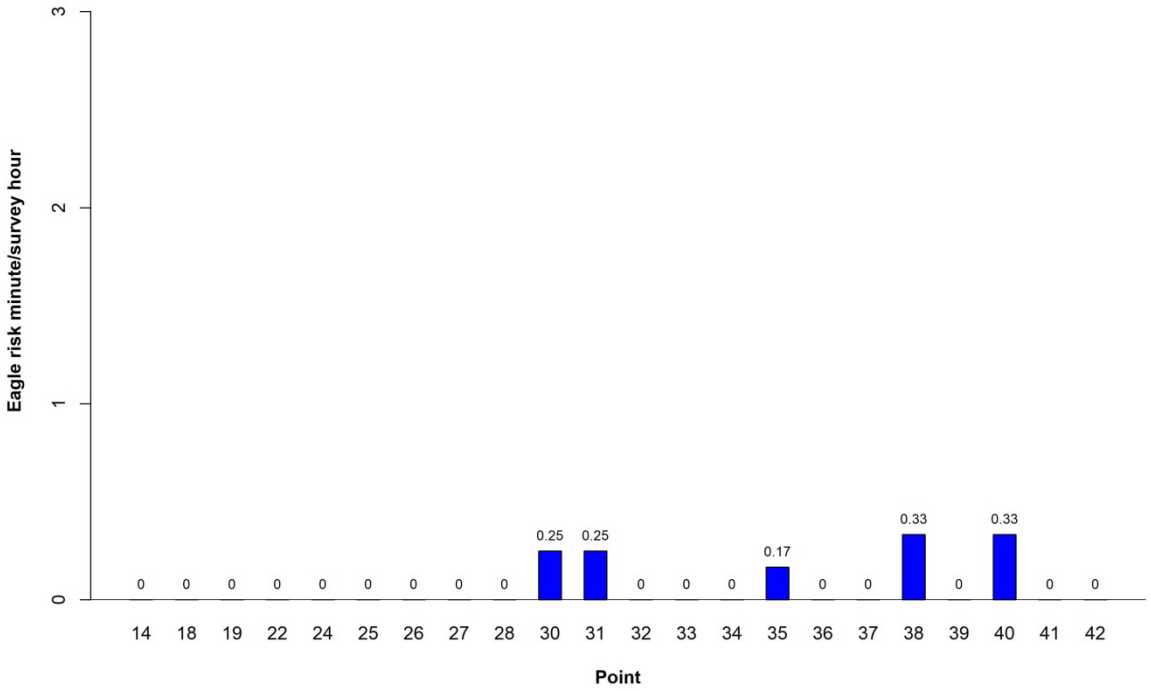


Figure 2.3. Number of golden eagle risk minutes per survey hour by observation point during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 29 − December 27, 2018.

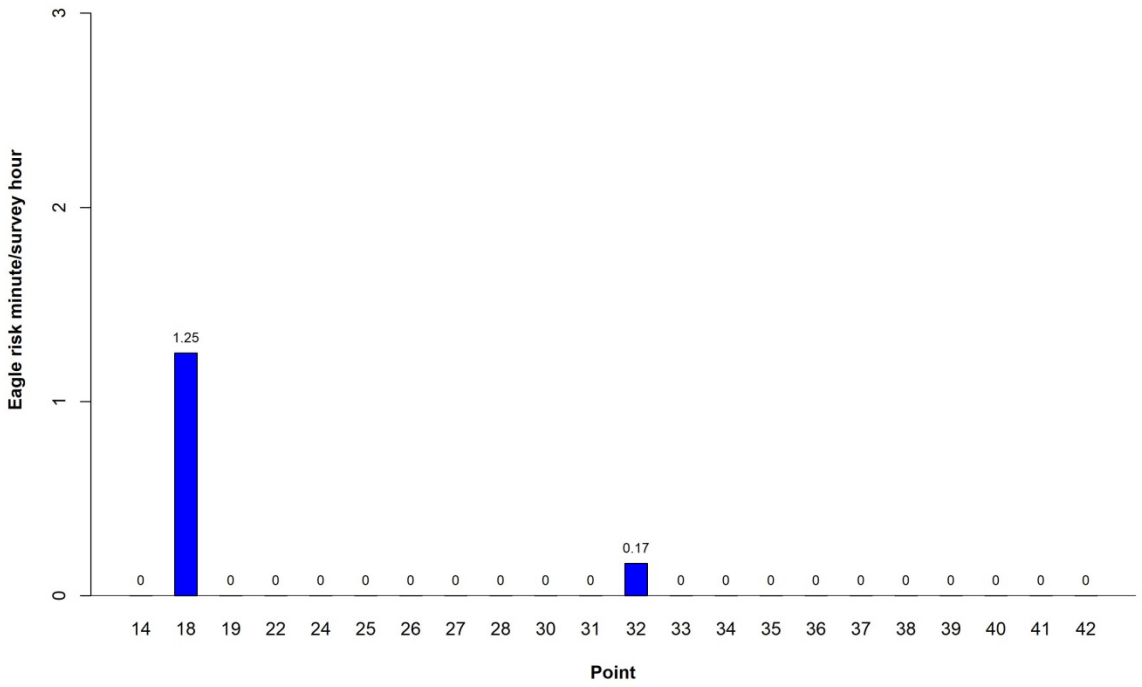


Figure 2.4. Number of bald eagle risk minutes per survey hour by observation point during large bird/eagle use surveys in the Mountain Breeze/Panorama Wind Project from January 29 − December 27, 2018.

Over the two years of large bird/eagle use surveys, flight paths and perch locations for bald and golden eagles were digitized and mapped (Figure 2.5). The point with the most golden eagle flight activity was Point 27, which had one flight recorded in March 2017 and three flights (likely the same individual) in October 2017. Point 13 had three golden eagle flights recorded in December 2017, also likely the same individual, and all occurring outside of the 800-m survey area. No other observation point had more than one flight path recorded for golden eagles during both study years.

For bald eagles, the point with the most activity was Point 18, with nine flight paths recorded for at least two individuals on one day (September 13, 2018; Figure 2.5). Point 32 was the only other point where bald eagles were observed, with one flight path recorded in November 2018. No eagles were observed perching during large bird/eagle use surveys.

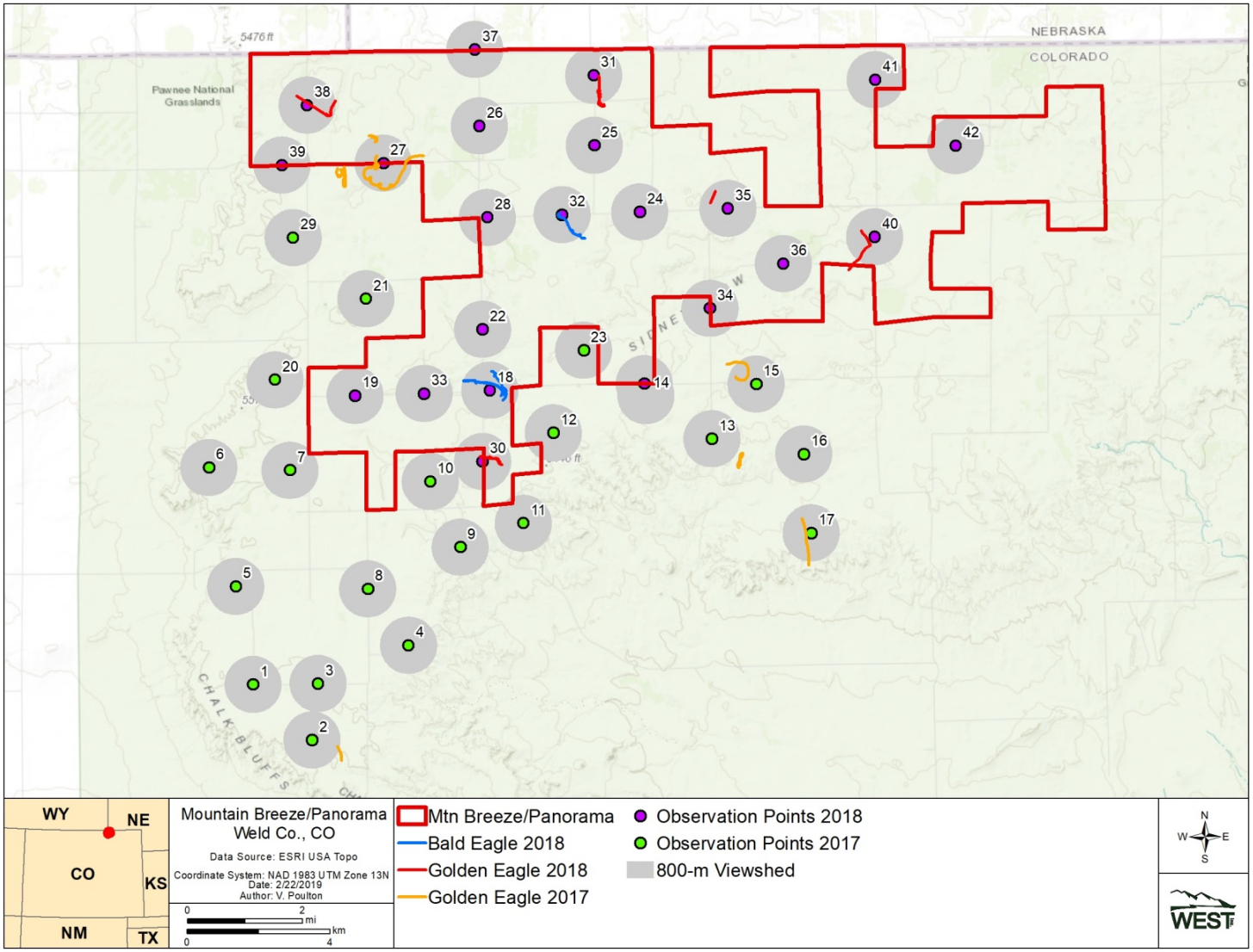


Figure 2.5. Eagle flight paths mapped during large bird/eagle use surveys in 2017 and 2018 for the Mountain Breeze/Panorama Project.

2.2 Eagle Nest Surveys

Aerial surveys for eagle nests were designed to detect any eagle nests within 16 km (10 mi) of the Project boundary. During the 2017 eagle nest surveys, the Project boundary encompassed the Mountain Breeze/Panorama Project as well as the neighboring Cedar Creek Wind Project (Figure 2.6). In 2018, the Project boundary was just the Mountain Breeze/Panorama Project as defined at that time (Figure 2.7). Two survey rounds were conducted between February and May from a helicopter with two observers in addition to the pilot. During the surveys, potential nesting habitat such as trees, power poles, rocky outcrops, and cliff faces were examined for stick nest structures and the presence of raptors. Golden eagle nest locations known from surveys related to the neighboring Cedar Creek Wind Project also were checked.

2017

Two aerial survey rounds for eagle nests were conducted at the Project on February 25-26 and May 2-3, 2017.

During the February survey, one occupied, active golden eagle nest, and 135 inactive nests were detected (Figure 2.6). Of the 135 inactive nests, 28 were large stick nests on cliffs that could potentially be used by golden eagles. The occupied, active golden eagle nest was in a previously unrecorded location about 14.1 km (8.8 mi) northwest of the Project (Figure 2.6).

During the May survey, four occupied, active golden eagle nests, three active nests of unknown species and 98 inactive nests were detected (Figure 2.7). Of the inactive nests, 23 were large stick nests that could potentially be used by golden eagles. One occupied, active golden eagle nest was within the Project boundary (Figure 2.7). The golden eagle nest that was detected in February was still active during the May survey, with an adult observed on the nest. Two golden eagle nests in known locations from previous years that were inactive in February were occupied and active with adults observed at the nests in May. One nest was about 0.7 mi (1.1 km) south of Project Turbine P15, and one was 7.0 mi (11.2 km) to the east. A fourth occupied, active golden eagle nest was in a previously unrecorded location 1.7 mi (2.7 km) southwest of Project Turbine A10.

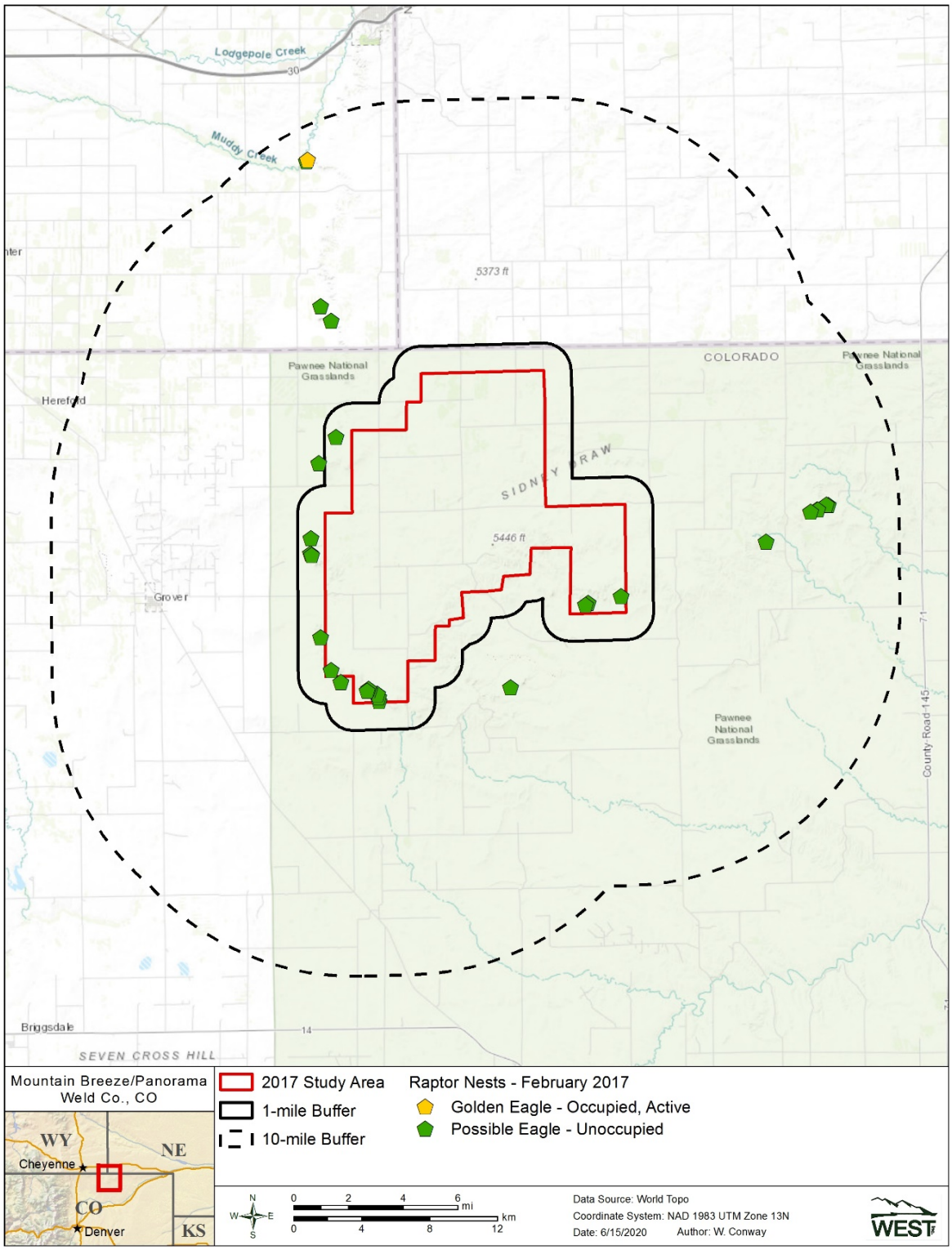


Figure 2.6 Eagle and possible eagle nests detected during eagle nest surveys for the Mountain Breeze/Panorama Wind Project, February 25 − 26, 2017.

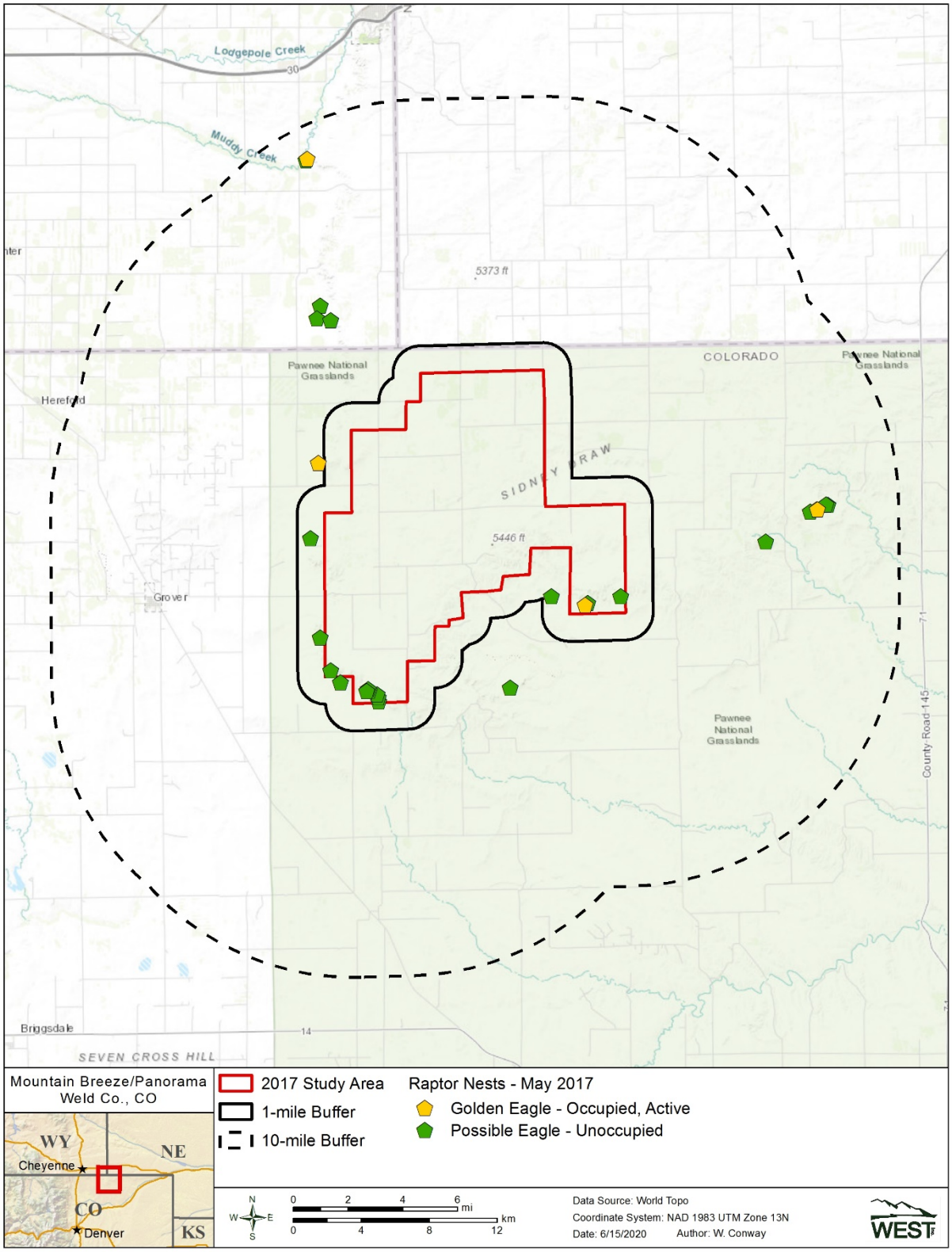


Figure 2.7. Eagle and possible eagle nests detected during eagle nest surveys for the Mountain Breeze/Panorama Wind Project, May 2 − 3, 2017.

2018

Two aerial survey rounds for eagle nests were completed at the Project on March 10-12 and May 8, 2018. Potential prey sources for golden eagles such as prairie dog colonies and waterfowl concentrations also were recorded during the first survey round (Figure 2.8). The second survey round targeted previously identified nest locations.

During the March survey, three occupied, active golden eagle nests and 51 inactive nests were detected. Of the inactive nests, 43 were large stick nests on cliffs that could potentially be used by golden eagles, but many were in poor condition. The three occupied, active golden eagle nests were in previously recorded locations to the south and east of the Project. The nearest golden eagle nest was about 6.4 km (4.0 mi) south-southwest of the Project boundary. Other golden eagle nest locations known from surveys during previous years were not occupied during the March 2018 survey.

During the May survey, there was increased nesting activity. Four golden eagle nests occupied, active, and 54 inactive nests were detected (Figure 2.8). Of the inactive nests, 39 were large stick nests that could potentially be used by golden eagles. One golden eagle nest that was occupied, active in March was not occupied during the May survey. All four occupied, active golden eagle nests were observed to have an adult on the nest, and chicks were seen in one of the nests. The nearest occupied, active golden eagle nest to the Project was 4.2 km (2.6 mi) west of the Project. Other active nests were between 7.5 km (4.7 mi) and 11.8 km (7.4 mi) from the Project boundary.

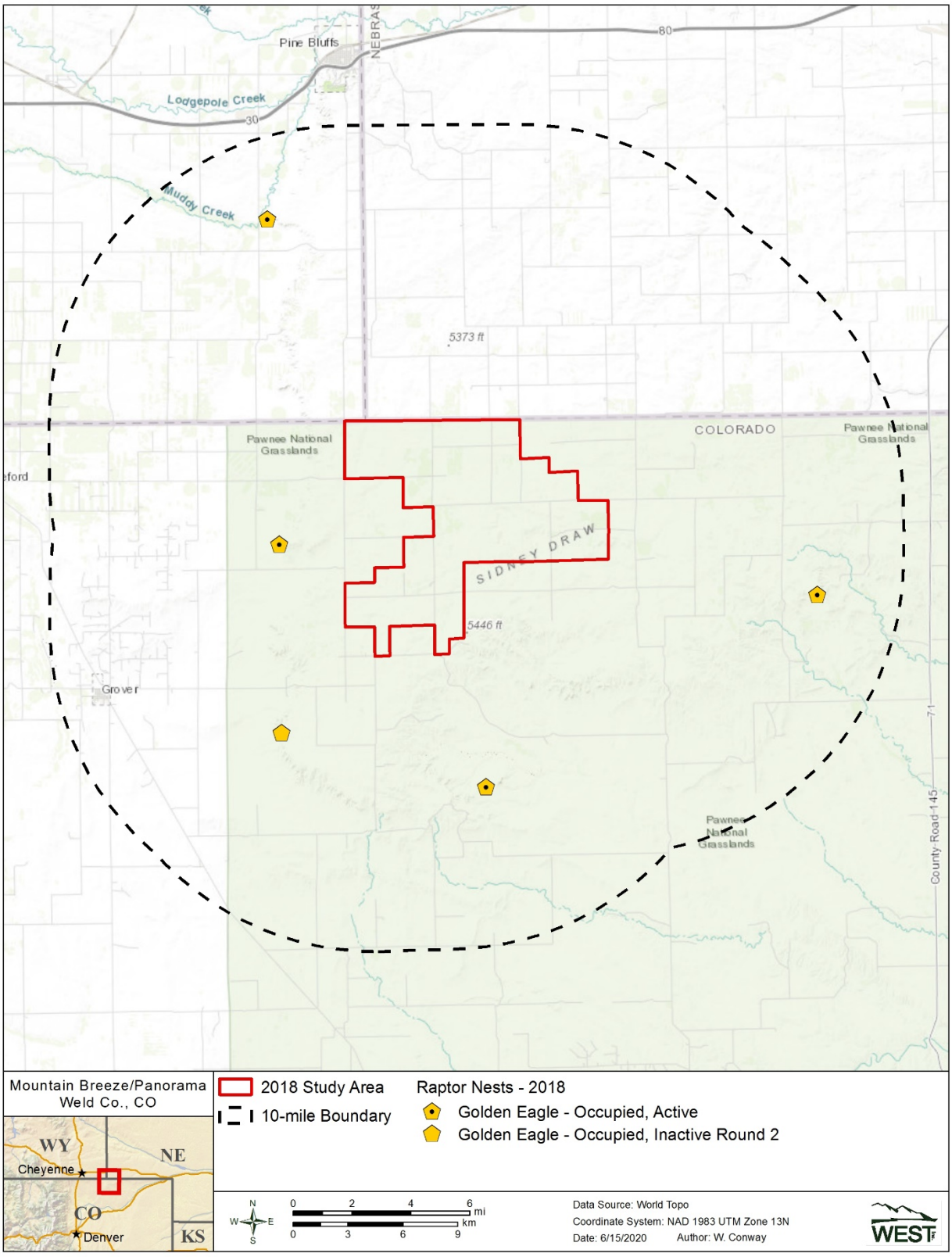


Figure 2.8. Eagle nests detected during aerial eagle nest surveys for the Mountain Breeze/Panorama Wind Project, May 2 − 3, 2018.

2.3 Prey Base Mapping

BTPD colonies in and around the Project were mapped during May 2018. The purpose of the survey was to understand where potential prey sources for golden eagles occur. Available BTPD colony data mapped by CPW in 2015 and from colonies recorded during raptor nest surveys conducted in March 2018 for the Project were used to target ground surveys. For ground surveys, a biologist drove on public roads in an attempt view mapped BTPD colonies. If the colony was visible, the biologist noted if the colony appeared to be active (had prairie dogs present) or not, if the mapped area appeared to be accurate or not, if there were changes in the active colony location, and if any sensitive species, including eagles or burrowing owls (*Athene cunicularia*), were seen in the area.

Twenty-two potential BTPD colonies were mapped by CPW within 16 km (10 mi) of the Project, and an additional 11 point locations for potential colonies were recorded by WEST during aerial surveys in March 2018 (Figure 2.9). Of these 33 total locations, 20 were visible from public roads. Five colonies were confirmed active, eight were confirmed inactive, and the remaining colony status remained unknown due to lack of visibility or sufficient visual evidence (Figure 2.9). Burrowing owls, a state-listed threatened species, were observed at three active colonies and one unknown status colony. No active BTPD colonies were observed within the Project boundary. The nearest colony was located approximately 1.0 km (0.6 mi) outside of the Project boundary to the south (Figure 2.9).

Waterfowl concentrations observed during aerial surveys in March 2018 also are included in Figure 2.9. These observations were not reviewed from the ground; rather they were recorded opportunistically during aerial nest surveys where waterfowl were observed using available stock ponds and other water impoundments.

Although a primary land use within the Project is rangeland grazing of livestock there are no known concentrated animal feeding operations that may provide concentrated sources of livestock carcasses for scavenging eagles. The Project area does contain some water impoundments and stock tanks for livestock, which may provide concentrations of livestock carcasses to a lesser extent. Big game ranges mapped by CPW indicate that mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), and pronghorn (*Antilocarpa americana*) winter range occurs over the entire Project, with a winter concentration area on the western side of the Project for mule deer, and on the eastern side for pronghorn (Figure 2.10). These winter ranges may produce episodic scavenging opportunities depending on the severity of winter weather.

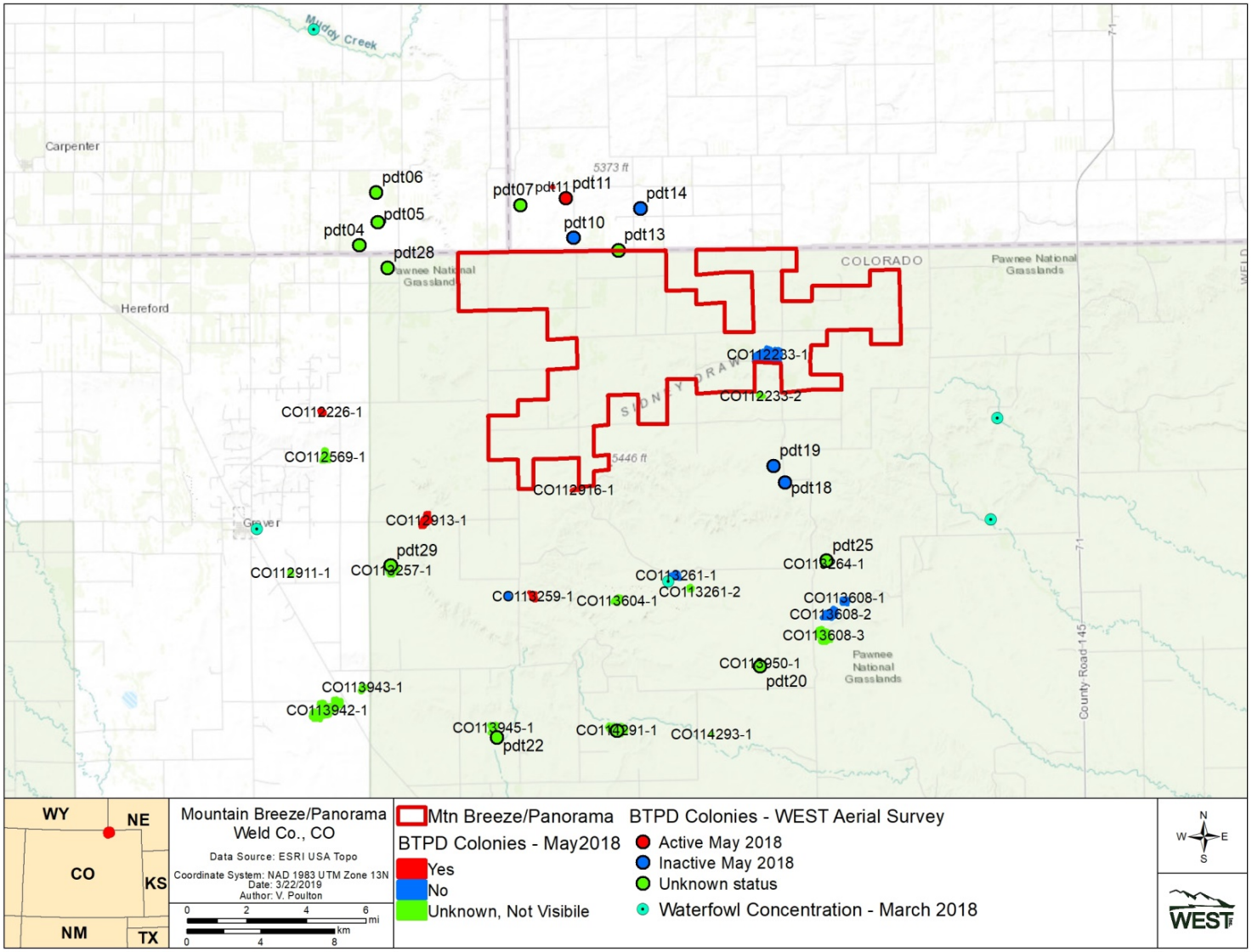


Figure 2.9. Black-tailed prairie dog colonies and waterfowl concentrations in the vicinity of the proposed Mountain Breeze/Panorama Project during May 2018.

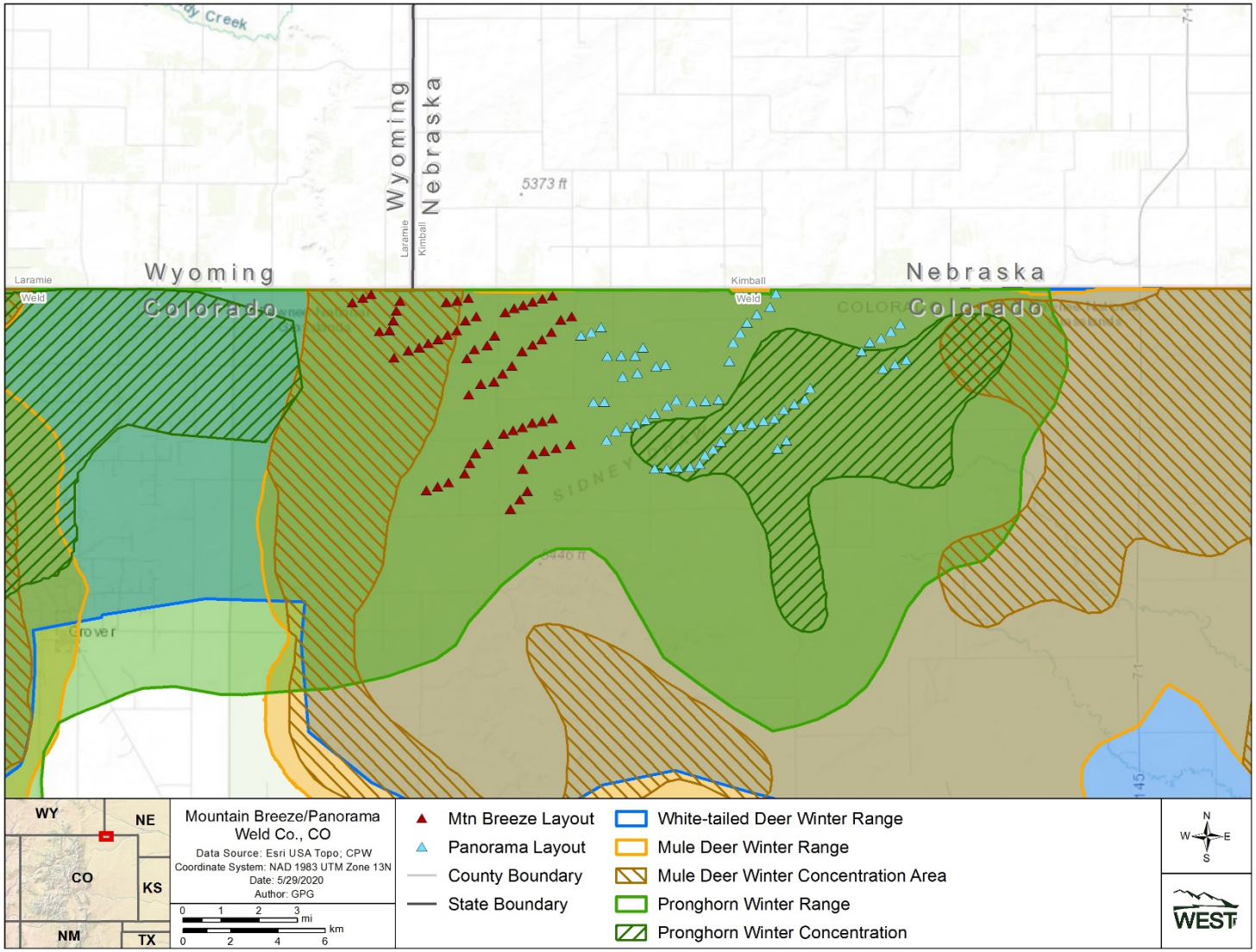


Figure 2.10. Ranges of big game species at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado.

2.4 Plains Sharp-tailed Grouse Lek Surveys

Ground-based lek surveys for PSTG were conducted at the Project and the neighboring Cedar Creek Wind Project during spring of 2018 and 2019. PSTG leks may be attractive prey sources for golden and bald eagles (Marks 2007). Lek surveys were designed with input from CPW. During each spring season, two survey rounds were conducted at each survey point. All surveys were planned to be completed between April 1 and May 7. Surveys were conducted from 30 minutes before sunrise to two hours post-sunrise (2.5 hours total per morning). At each survey point, the surveyor listened and conducted visual scans for PSTG for three minutes. Surveys were not conducted if there was heavy precipitation or windy conditions. PSTG detections were recorded as waypoints or were mapped on detailed topographic or aerial maps. Following guidance provided by CPW, observations of PSTG were considered leks if three or more birds were present; however, lekking activity also was observed or heard in some groups of fewer than three birds.

In spring 2018, the first survey round was April 10-12, and the second round was April 22 – 28. Survey points were spaced 0.5 mile apart, to the extent possible, along public roads, turbine access roads, and private access roads in grassland (grazed and ungrazed) in the Project and the neighboring Cedar Creek Wind Project. There were a total of 68 survey points in the Project and 106 survey points in the Cedar Creek Wind Project. During the first round of surveys, six PSTG leks were detected and seven non-lek observations were recorded (Figure 2.11). During the second survey round, one additional lek was detected (on two separate days), a lek from the first round was re-detected, and eight non-lek observations were recorded (Figure 2.11).

PSTG lek surveys in 2019 were intended to cover portions of the Project that were not included in the 2018 surveys due to changes in the Project boundary. The first survey round occurred April 4-25, and the second round was April 23 – May 3. Survey points were spaced 0.5 mile apart, to the extent possible, along public roads and on private lands in grassland (grazed and ungrazed) in the Project. Fifty-two survey points were placed to cover areas not covered during 2018 PSTG lek surveys. During the surveys, six PSTG leks were detected and mapped. There were 17 observations of PSTG that were not considered leks, either because only one or two birds were present, or larger groups were observed that were not engaged in lekking activity (Figure 2.12). Of the non-lek observations, 14 were recorded during surveys, and four were recorded incidentally while traveling around the Project. Sixteen additional observations were recorded where potential PSTG lek activity was detected by sound only, but the calls were heard at a distance, and a location could not be determined due to lack of access or ability to triangulate, as well as potential that these were previously detected leks or satellite leks.

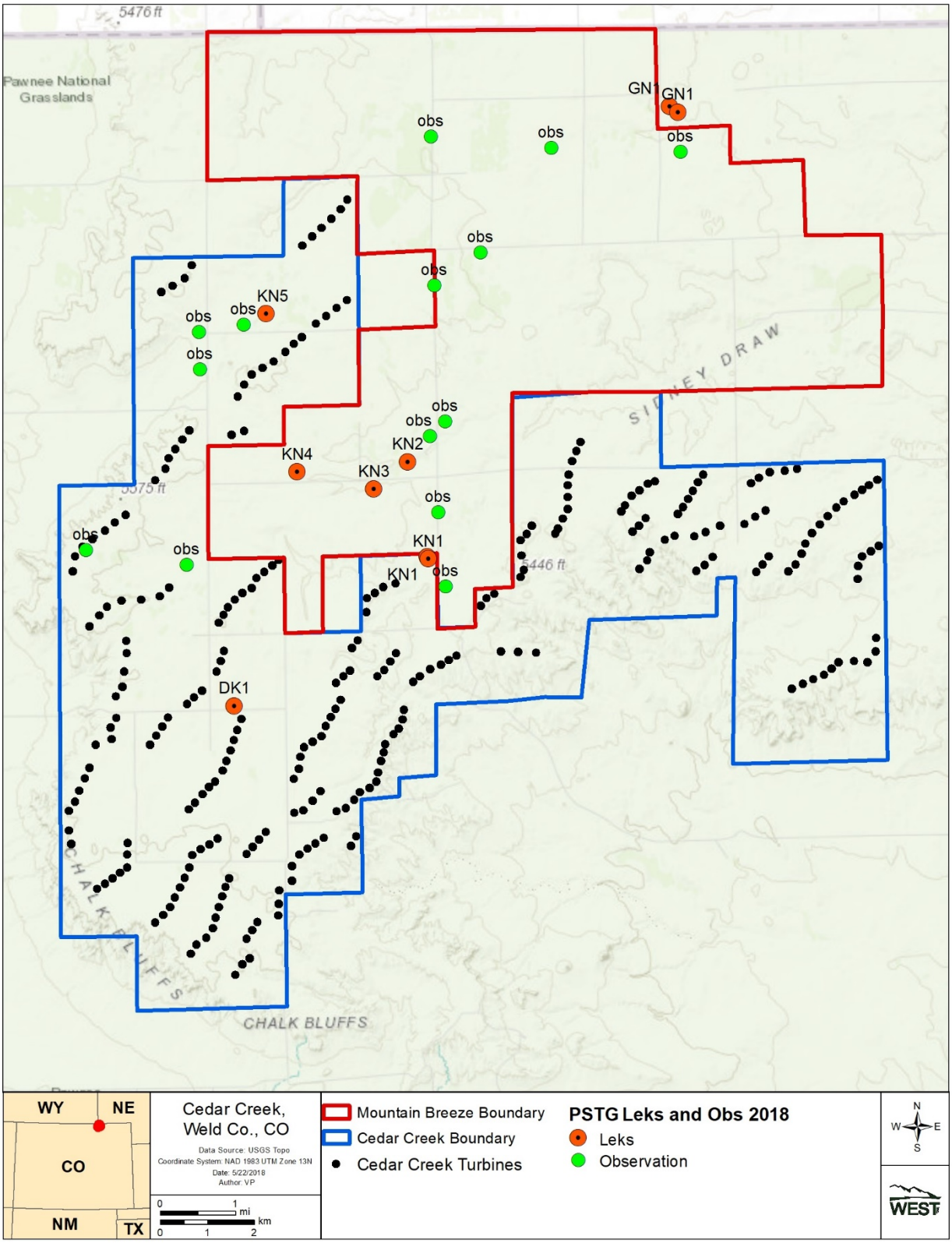


Figure 2.11. Lek locations and plains sharp-tailed grouse observations during ground-based lek surveys at the proposed Mountain Breeze Wind Project and existing Cedar Creek Wind Project, April 2018.

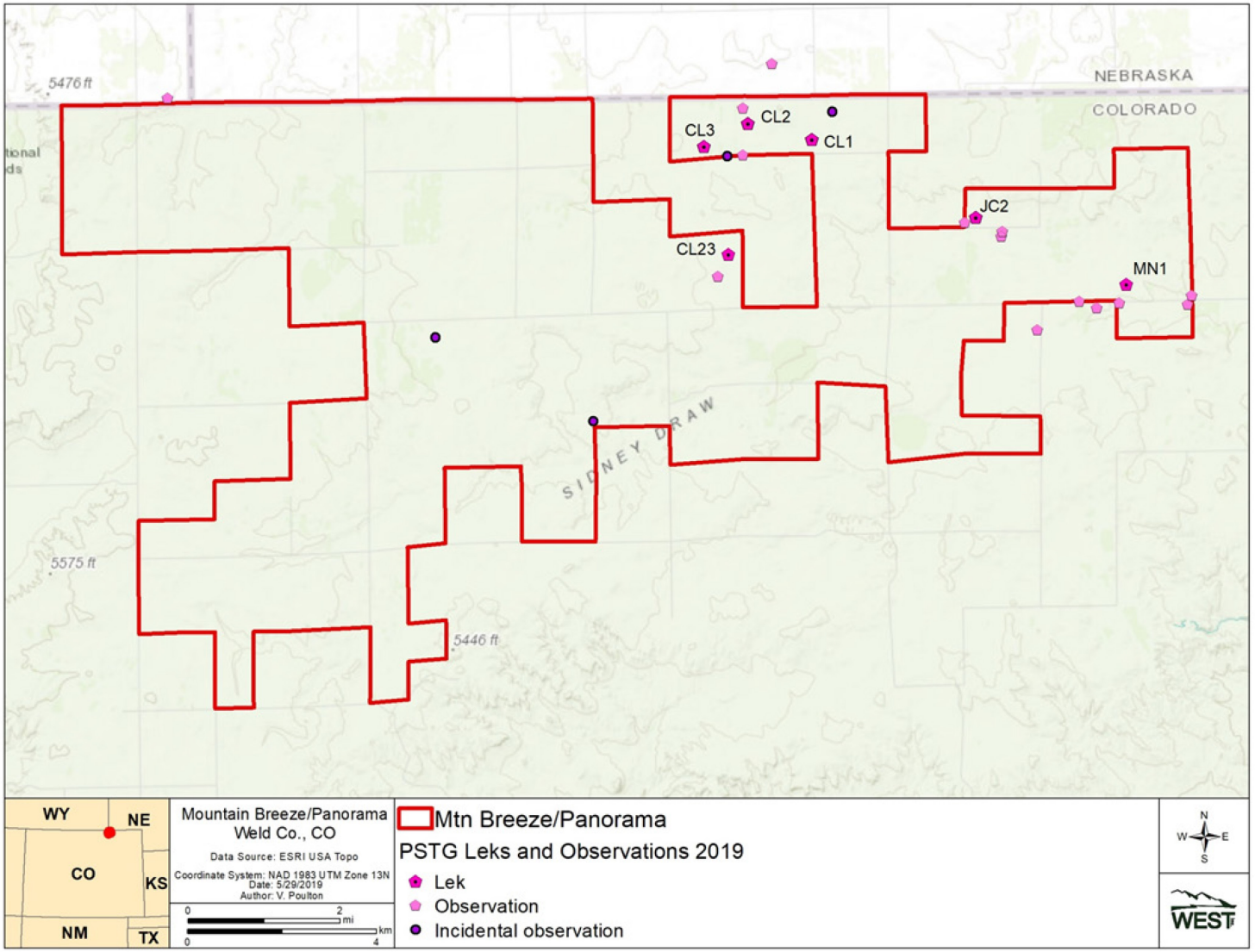


Figure 2.12. Locations of sharp-tailed grouse lek and non-lek observations during ground-based lek surveys conducted between April 2 and May 3, 2019, at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado.

3.0 AVOIDANCE AND MINIMIZATION OF RISKS DURING PROJECT PLANNING AND DESIGN

The Project incorporated impact avoidance and minimization recommendations from the USFWS and CPW, as well as various Best Management Practices (BMPs) and conservation measures to reduce risk to eagles during the pre-construction design phase, and will continue to implement BMPs and conservation measures during construction and operation. BMPs and conservation measures built into the Project during the pre-construction design phase are described in this section. BMPs and conservation measures that will reduce potential risk to eagles at the Project during construction and operation of the Project are presented in Section 6.0.

3.1 Project Siting

The Project considered potential impacts to wildlife throughout planning and development. Leases were initiated with landowners in 2017. The Project is sited in an area that contains little topographic relief compared to the surrounding areas, and suitable nesting habitat for eagles is very limited in the Project area as evidenced by lack of eagle nests within the Project boundary.

3.1.1 Golden Eagle Nests

Locations of golden eagle nests known from previous surveys for the neighboring Cedar Creek Wind Project, as well as information from nest surveys conducted in 2017 and 2018 for the Project, were taken into consideration when planning turbine locations. Additionally, the escarpment to the west of the Project is known to provide nesting habitat for golden eagles and other raptors, and areas close to the escarpment were avoided for turbine development to the extent practicable.

Following the 2013 ECPG, half of the mean inter-nest distance (½-MIND) for occupied nests located within 10 mi of the proposed Project was calculated to approximate territory size. In 2017, the ½-MIND was 8.1 km (5.1 mi) based on four occupied nests (Figure 2.7), and in 2018 the ½-MIND was 9.1 km (5.7 mi), based on four occupied nests (Figure 2.8). The ½-MIND calculated for 2018 does not include a nest location that was occupied during the March survey but was inactive during the second survey in May. When this nest location is included, the ½-MIND in 2018 is 7.5 km (4.7 mi).

The minimum distance of Project turbines from a golden eagle nest is 5.4 km (3.4 mi). Eagle use observations and mapped flight paths did indicate that eagles flew through the Project in the ½-MIND areas; however, there were no areas that received consistent use by eagles during the breeding season. A total of five golden eagle flight paths were recorded in the northwest corner of the Project on three different dates in 2017 and 2018, but four of the five flights were observed outside the breeding season, during October (Figure 3.1).

Turbines are planned to be located within 5.4 km (3.4 mi) of the golden eagle nest on the western side of the Project, 7.2 km (4.5 mi) from the nest to the south of the Project, and 7.5 km (4.7 mi) from the nest to the east of the Project. Some turbines are located within the ½-MIND for two of the three nests (Fig 3.1). No eagle flight paths were observed in the ½-MIND for the eastern-most nest location, and flight paths near the southern nest location were not observed closer than 1.3 km (0.8 mi) to planned turbine locations. Golden eagle flight paths were observed near planned turbine locations in the ½-MIND for the western-most golden eagle nests, but four of the five flights observed in the northwest Project were outside of the breeding season, in October. One flight was observed in March and could be associated with the nearby nest. Based on 580 hours of observational data collected over two years following the 2013 ECPG, golden eagle use in the Project was irregular, and no consistent patterns in eagle use were evident that would indicate any turbine locations were particularly risky. Based on nest and observational survey efforts completed for the Project, the USFWS did not recommend any turbine locations be moved due to golden eagle nest proximity or intersection with ½-MIND areas.

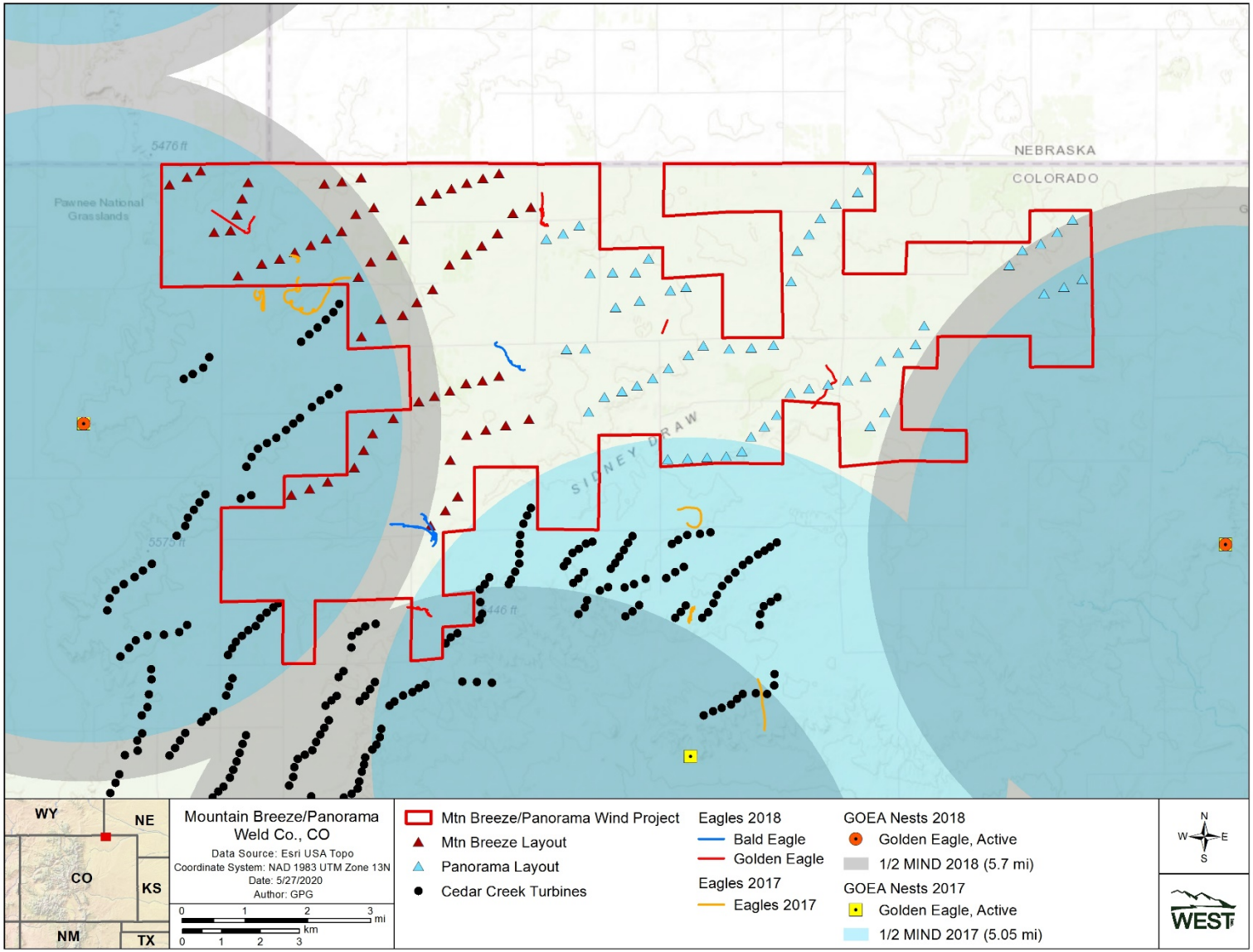


Figure 3.1. Eagle flight activity relative to the Mountain Breeze/Panorama Wind Project layout, golden eagle nests, and the ½ mean inter-nest distances calculated for 2017 and 2018.

3.1.2 Mapped Potential Prey Areas

Potential prey including BTPD colonies, waterfowl concentrations, big game winter concentrations, and PSTG leks, were mapped in or near the Project. No active prairie dog colonies were detected within the Project. An inactive colony was identified based on aerial photography in the eastern portion of the Project and was later determined to be non-existent (see Section 4.1.5). An active colony was identified just outside of the southern Project boundary (see Figure 2.9). A golden eagle flight was recorded over the inactive colony on October 25, 2018 (Figure 3.1). No waterfowl concentrations were mapped in the Project or within 6 km (4 mi) of the Project boundary, and lack of perennial water bodies in the Project makes occurrence of large groups of waterfowl unlikely on a regular basis. The Project has incorporated infrastructure setbacks of 30 m (100 ft) from wetlands. Golden eagle flights within the Project area were limited during the eagle use surveys, and occurred at the lowest frequency during winter. The timing of most eagle use therefore does not overlap use of winter concentration areas by big game, and risk associated with the winter concentrations is low.

Golden and bald eagles are listed as potential predators of PSTG (Marks 2007), and golden eagles are known predators of greater sage-grouse (*Centrocercus urophasianus*), another grouse species that congregates at leks to breed in the inter-mountain West (The Northeast Wyoming Sage-grouse Working Group 2006, Colorado Greater Sage-grouse Steering Committee 2008). PSTG leks were mapped within the Project boundary (Figure 3.10). While PSTG leks were detected in the Project, eagle activity was not observed in the vicinity of PSTG leks during the lekking season. The only eagle flight paths recorded within 1.0 km (0.6 mi) of lek locations were recorded during September and October when PSTG would not be present on the leks (Figure 3.1 for bald eagle flight path dated 9/13/2018 and golden eagle flight path dated 10/16/2018). Conservation measures used by the Project to avoid and reduce impacts to PSTG also will help to avoid and reduce risk to eagles that may be attracted to leks for prey.

3.1.3 Areas with Relatively Higher Eagle Use

The northwest corner of the Project had the most golden eagle activity (Figure 3.1). This area was not associated with any evidence of high prey availability, nor was it particularly close to nest locations (turbines are no closer than 5.7 km [3.4 mi] from the nearest golden eagle nest). Flight paths were recorded along an ephemeral drainage feature and around a hill.

Results from two years of post-construction monitoring (PCM) at the Cedar Creek Wind Project provide insight into risk to eagles in the area. Two golden eagle carcasses were documented during standardized monitoring from January 2008 through January 2010 at 25% of the 274 turbines at the Cedar Creek Wind Project. One of the eagle carcasses was due to electrocution at a riser pole over 3.0 km (1.9 mi) south of the Project. Five additional golden eagle carcasses have been found at Cedar Creek Wind Project since standardized monitoring ended in January 2010. No bald eagle carcasses have been found at the Cedar Creek Wind Project.

Since the Project is proposed to have substantially fewer turbines than the Cedar Creek Wind Project, and is located farther from the Chalk Cliffs escarpment and golden eagle nests, impacts are expected to be lower.

3.1.4 Overhead Line

Two overhead gen-tie lines are planned for the Project. On the western Mountain Breeze side of the Project, the gen-tie line will run south from the southwestern corner of the Project to the Cedar Creek Wind Project substation, and will not come closer than 3.8 km (2.4 mi) to a known golden eagle nest location. Furthermore, the gen-tie line will not cross the escarpment where the golden eagle nests are located. The gen-tie line for the eastern Panorama Wind portion of the Project will run approximately 10 mi south to the Tri-State Redtail substation. While the Panorama gen-tie line route has not yet been finalized, it may cross the southern escarpment as close as 1.6 km (1.0 mi) east of a golden eagle nest location that was active in 2017. The Project will buffer the golden eagle nest by at least 0.5 miles, and plan construction for the non-breeding season when the nearby golden eagle nest is non-active. If USFWS determines that disturbance take at the golden eagle nest is likely in association with constructing this power line then Leeward will apply to USFWS for a short term eagle incidental take permit to provide take coverage for this action.

Both gen-tie lines were routed in consultation with CPW to avoid important areas for PSTG. Perch discouragers will be installed on some poles near PSTG areas to reduce risk of raptors hunting PSTG from atop power poles. All above-ground gen-tie and collection lines will be constructed following the bird electrocution and collision prevention guidelines developed by the APLIC (APLIC 2006, 2012).

3.1.5 U.S. Fish and Wildlife Service Recommendations

In May 2019, USFWS provided recommendations about specific turbine locations that were considered to have potential impacts on biological resources. Only five turbine locations were identified as problematic, and these locations were identified due to proximity to potential prairie dog colonies (concentrated eagle prey-source) or proximity to red-tailed hawk, great horned owl, or burrowing owl nests (non-eagle related impacts). In a follow-up memorandum, USFWS expressed concern about Panorama turbines P45 and P46 due to their proximity to a prairie dog colony, and potential impacts to burrowing owls that may nest in that prairie dog colony. USFWS requested that turbines P45 and P46 be set back 800 m from the entire prairie dog colony to reduce risk of burrowing owls colliding with wind turbines. The Project complied with the USFWS recommendations to the maximum degree practicable relative to the magnitude of the impacts, to eagles based on current site conditions.

The Project removed one turbine location 13M that was identified as of concern due to proximity to a red-tailed hawk and great horned owl nest in the northern portion of the Project.

The two prairie dog colonies of concern (pdt13 and CO-112233-1; Figure 29) were accessed and determined to be inactive, with no prairie dogs or functional prairie dog burrows present. The turbine location 31M near prairie dog colony pdt13 was therefore considered to be not of concern.

The prairie dog colony CO-112233-1 was mapped by CPW in 2015 based on aerial imagery. WEST visited the colony in 2018 and determined it to be inactive. During another site visit on May 24, 2019, the area was examined closely for evidence of prairie dogs. No prairie dogs were found, and a wildlife biologist determined that no colony was present; therefore, since no prairie dogs or prairie dog burrows were present, the prairie dog colony was characterized as "not present" rather than "inactive." As such, there is no prairie dog colony upon which to base a setback distance. In addition, most of the land section where the turbines are proposed to be located is tilled agriculture so burrows or any similar structures would be impacted through agricultural practices.

3.2 Pre-construction Siting, Best Management Practices, and Conservation Measures

- Existing roads and transmission corridors were incorporated into infrastructure siting plans to the extent possible to minimize disturbance to native vegetation and associated golden eagle habitat.
- Infrastructure (turbines, roads, collection lines) were sited in previously disturbed areas (cultivated lands, existing rights-of-way) to the extent practicable to avoid impacting golden eagle habitat.
- Length and number of roads and collection lines were minimized to minimize impacts to golden eagles.
- Approximately 40% of Project turbine locations were altered to avoid areas containing prey concentrations (e.g., PSTG leks).
- Power poles for the gen-tie line that occurs near PSTG areas will have perch discouragers installed to prevent eagles from using power poles as perches to hunt PSTG.
- The operations and management facility at the Cedar Creek Wind Project, as well as a substation, will be used to support this Project, thereby eliminating the need to build separate facilities and overhead power lines.
- All collection lines will be buried underground. Above-ground lines will be developed based upon APLIC guidelines to minimize risks of eagle electrocution and collisions (APLIC 2006, 2012).
- Wind turbines will have tubular support towers that minimize eagle perching and nesting opportunities. External ladders and platforms will not be used, further minimizing perching opportunities for eagles.
- No guy wires will be included on permanent MET towers or if they are used, they will be marked with bird diverters to reduce collision risk to eagles.

- A fire safety plan will be developed and implemented during all phases (construction, operations, and decommissioning). Measures to reduce risk of fire hazards from vehicles and Project and contractor personnel will be implemented. An Emergency Response Plan will be developed and implemented during construction and operation. The plan will contain emergency fire precautions, notification procedures, and emergency response sequences. These measures will help reduce or avoid impacts to eagle habitat and prey species.
- A weed control plan will be developed, that is designed to prevent the spread of non-native and invasive plant species that may impact habitat quality for eagle prey.

4.0 ASSESSING BALD AND GOLDEN EAGLE RISK AND PREDICTING FATALITIES (STAGE 3)

The Project is committed to avoiding and minimizing impacts to eagles and other wildlife through implementation of measures identified in this ECP.

Risk to eagles was evaluated based on the two years of site-specific eagle use data collected for the Project. The risk assessment includes the USFWS Collision Risk Model using data collected during the standardized avian/eagle use surveys, as well as evaluation of other risk factors as identified in the 2013 USFWS ECPG. The 2013 USFWS ECPG states “evidence across multiple studies suggests that in addition to abundance, two main factors contribute to increased risk of collision by eagles: (1) the interaction of topographic features, season, and wind currents that create conditions for high-risk flight behavior near turbines; and (2) behavior that distracts eagles and presumably makes them less vigilant (e.g., active foraging or inter- and intra-specific interactions).”

4.1 Bald and Golden Eagle Risk Factors

4.1.1 Nesting and Breeding

Aerial nest surveys were conducted within 10 mi of the Project during the 2017 and 2018 breeding seasons. Four occupied golden eagle nests were documented during each year. No golden eagle nests were detected within the Project boundary, the nearest nest was 4.0 km (2.5 mi) west of the Project boundary and 5.5 km (3.4 mi) from the nearest planned turbine location (Figure 3.1). Other golden eagle nests were 7.2 to 11.8 km (4.5 to 7.3 mi) from planned turbine locations.

Following recommendations in the 2013 USFWS ECPG and Region 6 guidance, the MIND for the occupied active golden eagle nests within 10 mi of the proposed Project was determined to be approximately 16.3 km (10.1 mi) in 2017 and 18.4 km (11.4 mi) in 2018. The ½-MIND was 8.1 km (5.1 mi) in 2017 and 9.2 km (5.7 mi) in 2018. According to the 2013 USFWS ECPG, nests should be buffered by ½-MIND to represent an approximated territory size surrounding the nest.

Applying 5.1-mi and 5.7-mi buffers to identified golden eagle nests indicates potential overlap of breeding territories in one area to the southeast of the Project in 2017, and two areas to the southwest and northwest of the Project in 2018. All areas of potential territory overlap are outside

of the Project boundary. Golden eagle use data collected during pre-construction monitoring work did not show consistent use of the Project where it intersected the ½-MIND. Furthermore, turbines currently are in operation between the Project and all detected golden eagle nests, so construction of Project turbines will not be placing novel sources of risk in the area. Finally, all turbines will be placed outside a 5.5 km (3.4 mi) of a known occupied golden eagle nest, and this is a substantial spatial buffer exceeding current recommendations from USFWS for eagle nest search areas outside of wind energy projects and the 90th quantile of movements around the nest of golden eagles in the Northwestern Forested Mountains Ecogregion (USFWS 2020). Therefore, the location of the 36-40 turbines within the ½-MIND is considered by The Project to pose limited and acceptable risk to golden eagles.

No bald eagle nests were detected within 16 km (10 mi) of the Project during either survey year.

4.1.2 Eagle Concentration Areas (Communal roosts, foraging areas, migration corridors, and migration stopovers)

The 2013 USFWS ECPG states that migration concentration sites are defined as "places where geographic features (e.g. north-south oriented ridgelines, peninsulas) funnel migrating eagles, resulting in concentrated use during migration periods. Data collected during two years of standardized large bird/eagle use monitoring indicated that golden eagles use the Project irregularly throughout the year, with observations during January, March, August, October, and December. More golden eagle activity was recorded during fall and winter months (11 observations and 18 risk minutes between October and January) compared to spring and summer (four observations and 11 risk minutes between March and August).

There is an insufficient basis to identify patterns in seasonal or spatial use because there were very few eagle observations overall during the survey effort: i.e., 10 golden eagle observations recorded over 347 observation hours during 2017, and five observations over 234 observation hours during 2018. Data collected for the Project did not suggest that eagles used areas of greater topographic relief more than flatter areas. March and October were the only months when golden eagles were recorded during both years, but this is based on four or fewer observations, and different observations did not overlap spatially. Given the pattern of eagle use observed at the Project, there was no need to perform eagle migration surveys.

Prairie dog colonies, waterfowl concentrations, and PSTG leks also may concentrate eagles due to available prey. No active prairie dog colonies or waterfowl concentrations were detected within the Project (Figure 2.9); therefore, eagles will not be attracted to hunt in risky areas near wind turbines due to known prairie dog or waterfowl presence. PSTG leks were documented in the Project during surveys in 2018 and 2019 (Figure 2.10); however, as part of conservation measures for PSTG, turbine locations were moved away from areas with a number of documented leks, thereby reducing risk for eagles, and conservation agreements were made with landowners to protect important PSTG habitat from other development for the life of the Project.

Golden and bald eagles may scavenge large animal carcasses. Domestic livestock raised in the Project area include cattle and horses. Big-game observations included mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*). Big game ranges mapped by CPW

indicate that mule deer, white-tailed deer (*Odocoileus virginianus*), and pronghorn winter range occurs over the entire Project, with a winter concentration area on the western side of the Project for mule deer, and on the eastern side for pronghorn (CPW 2020; Figure 2.10).

No communal roosts or other concentration areas were observed for golden or bald eagles during standardized surveys or incidentally within or near the Project. Given these observations, it was determined that there was no need for formal eagle roost surveys at the Project.

4.1.3 Topography and Wind

Topography in the vicinity of the Project is provided in Figure 1.2. Elevations range from approximately 5,120-5,494 ft (1,561-1,675 m; Figures 1.2 and 1.3). In general, the Project boundary encompasses an area that consists of flat to rolling topography, but there is an escarpment called the Chalk Bluffs with steep slopes and cliffs along the western and southern sides of the Project boundary. The Chalk Bluffs are the most prominent topographical feature in close proximity to the Project area.

Turbines sited on or adjacent to steep slopes with a northwestern or southeastern facing aspect may present higher risk to eagles as these areas would most frequently have strong wind updrafts when hit by the prevailing winds. Turbines sited on steeper slopes, especially on upwind sides of ridges, and turbines sited in saddles or low-lying areas, may present increased risk to eagles in comparison to other areas without these characteristics (Barrios and Rodriguez 2004, de Lucas et al. 2008, Hoover and Morrison 2005, and Smallwood and Thelander 2004).

The prevailing wind direction at the Project is from the northwest, and to a lesser extent from the southeast (Figure 4.1). Northwestern winds are strongest during the winter, whereas southeast winds are more likely to occur in summer. The slope (steepness) and aspect (direction) of terrain at turbine locations were reviewed and assessed on an individual turbine basis within the Project area (Figures 4.2 and 4.3). The northwestern edge of the Project boundary has slopes that face northwest. While the northwestern portion of the Project had the most eagle flight paths mapped, none of this eagle activity was along or near the escarpment. In addition, all but one of the proposed 116 turbine locations (including alternates) that were evaluated are sited on flat slopes ranging from 0.03 to 4.11 degrees, with one additional turbine on a slope of 6.59 degrees. Moreover, only about 3% of turbine locations are on northwest facing slopes, and 14% are on southeast facing slopes, which are the two main prevailing wind directions. This slope and aspect information suggests that turbines are not located in high-risk conditions for eagles.

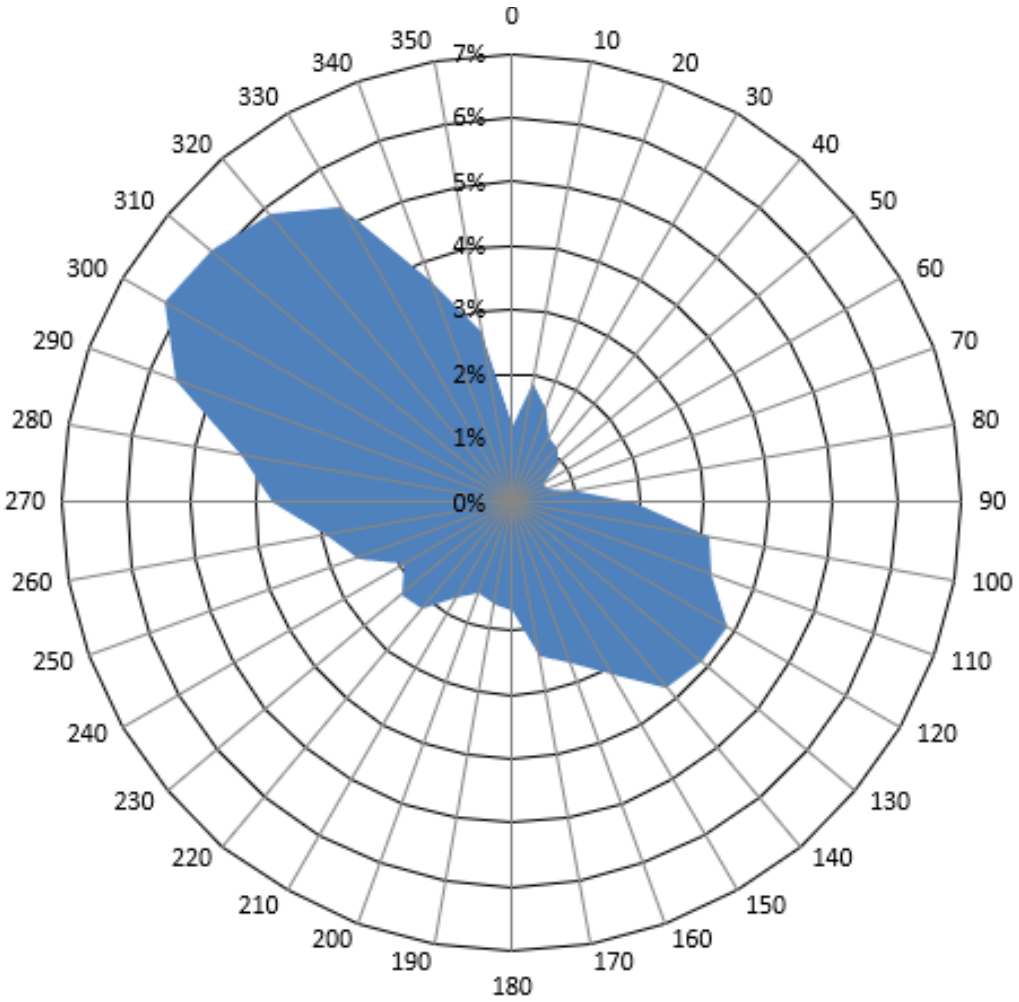


Figure 4.1. Wind rose showing the prevailing wind directions for the Mountain Breeze/Panorama Wind Project, Weld County, Colorado.

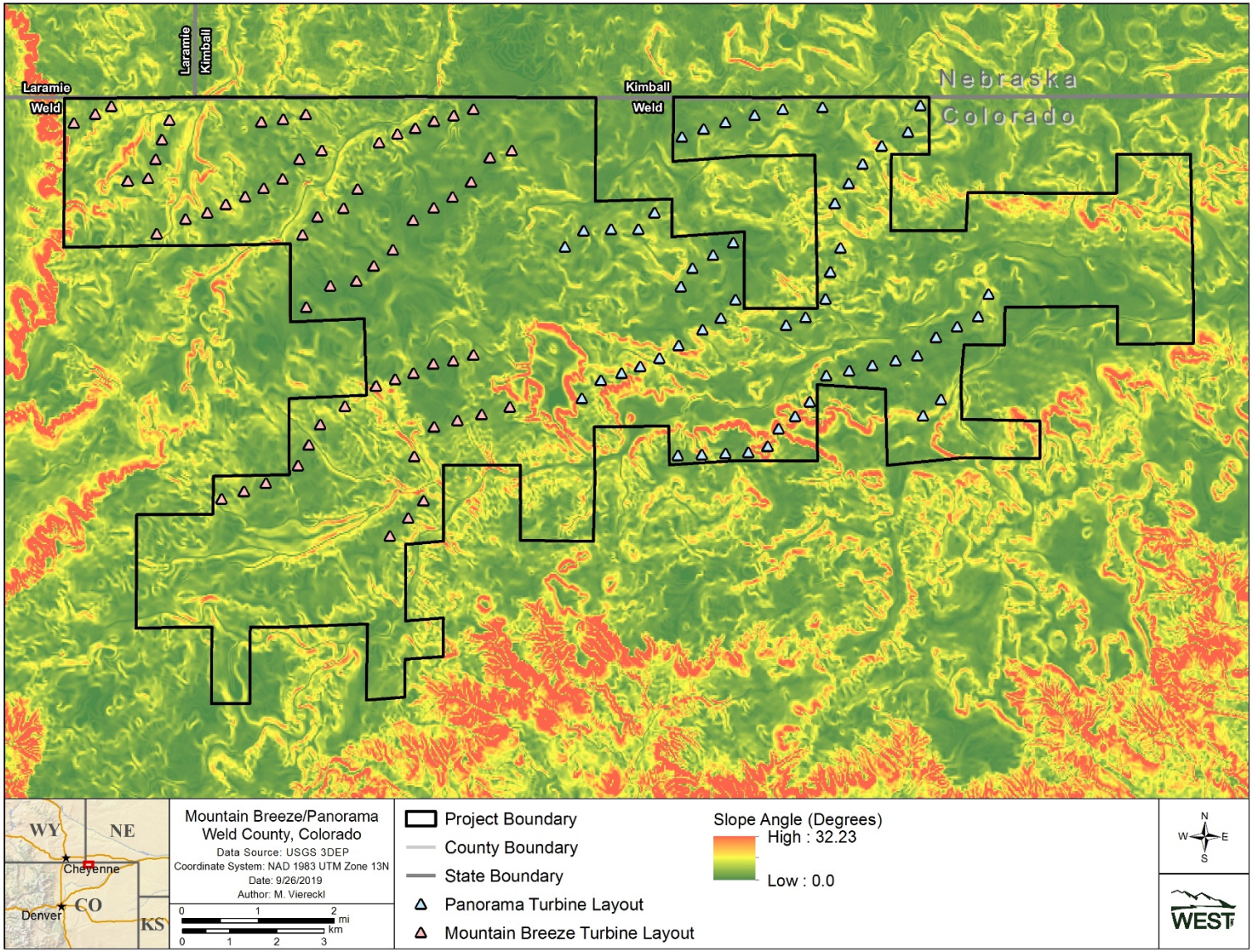


Figure 4.2. Slope angle (degrees) for the landscape where Mountain Breeze/Panorama turbines will be located.

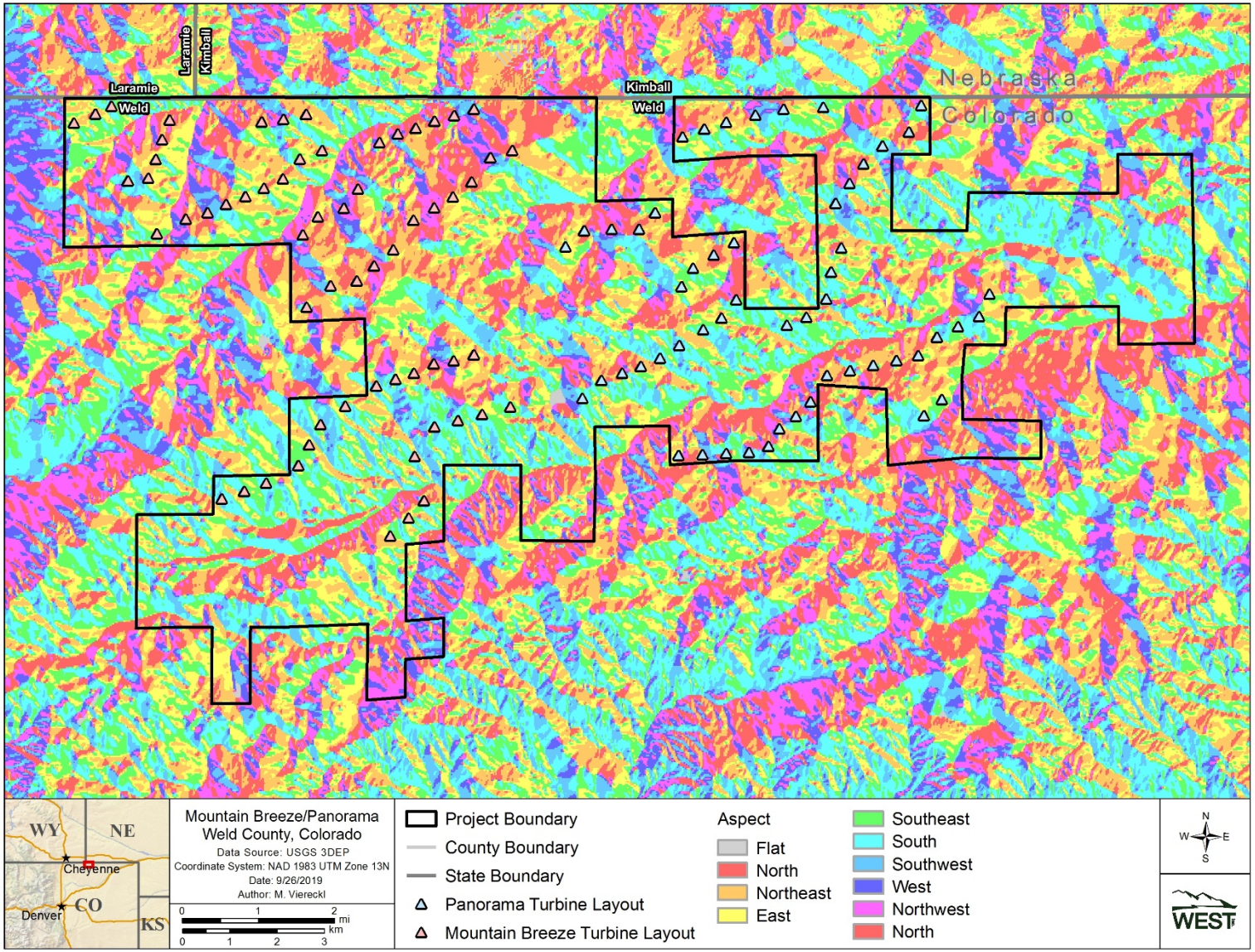


Figure 4.3. Slope aspect (direction) for the landscape where Mountain Breeze/Panorama turbines will be located.

4.1.4 Intra-specific Interactions and Foraging Behavior

Turbine collision risk may be increased by intra-specific competition and territorial defense interactions. Based on results of the 2017 and 2018 eagle nest surveys, it does not appear that there is overlap of approximated eagle territories in the Project (Figure 3.1). While this potential risk factor is identified in the 2013 USFWS ECPG, we are not aware of any studies that have documented if or how intra-specific competition and territorial defense is a risk factor for eagles.

Hunting behavior by golden eagles was documented during large bird/eagle use surveys, though not in the vicinity of known PSTG leks or prairie dog colonies. Lack of concentrated prey sources such as prairie dog colonies helps to reduce risk. Siting of turbines away from PSTG leks also helps to reduce risk. Carrion may present a potential foraging opportunity for eagles in the Project area. However, a carrion/carcass removal program will be implemented during Project operations to further reduce risk to foraging eagles within the Project (see Section 5.2 below).

4.2 Eagle Fatality Predictions

USFWS Region 6 will complete the fatality prediction for the Project using the eagle use data collected for the Project following the USFWS recommended protocol (USFWS ECPG 2013 and 81 FR 91494, 2016). Using pre-construction eagle use data collected for the Project, the USFWS generate a prediction of eagle take (bald eagle and golden eagle) for the Project. USFWS conducts this analysis as part of the Environmental Assessment (EA) that is completed pursuant to the National Environmental Policy Act (NEPA) requirements related to the federal action and decision about whether or not to issue an ETP for the Project. If after completion of the required NEPA process, USFWS Region 6 issues an ETP to the Project, the number of eagle takes authorized by the permit would be based solely on the USFWS analysis.

5.0 ADDITIONAL AVOIDANCE AND MINIMIZATION OF RISKS, CONSERVATION MEASURES, AND COMPENSATORY MITIGATION

Conservation Measures and BMPs will be implemented during construction of the Project to provide additional avoidance and minimization of risks to eagles.

5.1 During Construction

- Initial ground clearing, grading, and foundation work will be conducted outside of the breeding season to avoid disturbance of breeding eagles.
- Construction employees, contractors, and subcontractors will receive training on wildlife awareness, minimization of impacts to natural resources, and to facilitate employee understanding of their respective roles in ensuring compliance with the Project's permit conditions and commitments.
- Known occurrences of eagles and eagle nests identified near construction areas will be included in the training.

- Turbines will be erected no closer than 5.4 km (3.4 mi) from all currently known occupied golden eagle nests. No known nests are expected to have line-of-sight to construction activities. If new nests are discovered prior to construction, roads and collection that are within 0.40 km (0.25 mi) of occupied eagle nests not be constructed until nest monitoring indicates that the young have fledged from the nest.
- Speed limits for construction and operations personnel along the access and service roads will be restricted to 25 miles per hour (mph) or less to reduce the risk of wildlife or livestock collisions and to minimize sound emissions. Vehicle movement associated with the projects will be restricted to designated access roads and temporary construction areas. This measure will help to minimize collisions with wildlife resulting in carrion availability for golden and bald eagles.
- Garbage will be contained in appropriate receptacles and removed from the site regularly to avoid creating attractive scavenging opportunities for eagles.
- Where fencing is to be constructed, wildlife compatible design will be used, incorporating three or four-strand fencing with a bottom strand height of 16 inches and a maximum top strand height of 42 inches, along with installation of double stays between posts. Chain link and mesh fencing will kept to a minimum and used only to protect facilities where security is required. This measure will minimize the risk to eagles that may arise if game carcasses occur in association with fencing.
- Activities which may attract eagle prey near turbine locations will be minimized to the extent possible, including removal of rock and debris piles, and avoiding storage of parts or equipment near turbines, both of which could attract rabbits and rodents.
- The APLIC guidance on power line construction (APLIC 2006, 2012) will be followed to reduce electrocution risk to eagles at power poles and collision risk along overhead lines.
- To the extent possible, facility construction will minimize cutting into hill slopes, with an objective of achieving smooth, rounded terrain, rather than soil berms or cuts that could be attractive fossorial or burrowing mammals such as prairie dogs and ground squirrels that could attract foraging eagles.
- Gravel will be placed around each turbine foundation to discourage small mammals and reptiles from burrowing under or near turbine bases.
- Appropriate native seed mixtures or seed mixtures requested by landowners or recommended by agencies will be used for re-vegetation as soon as practical following construction. Seed mixes will avoid using forbs, which may attract mammalian or bird prey for eagles.

5.2 During Operation

During Project operations, the following conservation measures and BMPs will be implemented to provide additional avoidance and minimization of risks to eagles:

- Project personnel will be trained on wildlife awareness, minimization of impacts to natural resources, and to facilitate employee understanding of their respective roles in ensuring compliance with the Project's permit conditions and commitments.
- All carrion discovered on site during regular maintenance and monitoring activities, except carcasses used for searcher efficiency and carcass removal trials, will be removed to avoid attracting bald eagles and other raptors. The Project will begin working with relevant landowners within 24 hours of discovery to cover or remove wildlife or livestock carcasses to avoid attracting eagles to the vicinity of turbines.
- Management activities such as seeding forbs or creating rock piles, which attract potential eagle prey, will not be implemented.
- Parts and equipment which may be used as cover by prey will not be stored in the vicinity of wind turbines to avoid attracting eagles to the vicinity of turbines.
- Low- level speed limits (<25 mph) will be maintained on all roads within the projects to avoid wildlife collisions that could create carrion attractive to eagles.
- Personnel and all contractors will be instructed to immediately store garbage in appropriate receptacles and to regularly remove garbage from the site to avoid creating attractive scavenging opportunities for eagles.
- The Project will develop and implement a reporting system for wildlife carcasses and injuries at the start of operations for the Project (see Section 7.5 below). The reporting system will be implemented for the life of operations.
- Any temporary MET towers will be removed within one year of commencement of operations to minimize the potential for eagle collisions with guy wires.
- If snow removal is needed, roads will be plowed so as not to impede livestock and big game movement. Snow banks can cause livestock and big game to run along roads, resulting in their colliding with vehicles. Roadside carcasses attract eagles, subjecting them to collision as well.

5.3 Upfront Compensatory Mitigation

The Project expects to meet mitigation requirements through participation of the In-Lieu Fee (ILF) Program provided by Eagle Electrical Solutions, LLC of Fort Collins, Colorado. The ILF is a compensatory mitigation program authorized by the USFWS, and is structured to sell mitigation credits to users (i.e., permittees) to mitigate for incidental take of eagles under an ETP. The ILF Program offsets estimated eagle take by retrofitting high-risk power poles in the same eagle management unit as the permitted take. The ILF Program pools mitigation funds to implement retrofitting projects in coordination with local electric utilities that have conducted risk assessments and prescribed retrofitting plans. Under the ILF Program, the necessary number of credits is calculated using the Resource Equivalency Analysis (REA) assuming a 10-year effectiveness duration of the retrofits. The Project will pay the ILF Program based on the REA

calculated for eagle take predictions provided by the USFWS. Once the ILF Program is paid, a transaction receipt will be provided to USFWS to document the mitigation credits.

The Project intends to pay for retrofits initially to cover a 10-year time period, consistent with the REA analysis and ILF credits. At each 5-year review the USFWS and the Project will determine the need for any additional payments for retrofits to cover additional take in subsequent years. If golden eagle take is less than predicted within the five-year review period, there will be a retrofit credit to the Project that is advanced to the next review period by USFWS.

5.4 Cumulative Impacts

The USFWS has identified take rates of between 1% and 5% of the estimated total eagle population size at the local area population (LAP) scale (109-mi buffer surrounding the Project for golden eagles and 86 mi for bald eagles) as benchmarks, with 5% being at the upper end of what might be appropriate under the 1940 Bald and Golden Eagle Protection Act preservation standard — whether offset by compensatory mitigation or not (USFWS 2013). The 2013 USFWS ECPG (USFWS 2013) recommends calculating the local-area 5% benchmark as follows:

(Local-area * Regional Eagle Density) * 0.05.

USFWS Region 6 will complete the LAP analysis for the Project using a cumulative effects tool and proprietary data on known eagle mortality within the LAP area for each eagle species. This is not an analysis that project proponents are expected to complete. The USFWS analysis will provide a cumulative impacts assessment for both golden and bald eagles at the LAP scale within the 109 mi and 86 mi species-specific buffers. This review will consider eagle mortality records from other existing wind energy facilities as well as all other sources of known mortality such as electrocution, collisions, shootings, poisonings, etc. This information, and the accompanying analysis, will be fully presented in the EA that USFWS will complete for the Project. This information about known eagle mortality also will be used by USFWS Region 6 in the decision making process about whether or not to issue an programmatic ETP for the Project, and the level of take for golden and bald eagles that could potentially be authorized.

6.0 POST-CONSTRUCTION MONITORING (STAGE 5)

After permit issuance, PCM will be conducted for the life of the Project to detect eagle carcasses, and to ensure the Project remains in compliance with the authorized level of eagle take. The Project proposes the approach described in this section; however, the methods will be revised in coordination with USFWS once official guidance for PCM is finalized to make sure monitoring is consistent with the guidance. The proposed PCM study methods will include standardized searches to look for eagle carcasses, consisting of visual scans at 100% of Project turbines every two to three months. Project operations personnel will conduct the visual scans after being trained in search methods and eagle identification by a third-party contractor. Visual scans have been demonstrated to be effective for detecting eagle carcasses out to 100-150 meters (Hallingstad et al. 2018) in vegetation similar to the Project; while allowing efficient coverage of the Project turbines in support of permit conditions.

Experimental bias trials will be conducted for two years after permit issuance, with at least one year of bias trials occurring within the first five years of permit issuance. Bias trials will be administered by a third-party contractor, and will be conducted throughout the year to measure rates of searcher efficiency (the proportion of available carcasses detected by searchers) and carcass persistence (the average length of time carcasses remain available to be found). Annual fatality rates for eagles will be estimated by a third-party contractor for the years in which bias trials are conducted. Annual fatality rates for eagles will be based on the number of carcasses detected, adjusted to account for the site-wide probability a carcass was detected. The evidence of absence (EoA; Dalthorp et al. 2014) framework, or other appropriate statistical models, will be used to calculate annual eagle fatality rates.

PCM methods will have the goal of achieving a *g*-value of at least 0.25 on average during the two years of experimental bias trials. The *g*-value describes the probability that a carcass will be found, and is a function of searcher efficiency, carcass persistence, and the searchable area around all turbines. The *g*-value can be evaluated based on bias trials, and if low searcher efficiency or short carcass persistence rates cause the calculated value of *g* to fall below 0.25, survey methods during the survey years with bias trials can be adjusted to raise the value of *g*, generally by increasing survey effort.

During years with no bias trials, PCM will be conducted approximately every two to three months as part of regularly scheduled turbine maintenance. PCM will be completed by Project staff, or by Project staff in combination with third party consultants. PCM will be completed in the most cost-effective manner possible for the Project while still achieving an acceptable carcass detection level. Project personnel will be trained in proper scanning techniques and identification of eagle carcasses. Standard methods for documenting scans and reporting of finds will be developed and included in personnel training.

The PCM methods described in the section will be revised in coordination with USFWS to ensure they are consistent with national guidance when that guidance is finalized.

6.1 Eagle Nest Surveys

Eagle nest surveys will also be conducted by qualified biologists with appropriate experience for at least two years after construction is completed. Post-construction eagle nest monitoring will follow recommendations in Appendix H of the USFWS ECPG and the Updated Eagle Nest Survey Protocol (USFWS 2020) as well as methods followed for the pre-construction nest surveys in 2017 and 2018. The eagle nest surveys will target potential golden eagle nesting habitat within 2 mi of the Project, but large trees and man-made structures also will be surveyed in case golden or bald eagles build new nests in the area. Aerial survey methods may not be used in some areas due to landowner concerns, or presence of livestock or wildlife that may be disturbed by the helicopter. The nest surveys will assess nest occupancy status over two aerial survey rounds, with the first survey round in late February or early March, and the second survey round at least 30 days later. Ground-based surveys are not possible since the nests are not visible from publicly

accessible areas on the ground, and private lands where the nests are visible are not participating in the Project. Data from the nest surveys will be provided to the USFWS each year.

6.2 Reporting

All eagle carcasses will be reported to USFWS within 24 hours of discovery and positive identification. Field forms and photographs of all eagle carcasses will be reported to USFWS (Office of Law Enforcement, Ecological Services Field Offices, and Regional Migratory Bird Management Office) for their direction on collection and/or sending carcasses to the National Eagle Repository.

6.3 Wildlife Incident Reporting

The Project is committed to ongoing investigation of wildlife incidents involving company facilities and to work cooperatively with federal and state agencies in an effort to prevent and mitigate future bird and wildlife impacts. The Project will implement a Wildlife Incident Reporting System (WIRS) at the start of operations of the Project, and it will remain active for the life of the Project. The purpose of the WIRS is to standardize and describe actions that should be taken by site personnel in response to a wildlife mortality or injury encountered at the Project as part of operational monitoring or incidentally to other activities on site. The actions described in the WIRS also will promote accurate and timely reporting under permit requirements. The WIRS will provide a means of documenting (and collecting if appropriate permits are obtained) mortalities at the Project to be used to inform Adaptive Management (see Section 8.0). During the standardized post construction monitoring studies, any carcass found incidentally by site operations and maintenance personnel will be reported to the contractor conducting the post construction monitoring studies so that the contractor can process the carcass since carcasses found incidentally within the standardized search plots may be included in mortality estimates. Additionally, USFWS will be contacted immediately for direction regarding any eagle found injured within the Project as directed in the WIRS. Any incident (i.e., mortality or injury) involving a federally listed threatened or endangered species or a bald or golden eagle must be reported to the USFWS within 24 hours of identification (exclusive of weekends and holidays).

7.0 ADAPTIVE MANAGEMENT PROCESS

An adaptive management framework will be employed to keep eagle take within permitted levels over the permit term. Monitoring data will be reviewed with the USFWS on 5-year intervals during the term of the permit. Additional avoidance and minimization measures may be implemented if the parties determine during a five-year review that the level of authorized take is likely to be exceeded prior to the end of the 30-year permit term. Such measures will be developed in coordination with USFWS.

8.0 OTHER PERMITS

If an ETP is issued by USFWS for the Project there will be a permit condition to apply for a USFWS, Migratory Bird Treaty Act (MBTA) 21.27 Special Purpose Utility Permit and to maintain this permit over the life of the ETP, and comply with the MBTA 21.27 permit reporting requirements. Additionally, the Project will obtain and maintain a CPW scientific collecting permit for mammals and birds.

9.0 CONCLUSION

This document was written to provide guidance for all eagle avoidance, minimization, mitigation and monitoring efforts prior to, during, and after construction of the Project. The measures described in this document are intended to help avoid and minimize impacts to eagles, as well as to monitor potential impacts to eagles following implementation of the Project. It is anticipated that this ECP will adaptively manage potential eagle impacts from the Project based on findings following construction.

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Appendix A. Baseline Wildlife Studies Conducted for the Mountain Breeze/Panorama Wind Project

Avian Use Studies

Mountain Breeze/Panorama Wind Project

Weld County, Colorado

Final Report

January 2017 – December 2018



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DRAFT - Confidential Business Informational/Pre-Decisional

EXECUTIVE SUMMARY

Leeward Renewable Energy Development, LLC (Leeward), the sole member of two subsidiaries, Mountain Breeze Wind, LLC and Panorama Wind, LLC, has proposed the development of the Mountain Breeze and Panorama Wind Projects (Project) in Weld County, Colorado. In support of Project development, Leeward contracted Western EcoSystems Technology, Inc. (WEST) to conduct two years of pre-construction baseline avian use studies in the Project area. The principal objectives of the studies were to: 1) provide site-specific bird resource and use data that would be useful for evaluating potential impacts from the proposed wind energy facility; 2) provide information that could be used for Project planning and design of the facility to minimize impacts to eagles and other birds; 3) collect data on eagle use in the area following the *Eagle Conservation Plan Guidance*; and 4) recommend further studies or potential mitigation measures, if warranted.

The 14,557-hectare (35,975-acre) Project area is dominated by grassland land cover (65.8%), and cultivated crops (mostly winter wheat) are the next most common cover type (30.9%), while approximately 3.2% of land cover within the Project area is developed open space, hay/pasture, deciduous forest, woody wetlands, and open water. The primary land uses within the Project are rangeland used for grazing livestock and crop production. The Project itself has rolling to hilly topography, with more rugged topography along an escarpment to the south and west. There is one intermittent drainage feature that flows to the northeast through the Project area. There are no perennial water bodies except for impoundments and stock tanks for livestock.

Eagle/large bird use surveys and small bird use surveys were conducted at the Project for two years, from January 2017 through December 2018. The primary objective of the eagle/large bird use surveys was to document use by eagles and other large birds, both seasonally and spatially, within the Project area. Surveys consisted of 1-hour counts of eagles and other large birds within 800-meter (m; 2,625-feet [ft]) radius plots centered on an observation point. Small bird use surveys were conducted for 10 minutes (min) immediately prior to eagle and large bird use surveys at the same observation points, with a survey radius of 100 m (328 ft). Twenty-nine observation points were used in 2017 to cover the Project and the neighboring Cedar Creek Wind Project. In 2018, 17 observation points were used to cover the Project, and five more points were added in the summer.

In 2017, 347 eagle/large bird surveys were conducted, and 19 large bird species and 23 small bird species were identified. Canada goose, rock pigeon, and common nighthawk were the most commonly recorded large bird species, while horned lark, western meadowlark, and lark bunting were the most common small bird species. Diurnal raptor use was highest during summer (0.84 bird/800-m plot/60-min survey) and lowest during winter (0.41). High use during summer and spring was primarily due to Swainson's hawk, while use in fall and winter was due mostly to rough-legged hawk. Swainson's hawk had the highest exposure index of all large bird species. Diurnal raptor use was highest at point 27, primarily due to use by buteos. Mean annual diurnal raptor use, standardized to 20 min surveys, was 0.20 raptor/plot/20-min survey, which ranked relatively low compared to 48 other similar studies of raptor use at wind energy facilities.

During 346.8 eagle/large bird use survey hours in 2017, 10 golden eagle and one unconfirmed eagle observations were recorded. A total of 15 golden eagle risk minutes (eagles flying within 800 m of the surveyor and 200 m [656 ft] of ground level) were documented, and an additional risk minute was recorded for the unconfirmed eagle observation. The highest number of eagle risk minutes per month was recorded during March 2017 (eight eagle risk minutes), followed by October, with four eagle risk minutes, January 2017 with two eagle risk minutes, and August with one eagle risk minute. No golden eagle observations were recorded during other months Golden eagles were observed at four observation points. No bald eagles were observed.

In 2018, 234 eagle/large bird surveys were conducted. Twenty-one large bird species and 23 small bird species were identified. Mourning dove, rock pigeon, Swainson's hawk, and sandhill crane were the most commonly recorded large bird species, while horned lark, western meadowlark, and lark bunting were again the most common small bird species. Diurnal raptor use was highest during fall (1.14 bird/800-m plot/60-min survey) and lowest during summer (0.80). Northern harrier, Swainson's hawk, and rough-legged hawk were the most commonly recorded raptor species. Swainson's hawk had the highest exposure index of all raptors and the second highest among all large bird species. Diurnal raptor use was highest at Point 36, primarily due to use by buteos. Mean annual diurnal raptor use, standardized to 20 min surveys, was 0.31 raptor/plot/20-min survey, which ranked relatively low compared to 48 other similar studies of raptor use at wind energy facilities.

During 234 eagle/large bird use survey hours in 2018, five golden eagle observations were recorded. A total of 14 golden eagle risk minutes, with 12 risk minutes recorded in October and two recorded in March. Golden eagles were observed at five observation points. Ten bald eagles were observed, with a total of 17 bald eagle risk minutes (15 risk minutes in September and two in November). Bald eagles were observed at two observation points.

During surveys and observations outside of standardized survey periods in 2017 and 2018, 11 special status species were observed within the Project including golden and bald eagle, five additional US Fish and Wildlife Service Birds of Conservation Concern (prairie falcon, chestnut-collared longspur, lark bunting, loggerhead shrike, McCown's longspur), the state-listed endangered plains sharp-tailed grouse, and three additional species of State Special Concern (sandhill crane, ferruginous hawk, and swift fox). Observations may represent repeated observations of the same individual.

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1 INTRODUCTION

Leeward Renewable Energy Development, LLC (Leeward), the sole member of two subsidiaries, Mountain Breeze Wind, LLC and Panorama Wind, LLC, has proposed the development of the Mountain Breeze and Panorama Wind Projects in Weld County, Colorado (Figure 1.1). The Mountain Breeze and Panorama projects will be constructed and operated as one, and so, are referred to as the "Project" in this report. In support of Project development, Leeward contracted Western EcoSystems Technology, Inc. (WEST) to conduct two years of pre-construction baseline avian use studies in the Project area. Study methods were consistent with the US Fish and Wildlife Service's (USFWS) *Final Land-Based Wind Energy Guidelines* (WEG; USFWS 2012), USFWS *Eagle Conservation Plan Guidance, Module 1 – Land-Based Wind Energy Guidance* (ECPG; USFWS 2013), and the USFWS *Revisions to Regulations for Eagle Incidental Take and Take of Eagle Nests* (USFWS 2016). Study methods were reviewed with USFWS and Colorado Parks and Wildlife (CPW), and agency suggestions were incorporated into study design. Results from aerial eagle/raptor nest surveys, plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) lek surveys, and prairie dog (*Cynomys* spp.) colony mapping are presented in separate memos.

The principal objectives of the studies were to: 1) provide site-specific bird resource and use data that would be useful for evaluating potential impacts from the proposed wind energy facility; 2) provide information that could be used for Project planning and design of the facility to minimize impacts to eagles and other birds; 3) collect data on eagle use in the area following the ECPG (USFWS 2013); and 4) recommend further studies or potential mitigation measures, if warranted.

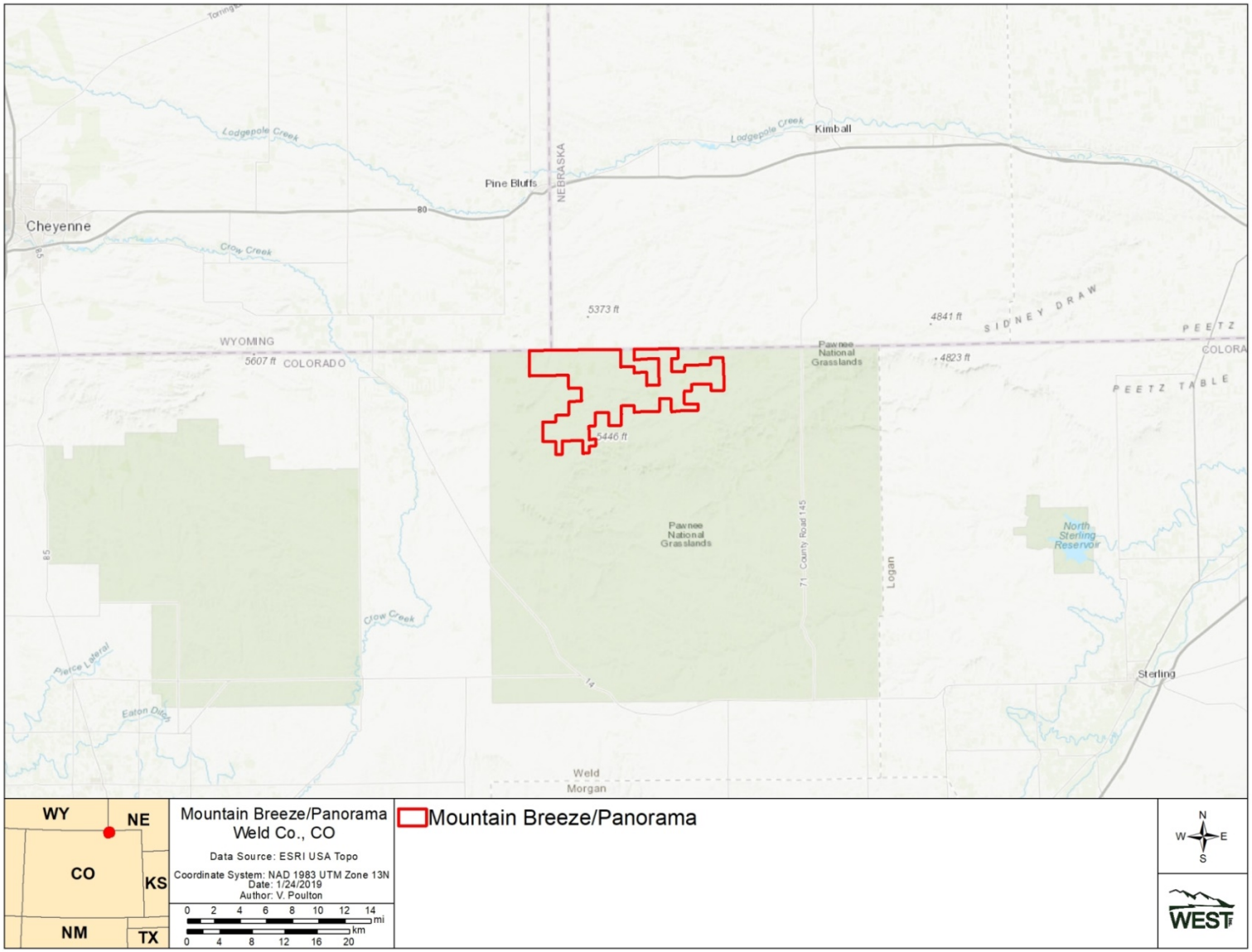


Figure 1.1. Location of the Mountain Breeze/Panorama Wind Energy Project Area, Weld County, Colorado.

2 PROJECT AREA

The Project is located on approximately 14,557 hectares (ha; 35,970 acres [ac]) of mostly private land in the high-altitude plains east of the Rocky Mountains (Figure 1.1). Elevations range from approximately 1,561 to 1,675 meters (m; 5,120 to 5,494 feet [ft]; Figure 2.1). The Project area itself has rolling to hilly topography, with more rugged topography along an escarpment to the south and west (Figures 2.2). There is one intermittent drainage feature (Sidney Draw) that flows to the northeast through the Project area (Figure 2.1). Sidney Draw joins with Lodgepole Creek, which is a tributary to the South Platte River. The dominant land use within the Project area is livestock (mostly cattle) grazing, although there are also some cultivated lands within the Project area (Figure 2.2).

Land cover in the Project area is dominated by grassland/herbaceous (9, 573 ha [23,655 ac]; 65.8%), and cultivated crops (mostly winter wheat [*Triticum aestivum*]) are the next most common cover type (4501.65 ha [11,124 ac]; 30.9%), while approximately 3.2% of land cover within the Project area is developed open space, hay/pasture, deciduous forest, woody wetlands, and open water (US Geological Survey National Land Cover Database 2011; Table 2.1, Figure 2.2). Developed low intensity, barren land, shrub/scrub, emergent herbaceous wetlands, and evergreen forest together represent about 0.1% of land cover (Table 2.1, Figure 2.2). The density of human habitation in the vicinity of the Project is very low, consisting primarily of homesteads or buildings for ranching and farming operations.

Table 2.1. Land cover types, coverage, and percent (%) composition in the Mountain Breeze/Panorama Wind Energy Project Area, Weld County, Colorado.

Land Cover Types	Coverage (Acres)	% Composition
Grassland/Herbaceous	23,654.84	65.8
Cultivated Crops	11,123.81	30.9
Developed, Open Space	669.92	1.9
Pasture/Hay	261.05	0.7
Deciduous Forest	85.12	0.2
Woody Wetlands	78.59	0.2
Open Water	60.25	0.2
Developed, Low Intensity	13.31	<0.1
Barren Land (Rock/Sand/Clay)	9.95	<0.1
Shrub/Scrub	8.37	<0.1
Emergent Herbaceous Wetlands	6.23	<0.1
Evergreen Forest	3.11	<0.1
Total	35,974.55	100.0

Source: US Geological Survey National Land Cover Database 2011, Homer et al. 2015

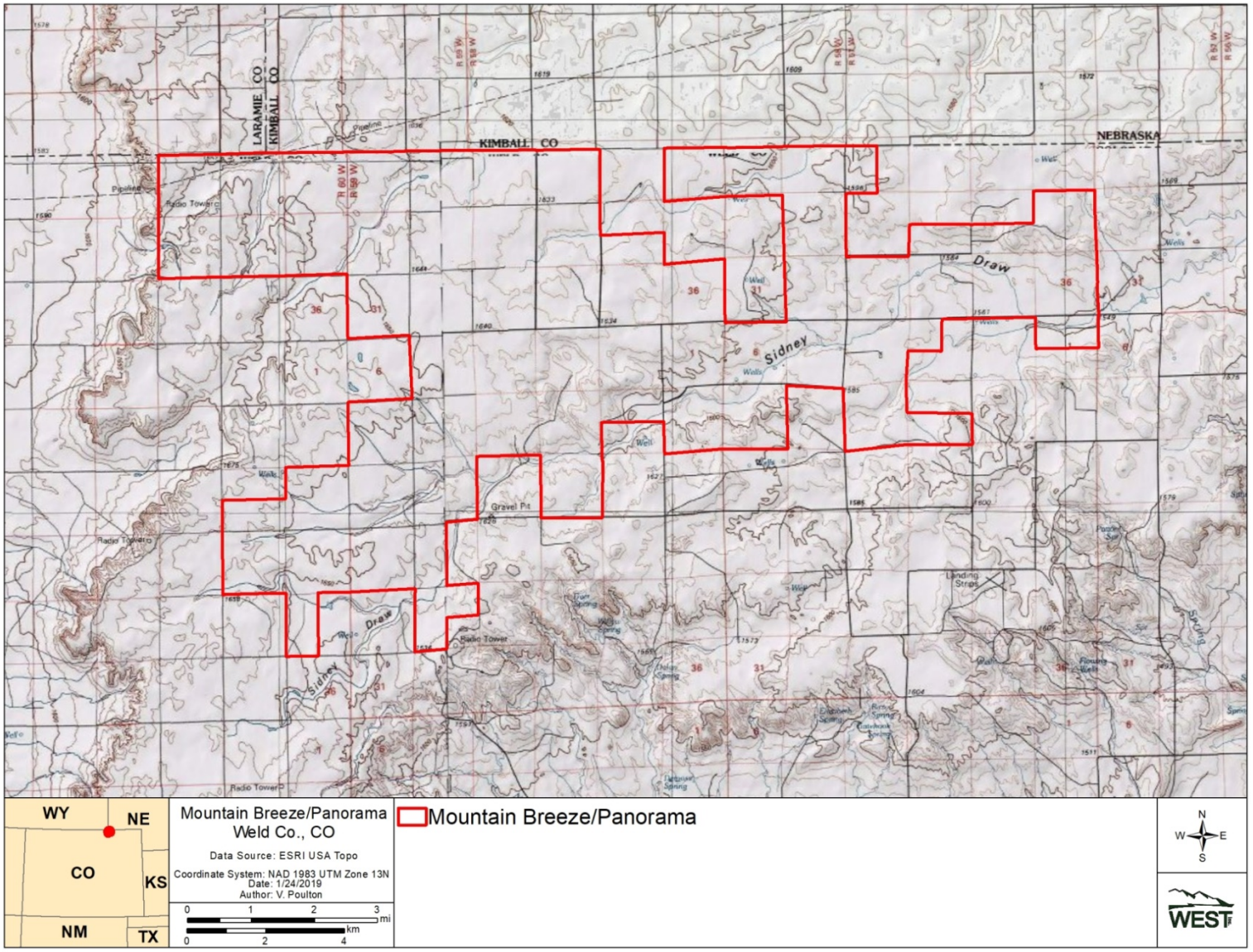


Figure 2.1. Topography of the Mountain Breeze/Panorama Wind Energy Project Area, Weld County, Colorado.

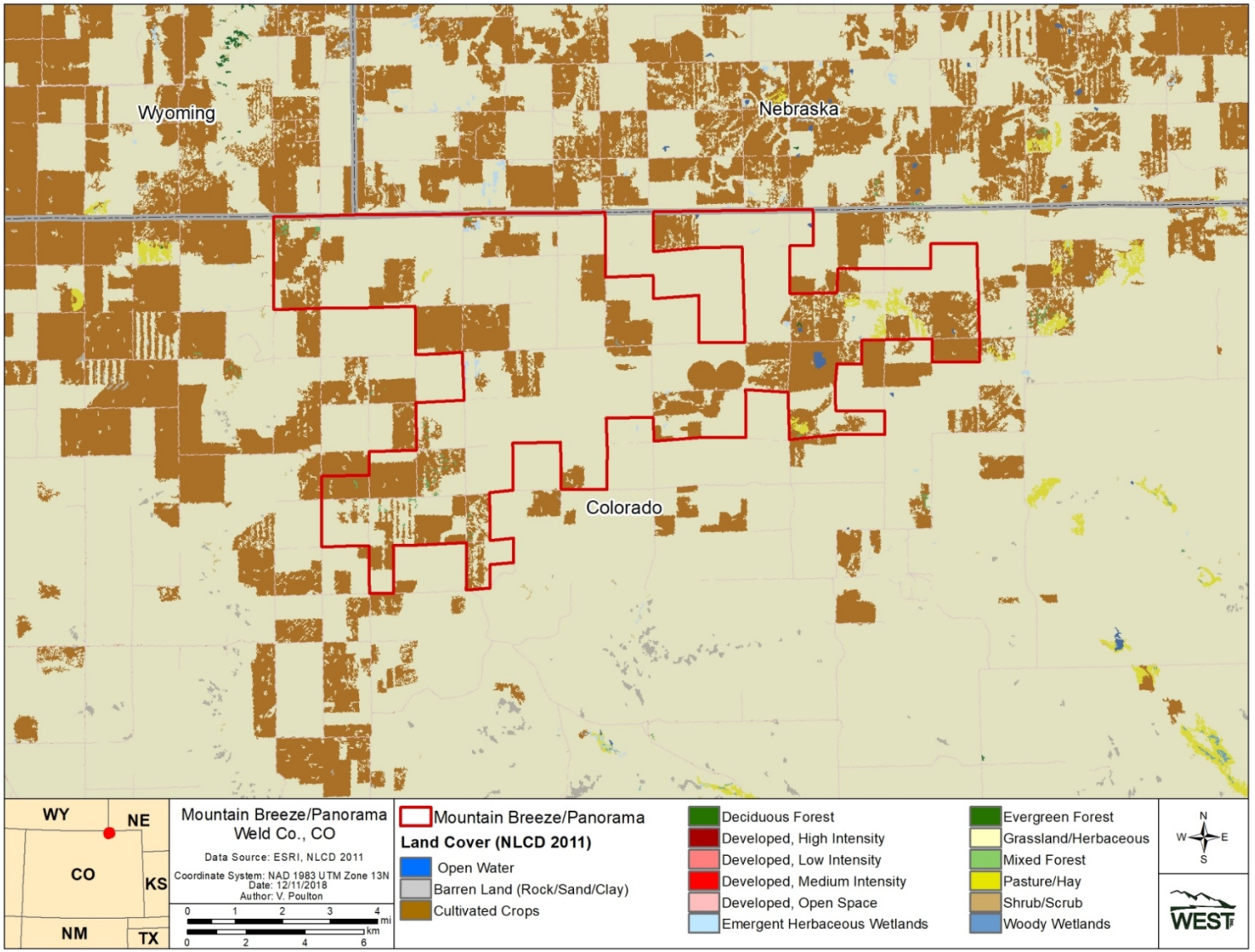


Figure 2.2. Land cover in the Mountain Breeze/Panorama Wind Energy Project Area, Weld County, Colorado (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

3 METHODS

Eagle/large bird use surveys and small bird use surveys were conducted at the Project for two years, from January 2017 through December 2018. Surveyors also recorded incidental wildlife observations when they encountered wildlife species of interest while traveling between points or were otherwise working within or near the Project.

3.1 Eagle/Large Bird Use Surveys

The primary objective of the eagle/large bird use surveys was to document use by eagles and other large birds, both seasonally and spatially within the Project area. Data on avian use patterns may be used to predict potential impacts and identify methods of avoiding and/or mitigating Project impacts. Surveyors conducted fixed-point bird use surveys (variable circular plots) using methods described by Reynolds et al. (1980). Eagle data were collected following the ECPG (USFWS 2013) as well as eagle permit rules published on December 16, 2016.

3.1.1 Survey Locations

Surveys consisted of counts of eagles and other large birds within circular plots centered on an observation point. The maximum survey radius around each observation point was 800 m (2,625 ft). The ECPG (USFWS 2013) recommends survey plots cover approximately 30% of the area within a minimum convex polygon that encompasses the hazardous areas around all proposed turbine locations. Since a turbine layout was not established when surveys were initiated, the area encompassed by the Project boundary was used for the survey area. Twenty-nine observation points were selected initially in 2017 to provide at least 30% coverage of the Project area, which at the time included the existing Cedar Creek Wind Project (Figure 3.1). The Project boundary changed by the beginning of 2018, so 17 observation points including eight from the 2017 study year were used from January through June 2018 to provide 30% coverage of the working Project area (Figure 3.1). The Project boundary changed again in summer 2018, so five more points, including one from 2017, were added in July 2018, for a total of 22 points (Figure 3.1). Point location was randomized to the extent practicable by randomly selecting a land section and finding the nearest public access to the center of the land section. Observation points were adjusted in the field to achieve an adequate viewshed.

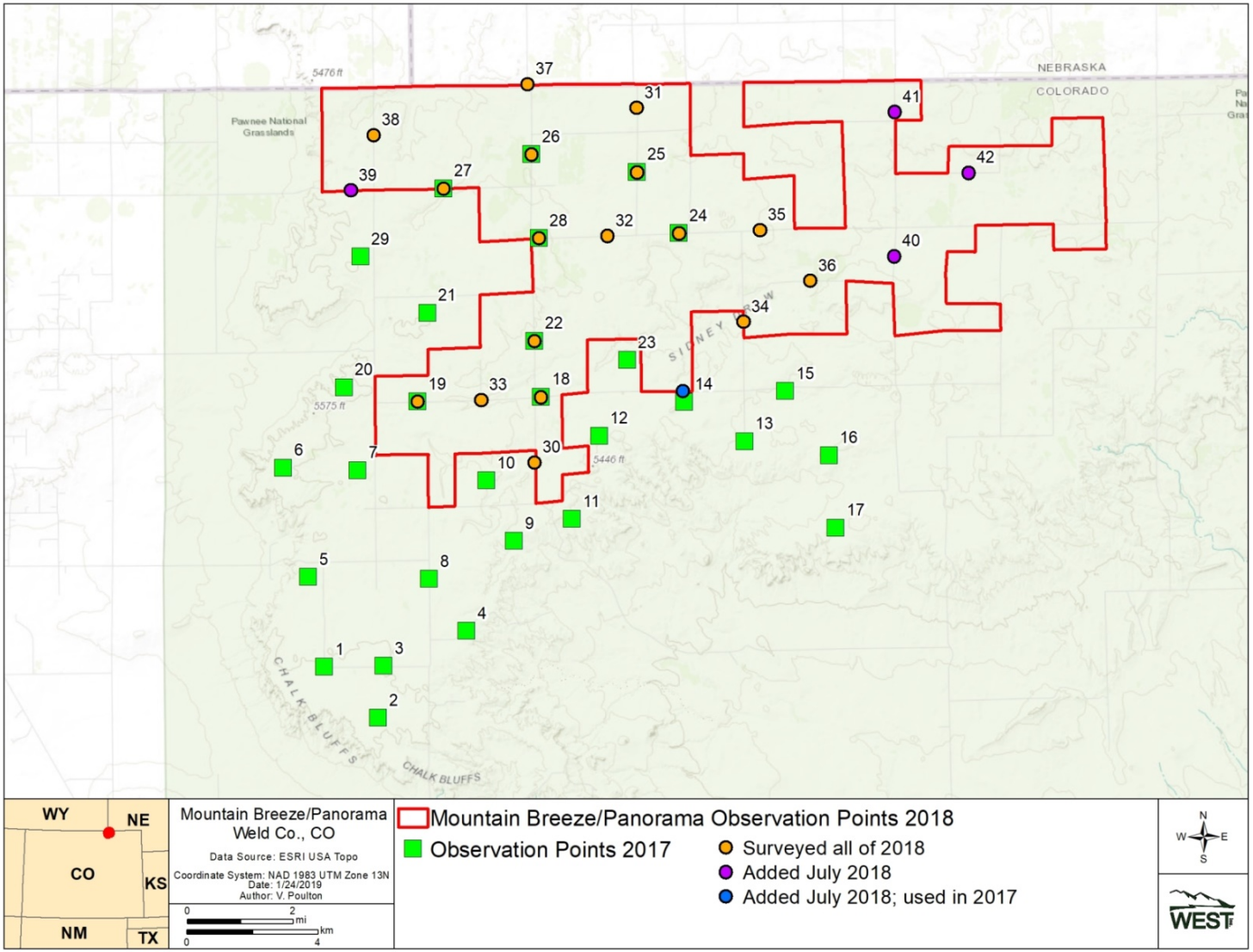


Figure 3.1 Avian use survey locations in the Mountain Breeze/Panorama Wind Energy Project, Weld County, Colorado, from January 2017 through December 2018.

3.1.2 Survey Methods

Surveys for eagles/large birds at each point were conducted for 60 minutes (min). Large birds were defined as waterbirds, waterfowl, shorebirds, diurnal raptors (i.e., kites, accipiters, buteos, eagles, falcons, harriers, and ospreys), vultures, upland game birds, doves and pigeons, large corvids (e.g., magpies, crows, and ravens), and goatsuckers. The initial 20 min of the 60-min eagle/large bird survey allowed for comparison of large bird use with other wind energy facilities in the region, while the full 60-min survey was consistent with the ECPG and was used to obtain a more robust dataset with which to evaluate eagle use of the Project. Eagles/large birds observed within an 800-m survey plot during the 60-min survey period were used for quantitative analysis and development of other comparative metrics. Observations of large birds beyond the 800-m radius were not included in the analyses.

For each survey, field technicians recorded the date, start and end time, habitat, and weather (i.e., temperature, wind speed, wind direction, precipitation, and percent cloud cover). Additionally, the technician recorded the following data for each individual or group of species seen:

- Species (or best possible identification)
- Number of individuals
- Sex and age class
- Distance from survey plot center when first observed
- Closest distance observed
- Flight height above ground level (AGL) when first observed
- Flight direction
- Activity (e.g., flying compared to perched)

Field technicians recorded approximate flight direction, flight height, and distance from survey plot center at first observation. Flight height and distance from plot center were measured to the nearest 5-m (16-ft) interval; technicians recorded the approximate lowest and highest flight heights of observations, as well as the closest distance of the bird(s) from plot center. Flight paths and perch locations of raptors were recorded on field maps, and were digitized using ArcGIS software.

3.1.3 Eagle Minutes

For any golden eagle (*Aquila chrysaetos*) or bald eagle (*Haliaeetus leucocephalus*) observations during the survey period, data were collected following ECPG methodology (USFWS 2013). Surveyors recorded eagle behavior (i.e., flight height, distance from observer, activity) each minute, at the top of the minute. Minute data were examined to count eagle risk minutes, defined as the number of minutes an eagle was observed in flight within the risk cylinder (identified as the

area within 800 m of the survey point and up to 200 m [656 ft] AGL) during the 60-min survey period. Observations of perched eagles and those outside of survey plots are not considered eagle risk minutes; however, the perch locations and flight paths of all eagles were mapped to qualitatively assess areas of eagle use within the Project area.

In addition to reporting the total number of eagle risk minutes observed during surveys, eagle risk minutes were standardized by survey plot and survey duration to enable spatial and temporal assessments of eagle risk minutes recorded in the Project area.

3.1.4 Observation Schedule

Eagle use surveys were conducted once per month at each observation point, for a total of 12 survey rounds in the study year. Seasons were defined as: winter (January – February), spring (March – June), summer (July – August), and fall (September – December). Season durations were uneven to accommodate changes in number of survey points during 2018, and were used during both survey years to facilitate comparison. Surveys were 60 min in duration, and were scheduled to cover all daylight hours as specified in the WEG (USFWS 2012), ECPG (USFWS 2013), and new eagle rule (USFWS 2016). To the extent practicable, and as dictated by changes to Project boundaries and resultant changes to surveyed plots, each point was surveyed approximately the same number of times.

3.2 Small Bird Use Surveys

Fixed-point small bird use surveys were conducted to provide a species list of small birds, and to document small bird abundance in the Project. The small bird use surveys consisted of small bird counts at the same observations points used for eagle/large bird use surveys.

3.2.1 Methods

Small bird use surveys were conducted for 10 min immediately prior to eagle and large bird use surveys. The small bird survey plots had a radius of 100 m. Small bird observations were recorded beyond 100 m (328 ft), but those data were analyzed separately from data collected on birds observed within the 100-m circular plot. The estimated distance to each bird observed was recorded to the nearest five m. The surveyor recorded the date, start and end time, plot number, species (or best possible identification), number of individuals, sex, age class, distance from plot center when first observed, closest distance, flight height above ground, behavior, and habitat. Flight paths were not mapped for small bird observations.

3.3 Incidental Observations

Incidental observations are wildlife observations seen outside of the standardized surveys, but within the Project area. Incidental observations focused on recording special status species (i.e., state- or federally listed species or eagles), large flocks of individuals, unusual observations, and species not yet recorded while conducting point count surveys. Surveyors recorded data in a similar fashion to data recorded for standardized surveys

3.4 Data Management and Statistical Analysis

3.4.1 Quality Assurance and Quality Control

WEST implements quality assurance and quality control (QA/QC) measures at all stages of the study, including in the field, during data entry and analysis, and report writing. Following surveys, surveyors were responsible for inspecting data forms for completeness, accuracy, and legibility. If errors or anomalies were found within the data, follow-up measures were implemented including discussions and review of field data with field personnel and/or Project managers. WEST traced back any errors, omissions, or problems identified in later stages of analysis to the raw data forms where appropriate changes and measures were implemented, no matter what stage of analysis. Multiple reviews were conducted as QA/QC measures.

3.4.2 Data Compilation and Storage

A Microsoft® SQL database was specifically developed to store, organize, and retrieve survey data. Project data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. WEST retained all data forms and electronic data files for reference.

3.4.3 Data Analysis

For analysis purposes, a visit was defined as surveying all of the survey plots in the sample once within the study area. Visits were assigned according to the following criteria: 1) a single visit had to be completed in a single season and 2) a visit could be spread across multiple dates, but a single date could not contain surveys from multiple visits. Under certain circumstances, such as extreme weather conditions, plots were not surveyed during some visits. In these cases, a visit might not have constituted a complete survey of all plots. Results are presented separately for 2017 and 2018 due to differences in location and number of observation points.

3.4.3.1 Species Richness and Index to Species Richness

Species richness is the total number of species identified during avian use surveys. WEST generated species lists (with the number of individuals and the number of groups) by season including all bird observations recorded, regardless of their distance from the observer. Species observed include those seen visually or heard aurally. In some cases, the count of observations may represent repeated observations of the same individual.

The index to species richness is the average number of species observed within the observer viewshed per survey plot per visit within seasons (species observed/plot/visit/season). This metric was calculated by summing the total number of species observed within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the seasons. The annual index to species richness was calculated as a weighted average of seasonal values by the number of days in each season. Species richness and index to species richness were compared among seasons for avian use surveys. These metrics were analyzed separately for small and large birds.

3.4.3.2 Bird Use, Percent of Use, and Frequency of Occurrence

Bird use estimates are the average observations of birds by survey effort and season, for large birds recorded within the 800-m radius plot during 60-min surveys and small birds recorded within a 100-m radius plot during 10-min surveys. Mean bird use is the average number of birds observed per plot per survey, for each survey type. Comparisons were made between standardized estimates of mean bird use among bird types, seasons, survey points, and other studies where similar methods were used. Mean use was calculated by: 1) summing birds per plot per visit; 2) averaging number of birds over plot within a visit; and 3) averaging number of birds across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of survey days in each season. Estimates were calculated separately for large birds and small birds.

Percent of use was calculated as the percentage of large or small bird use that was attributable to a particular bird type or species, and frequency of occurrence was calculated as the percent of surveys in which a particular bird type or species was observed.

3.4.3.3 Bird Flight Height and Behavior

Bird flight heights are important metrics to assess relative exposure. Flight height information was used to calculate the percentage of birds observed flying within the rotor-swept height (RSH) for turbines likely to be constructed. An RSH was used for potential collision with a turbine blade of 25 to 150 m (82 to 492 ft) AGL for the purposes of the analysis. Flight height was recorded during the initial observation to calculate the percentage of birds flying within the RSH and mean flight height. Percentage of birds flying within the RSH at any time was calculated using the lowest and highest flight heights recorded.

3.4.3.4 Bird Exposure Index

The bird exposure index is used as a relative measure of species-specific risk of turbine collision and the species most likely to occur as fatalities at the wind energy facility. A relative index of bird exposure (R) was calculated for bird species observed during the surveys using the following formula:

$$R = A*P_f*P_t$$

where A equals mean relative use for species *i* (# small birds/100-m plot/10-min survey) and (# large birds/800-m plot/60-min survey) averaged across all surveys, P_f equals the proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t equals the proportion of all initial flight height observations of species *i* within the likely RSH. The exposure index does not account for other possible collision risk factors, including avoidance, foraging, or courtship behavior.

3.4.3.5 Spatial Use

Eagle and other large bird locations and flight paths were mapped to identify areas of concentrated use and/or consistent flight patterns within the Project. This information can be useful in turbine layout design or micro-siting individual turbines to reduce risk to birds. Bird use calculated for each survey plot also was used to make spatial comparisons.

4 RESULTS

4.1 Bird Use Surveys 2017

During 2017, eagle/large bird and small bird fixed-point bird use surveys were conducted within the Project area between January 25 and December 22 (Tables 4.1.a and 4.1.b). Survey results are summarized below, supplemented by the appendices, which present species-level detail on the numbers of bird groups and individuals observed during each season (Appendices A1 and A2), species-level detail on seasonal use statistics (Appendices B1 and B2), and species-level detail on exposure index values based on in-flight observations (Appendices C1 and C2). Due to different survey methods, results for large and small birds are not directly comparable.

Six hundred large bird observations were recorded within 287 separate groups (defined as one or more individuals observed together) and irrespective of distance from observer, during the 60-min eagle/large bird surveys at the Project in 2017 (Appendix A1). Canada goose (*Branta canadensis*) was the most commonly recorded large bird species, with 180 observations in two groups recorded during winter (Appendix A1). Swainson's hawk (*Buteo swainsoni*) was the second most commonly recorded large bird, with 79 observations in 67 groups, and rock pigeon (*Columba livia*) was the third most commonly recorded large bird, with 56 observations recorded in 11 groups throughout the survey year (Appendix A1). Nine raptor species were recorded totaling 240 observations (Appendix A1). Swainson's hawk, rough-legged hawk (*Buteo lagopus*) and northern harrier were the most commonly recorded raptor species, with 79, 47, and 35 observations, respectively (Appendix A1).

During small bird surveys, 1,456 small bird observations were recorded in 743 separate groups, irrespective of distance from observer (Appendix A2). All small bird observations were of passerines. Three small bird species made up 79.2% of all small bird observations: horned lark (715 observations), western meadowlark (*Sturnella neglecta*; 227), and lark bunting (*Calamospiza melanocorys*; 211; Appendix A2).

4.1.1 Species Richness and Index to Species Richness

Nineteen large bird species were recorded over the course of all 60-min bird use surveys (Table 4.1.a, Appendix A1). Large bird species richness (the total number of species identified) was highest during spring (15 species), followed by fall (12), and summer and winter (eight each; Table 4.1.a). The large bird species richness index (the average number of species identified within the observer viewshed per plot per visit within seasons) was highest during summer (0.66 species/800-m plot/60-min survey) and lower during spring (0.54), fall (0.46) and winter (0.45; Table 4.1.a).

During all 10-min small bird surveys, 23 species were identified. (Table 4.1.b, Appendix A2). Small bird species richness was highest during spring (19 species identified) and summer (16), and was lower in fall (five) and winter (one; Table 4.1.b). The small bird species richness index was also highest during spring (2.25 species/100-m plot/10-min survey), followed by summer (1.88), fall (0.53), and winter (0.47; Table 4.1.b).

Table 4.1.a. Summary of large bird species richness (total number of species identified) and the species richness index (average number of species observed within the 800-m viewshed/plot/visit/season) during large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Season	Number of Visits	# Surveys Conducted	Species Richness	Species Richness index
Winter	2	58	8	0.45
Spring	4	115	15	0.54
Summer	2	58	8	0.66
Fall	4	116	12	0.46
Overall	**12**	**347**	**19**	**0.52**

Table 4.1.b. Summary of small bird species richness (total number of species identified) and the species richness index (average number of species observed within the 100-m viewshed/plot/visit/season) during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Season	Number of Visits	# Surveys Conducted	Species Richness	Species Richness index
Winter	2	58	1	0.47
Spring	4	116	19	2.25
Summer	2	58	16	1.88
Fall	4	116	5	0.53
Overall	**12**	**348**	**23**	**1.31**

4.1.2 Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for large and small bird types (Tables 4.2.a and 4.2.b) and species (Appendices B1 and B2). Large bird use was highest during winter (4.05 birds/800-m plot/60-min survey), followed by spring (1.29), summer (1.22), and fall (0.88; Table 4.2.a). Small bird use was highest in summer (5.33 birds/100-m plot/10-min survey), followed by spring (4.91), fall (3.35), and winter (1.29; Table 4.2.b).

4.1.2.1 Waterbirds and Waterfowl

Waterbird and waterfowl use of the Project area was infrequent and highly variable. Waterbirds were observed only in spring, and the only waterbird species was American white pelican (*Pelecanus erythrorhynchos*), recorded in a group of 12 birds (Table 4.2.a, Appendix A1, Appendix B1). The only waterfowl species identified was Canada goose, occurring in two groups

totaling 180 observations in winter only, though an unidentified duck also was recorded in fall (Table 4.2.a, Appendix A1). Waterfowl had the highest use of all large bird types in winter (Table 4.2.a).

4.1.2.2 Diurnal Raptors

A total of 240 diurnal raptor observations were recorded within the Project area, representing nine species (Appendix A1). Diurnal raptor use was highest during summer (0.84 bird/800-m plot/60-min survey), followed by spring (0.68), fall (0.59), and winter (0.41; Table 4.2.a). Raptors had the highest use of all large bird types during spring, summer, and fall (Table 4.2.a). High use during summer and spring was primarily due to Swainson's hawk (*Buteo swainsoni*), while use in fall and winter was due mostly to rough-legged hawk (Appendix B1). Throughout the year, raptors made up 10.2% to 69.0% of all large bird observations and were observed during 29.3% to 44.8% of surveys, seasonally (Table 4.2.a).

4.1.2.3 Doves/Pigeons

Doves/pigeons were observed throughout the year, and seasonal use ranged from 0.09 bird/800-m plot/60-min survey in spring to 0.47 in winter (Table 4.2.a). Most dove/pigeon use during winter, spring, and fall was attributed to rock pigeon, a non-native, non-protected species (Appendix B1). Another dove/pigeon species, Eurasian collared-dove (*Streptopelia decaocto*), also is non-native and non-protected. Doves/pigeons made up 6.7% to 17.6% of all large bird use and they were observed during 5.2% or fewer of all large bird surveys, seasonally (Table 4.2.a).

4.1.2.4 Goatsuckers

Common nighthawk was the only goatsucker, or nightjar (*Antostomus* spp.), species identified in the Project (Appendix B1). Use by common nighthawk was the second highest of all large birds during spring and summer, and none were observed in winter (Table 4.2.a, Appendix B1). Common nighthawks made up 26.7% of all large bird use in spring, 16.9% in summer, and 1.0% in fall (Table 4.2.a, Appendix B1). They were observed during 0.9% to 5.2% of all large bird surveys, seasonally (Table 4.2.a, Appendix B1).

4.1.2.5 Small Birds

Passerines were the only small bird species type recorded during the study (Table 4.2.b). Horned lark was the passerine with the highest use during winter, spring, and fall (Appendix B2). During summer, lark bunting had the highest use of all small birds (Appendix B2). Passerines were commonly seen during surveys in spring (91.4% of surveys) and summer (84.5%) and were less frequently observed in winter (46.6%) and fall (40.5%; Table 4.2.b).

Table 4.2.a. Large bird mean use, (number of birds/800-m plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during eagle/large bird fixed-point bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	**0**	**0.10**	**0**	**0**	**0**	**8.0**	**0**	**0**	**0**	**0.9**	**0**	**0**
Waterfowl	**3.10**	**0**	**0**	**0.03**	**76.6**	**0**	**0**	**2.9**	**1.7**	**0**	**0**	**0.9**
Shorebirds	**0**	**0.03**	**0**	**0.03**	**0**	**2.0**	**0**	**3.9**	**0**	**1.7**	**0**	**0.9**
Diurnal Raptors	**0.41**	**0.68**	**0.84**	**0.59**	**10.2**	**53.1**	**69.0**	**67.6**	**29.3**	**34.8**	**44.8**	**31.9**
Accipiters	*0*	*0.03*	*0*	*0*	*0*	*2.0*	*0*	*0*	*0*	*1.8*	*0*	*0*
Buteos	*0.24*	*0.50*	*0.60*	*0.38*	*6.0*	*39.0*	*49.3*	*43.1*	*20.7*	*22.6*	*29.3*	*21.6*
Northern Harrier	*0.07*	*0.06*	*0.14*	*0.14*	*1.7*	*4.7*	*11.3*	*15.7*	*6.9*	*5.2*	*12.1*	*9.5*
Eagles	*0.02*	*0.02*	*0.02*	*0.02*	*0.4*	*1.3*	*1.4*	*2.0*	*1.7*	*1.7*	*1.7*	*0.9*
Falcons	*0.03*	*0.04*	*0.05*	*0.04*	*0.9*	*3.4*	*4.2*	*4.9*	*3.4*	*4.4*	*5.2*	*2.6*
Other Raptors	*0.05*	*0.03*	*0.03*	*0.02*	*1.3*	*2.7*	*2.8*	*2.0*	*5.2*	*3.5*	*1.7*	*1.7*
Vultures	**0**	**0.03**	**0**	**<0.01**	**0**	**2.7**	**0**	**1.0**	**0**	**1.7**	**0**	**0.9**
Upland Game Birds	**0**	**0**	**0**	**0.03**	**0**	**0**	**0**	**3.9**	**0**	**0**	**0**	**0.9**
Doves/Pigeons	**0.47**	**0.09**	**0.17**	**0.16**	**11.5**	**6.7**	**14.1**	**17.6**	**3.4**	**3.5**	**5.2**	**3.4**
Large Corvids	**0.07**	**<0.01**	**0**	**0.02**	**1.7**	**0.7**	**0**	**2.0**	**1.7**	**0.9**	**0**	**0.9**
Goatsuckers	**0**	**0.34**	**0.21**	**<0.01**	**0**	**26.7**	**16.9**	**1.0**	**0**	**3.4**	**5.2**	**0.9**
Large Birds Overall	**4.05**	**1.29**	**1.22**	**0.88**	**100**	**100**	**100**	**100**				

Table 4.2.b. Mean small bird use (number of small birds/100-m plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	1.29	4.84	5.29	3.20	100	98.8	99.4	95.4	46.6	91.4	84.5	40.5
Unidentified Birds	0	0.06	0.03	0.16	0	1.2	0.6	4.6	0	5.2	3.4	8.6
Small Birds Overall	**1.29**	**4.91**	**5.33**	**3.35**	**100**	**100**	**100**	**100**				

4.1.3 Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for bird types and species (Tables 4.3.a and 4.3.b, Appendix C1 and C2). During the eagle/large bird use surveys, 248 groups of large birds initially were observed flying within the 800-m survey plots, totaling 535 individual observations. Overall, 26.0% of flying large birds initially were recorded within the RSH (25 – 150 m), 39.1% were below the RSH (zero – 25 m), and 35.0% were flying above the RSH (higher than 150 m; Table 4.3.a). About half (50.5%) of flying diurnal raptors were observed within the RSH, 46.2% were below the RSH, and 3.4% were observed flying above the RSH, based on the initial observation (Table 4.3.a). Among the large bird types and raptor subtypes for which 10 or more groups were observed in flight over the course of the study period, buteos initially were observed within the RSH during more than half of observations (66.2%), whereas all other large bird types and raptor subtypes (i.e., northern harrier, falcons, doves/pigeons, goatsuckers) had the majority of observations below the RSH (Table 4.3.a). Of six eagle observations, 50% initially were within the RSH and 50% were below the RSH (Table 4.3.a).

Among small birds, 380 groups consisting of 905 individual observations of birds in flight were recorded (Table 4.3.b). Almost all (99.8%) of small bird flight activity occurred below the RSH (Table 4.3.b).

Table 4.3.a. Flight height characteristics by large bird type[a] and raptor subtype during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017. Flight heights are based on height at initial observation.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories		
					0 – <25 m	25 – 150 m[b]	>150 m
Waterbirds	**1**	**12**	**100**	**100**	**0**	**100**	**0**
Waterfowl	**3**	**183**	**220.00**	**100**	**1.6**	**0**	**98.4**
Shorebirds	**2**	**6**	**5.50**	**85.7**	**100**	**0**	**0**
Diurnal Raptors	**190**	**208**	**45.24**	**94.1**	**46.2**	**50.5**	**3.4**
Accipiters	*2*	*3*	*20.00*	*100*	*33.3*	*66.7*	*0*
Buteos	*127*	*142*	*57.72*	*94.0*	*29.6*	*66.2*	*4.2*
Northern Harrier	*33*	*34*	*12.39*	*97.1*	*97.1*	*0*	*2.9*
Eagles	*6*	*6*	*53.33*	*100*	*50.0*	*50.0*	*0*
Falcons	*14*	*15*	*11.07*	*100*	*80.0*	*20.0*	*0*
Other Raptors	*8*	*8*	*42.62*	*72.7*	*62.5*	*37.5*	*0*
Vultures	**4**	**5**	**97.50**	**100**	**0**	**100**	**0**
Upland Game Birds	**1**	**4**	**3.00**	**100**	**100**	**0**	**0**
Doves/Pigeons	**13**	**59**	**10.77**	**90.8**	**93.2**	**6.8**	**0**
Large Corvids	**5**	**7**	**12.80**	**100**	**85.7**	**14.3**	**0**
Goatsuckers	**29**	**51**	**28.76**	**96.2**	**76.5**	**23.5**	**0**
Large Birds Overall	**248**	**535**	**43.54**	**96.1**	**39.1**	**26.0**	**35.0**

[a] 800-meter (m; 2,625-foot [ft]) radius plot for large birds.

[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Note: obs = observations.

Table 4.3.b. Flight height characteristics by bird type[a] during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017. Flight heights are based on height at initial observation.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories		
					0 – <25 m	25 – 150 m[b]	>150 m
Passerines	370	887	2.09	67.5	99.9	0.1	0
Unidentified Birds	10	18	5.60	66.7	94.4	5.6	0
Small Birds Overall	**380**	**905**	**2.18**	**67.4**	**99.8**	**0.2**	**0**

[a] 100-meter (m; 328-foot [ft]) radius plot for small birds.

[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Note: obs = observations.

4.1.4 Bird Exposure Index

A relative exposure index based on initial flight height observations and relative abundance (defined as the use estimate) was calculated for each bird species (Appendices C1 and C2). Species having exposure to the RSH are listed in Table 4.4. Swainson's hawk had the highest exposure index of all large bird species (0.14), followed by rough-legged hawk (0.09), common nighthawk (0.03), and American white pelican (0.03; Table 4.4). Eleven other large bird species or unidentified bird types had exposure indices greater than zero, including the golden eagle (Table 4.4). Based on observations within 100-m survey plots, only horned lark and unidentified small birds had exposure indices greater than zero (less than 0.01; Table 4.4, Appendix C2).

Table 4.4. Relative exposure index and flight characteristics for bird species[a] during bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species[a]	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial Obs	Exposure Index	% Within RSH at Anytime
Large Birds[c]						
Swainson's hawk	63	0.23	94.9	66.2	0.14	79.7
rough-legged hawk	39	0.13	95.6	72.1	0.09	86.0
common nighthawk	29	0.15	96.2	23.5	0.03	49.0
American white pelican	1	0.03	100	100	0.03	100
unidentified buteo	9	0.03	90.0	66.7	0.02	77.8
red-tailed hawk	14	0.04	87.5	42.9	0.02	71.4
turkey vulture	4	0.01	100	100	0.01	100
rock pigeon	9	0.17	91.1	7.8	0.01	7.8
unidentified raptor	8	0.03	72.7	37.5	<0.01	37.5
golden eagle	6	0.02	100	50.0	<0.01	100
unidentified falcon	4	0.01	100	40.0	<0.01	60.0
ferruginous hawk	2	<0.01	100	100	<0.01	100
unidentified accipiter	1	<0.01	100	100	<0.01	100
common raven	5	0.02	100	14.3	<0.01	85.7
prairie falcon	4	0.01	100	25.0	<0.01	25.0
Small Birds[c]						
horned lark	165	1.91	77.1	0.2	<0.01	0.2
unidentified bird (small)	10	0.07	66.7	5.6	<0.01	5.6

[a] Only include species with exposure index values greater than zero.

[b.] The likely rotor-swept heights (RSH) for potential collision with a turbine blade or 25 to 150 meters (m; 85 to 492 feet [ft]) above ground level.

[c.] 800-m (2,625-ft) radius survey plot for large birds; 100-m (328-ft) radius survey plot for small birds

4.1.5 Spatial Variation Across the Landscape

4.1.5.1 Mean Use by Point

Mean use for all large birds combined was highest at Point 28 (16.0 birds/60-min survey; Figure 4.1.a, Appendix D1). Large bird use at other points ranged from 0.08 to 3.42 birds/60-min survey. The highest mean use estimate for Point 28 was due to high use by waterfowl (Canada geese) at this point (15.25 birds/60-min survey), but this was based on two large groups of geese observing flying over this location. Raptor use was highest at Point 27 with 1.25 birds/60-min survey, and raptor use ranged from 0.08 to 1.08 birds/60-min survey at other points (Figure 4.1.b). While buteos made up most raptor use, the highest use by buteos was observed at points 7 and 20 (1.00 bird/60-min survey). Golden eagle use was recorded at points 2, 15, and 17 (0.08 bird/60-min survey), and at Point 27 (0.25). Use by doves/pigeons was recorded at 10 points and ranged from 0.08 to 2.17 birds/60-min survey. Goatsuckers were recorded at seven points and ranged from 0.08 to 1.75 birds/60-min survey. Small bird use was highest at Point 8 (12.58 birds/10-min survey) and ranged from 1.33 to 7.33 bird/10-min survey at other points (Figure 4.1.c).

4.1.5.2 Flight Paths

Field data was used to digitize and map flight paths of large bird species (Figures 4.2.a-d). Buteo flight activity was recorded throughout the Project, though flight activity appeared to be less common at the southeastern observation points (Figure 4.2.a). Northern harriers also were recorded flying at most observation points except for the eastern-most points (Figure 4.2.b). Golden eagles were recorded most often in the northwestern portion of the Project, and also at southwestern and eastern observation points (Figure 4.2.c). Because there are few trees in the Project, many raptor perch locations are associated with fence posts and power poles. No other clear patterns were apparent in large bird flight paths.

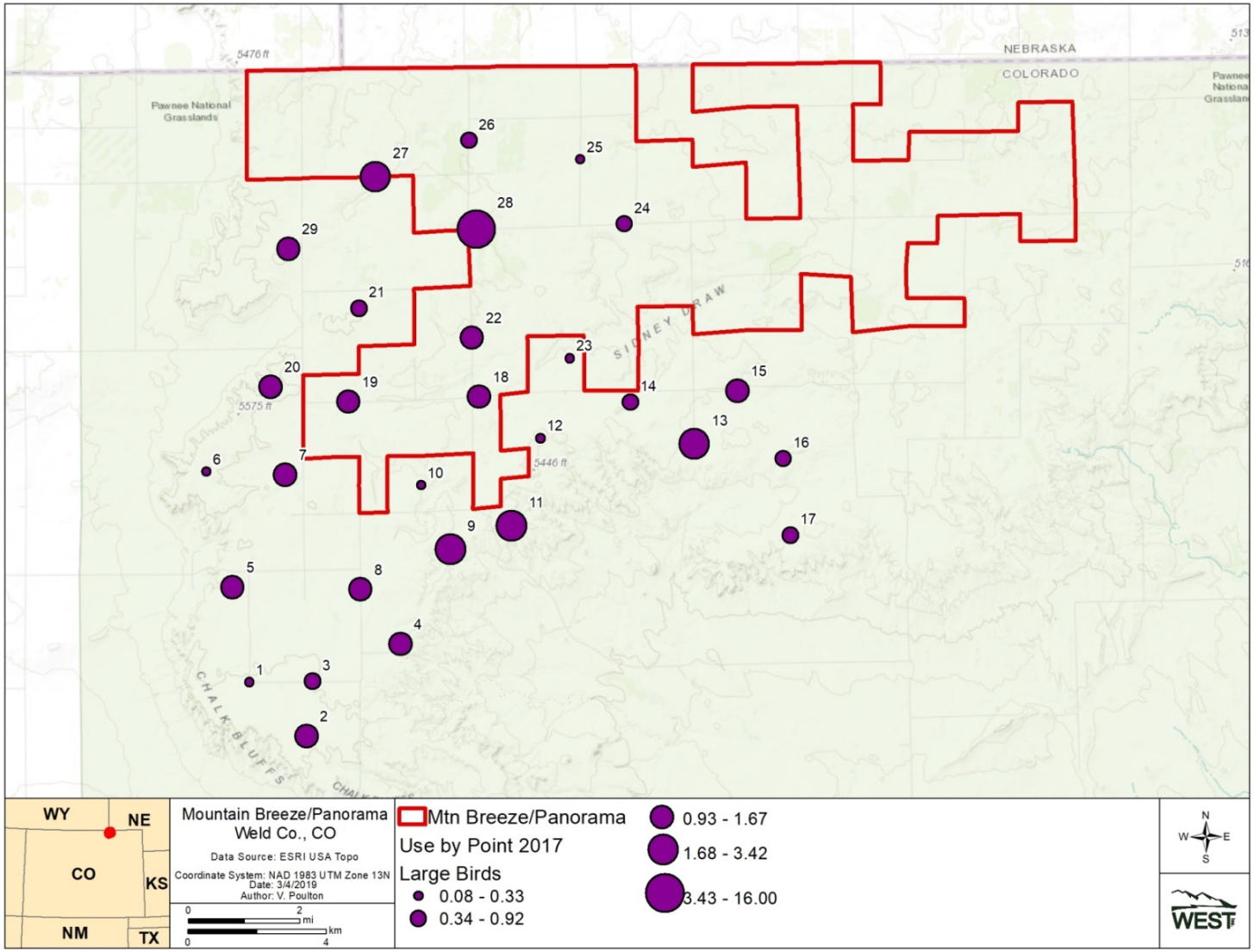


Figure 4.1.a. Mean use by observation point for large birds during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

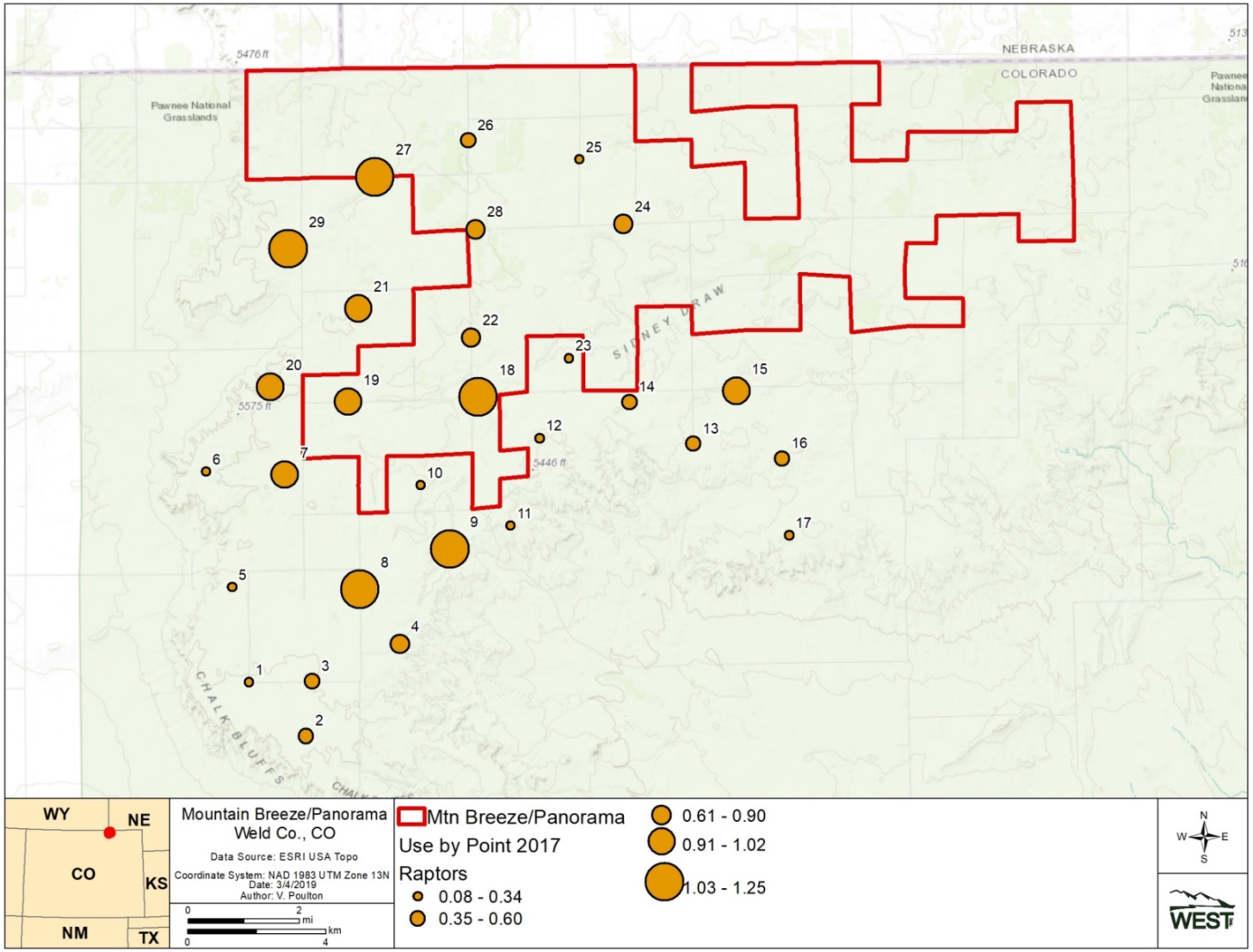


Figure 4.1.b. Mean use by observation point for raptors during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

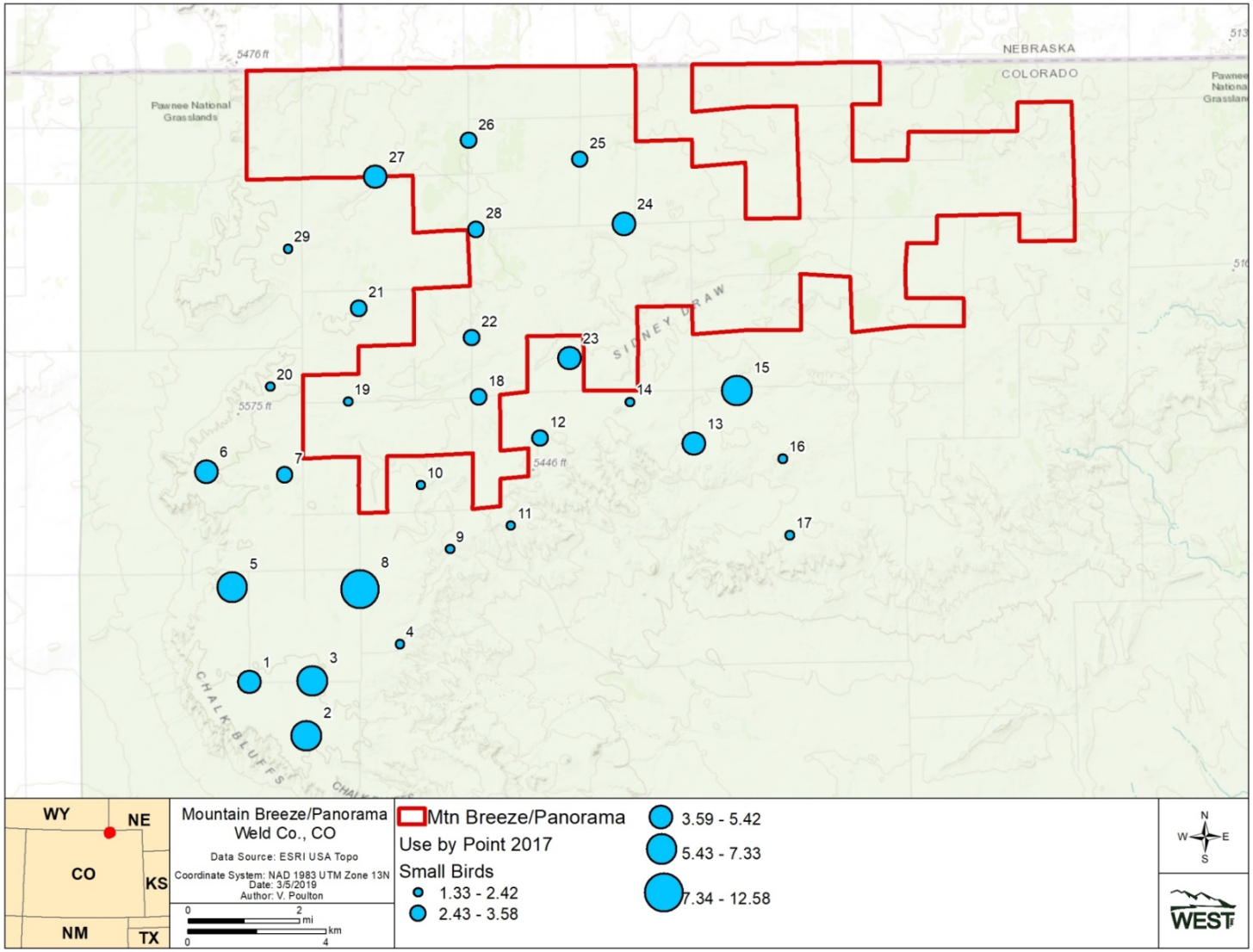


Figure 4.1.c. Mean use by observation point for small birds during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

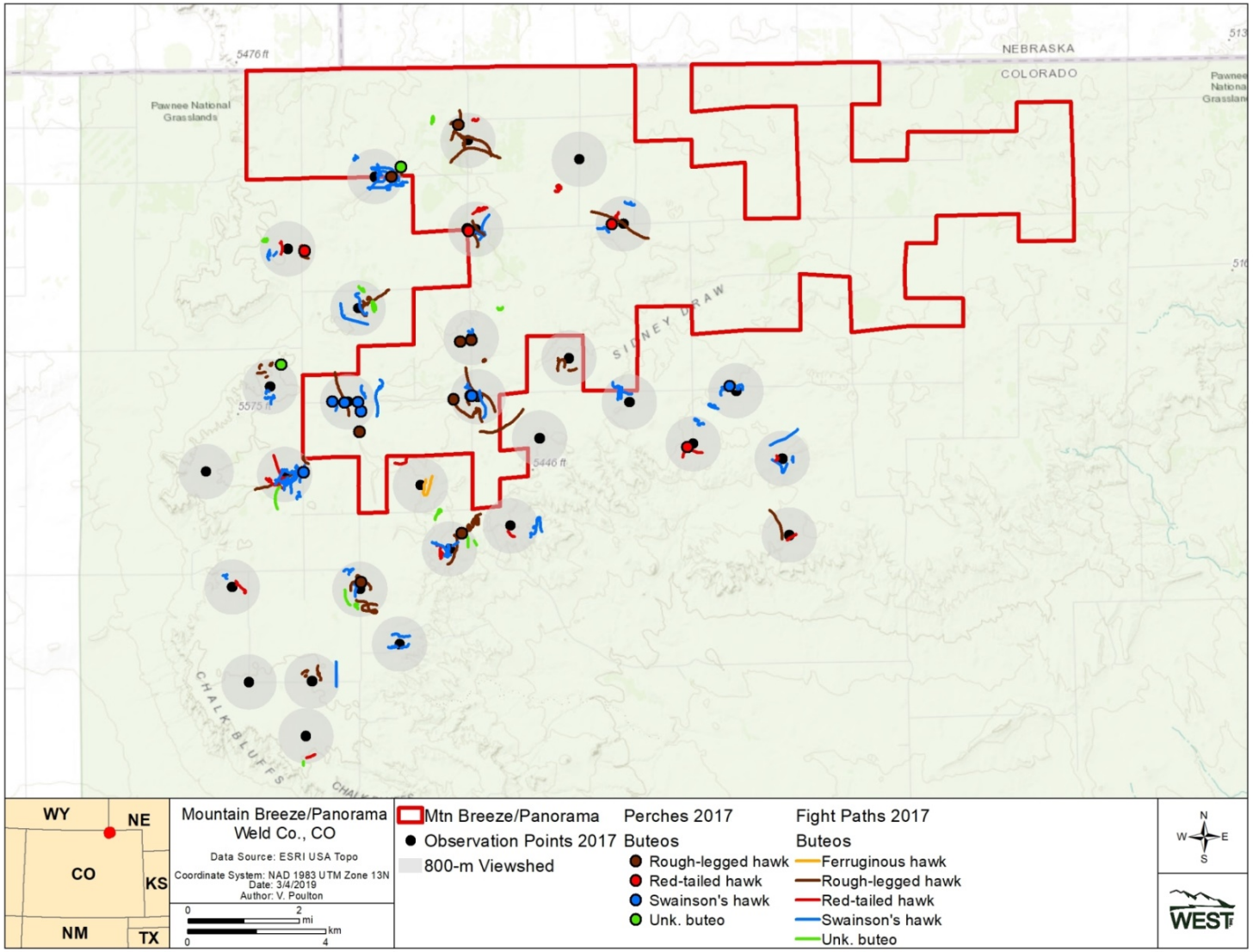


Figure 4.2.a. Flight paths for buteos during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

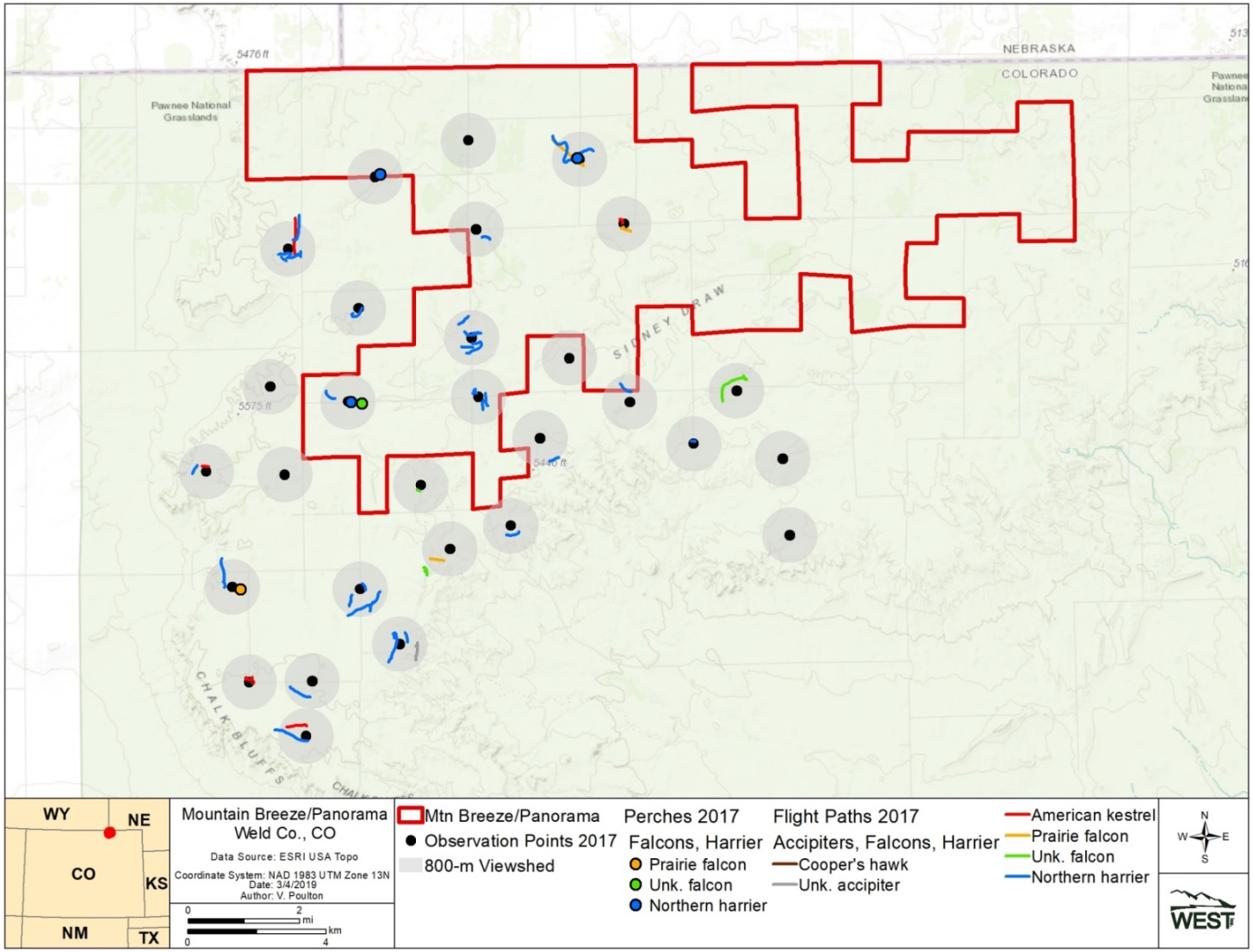


Figure 4.2.b. Flight paths for accipiters, falcons, and harriers during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

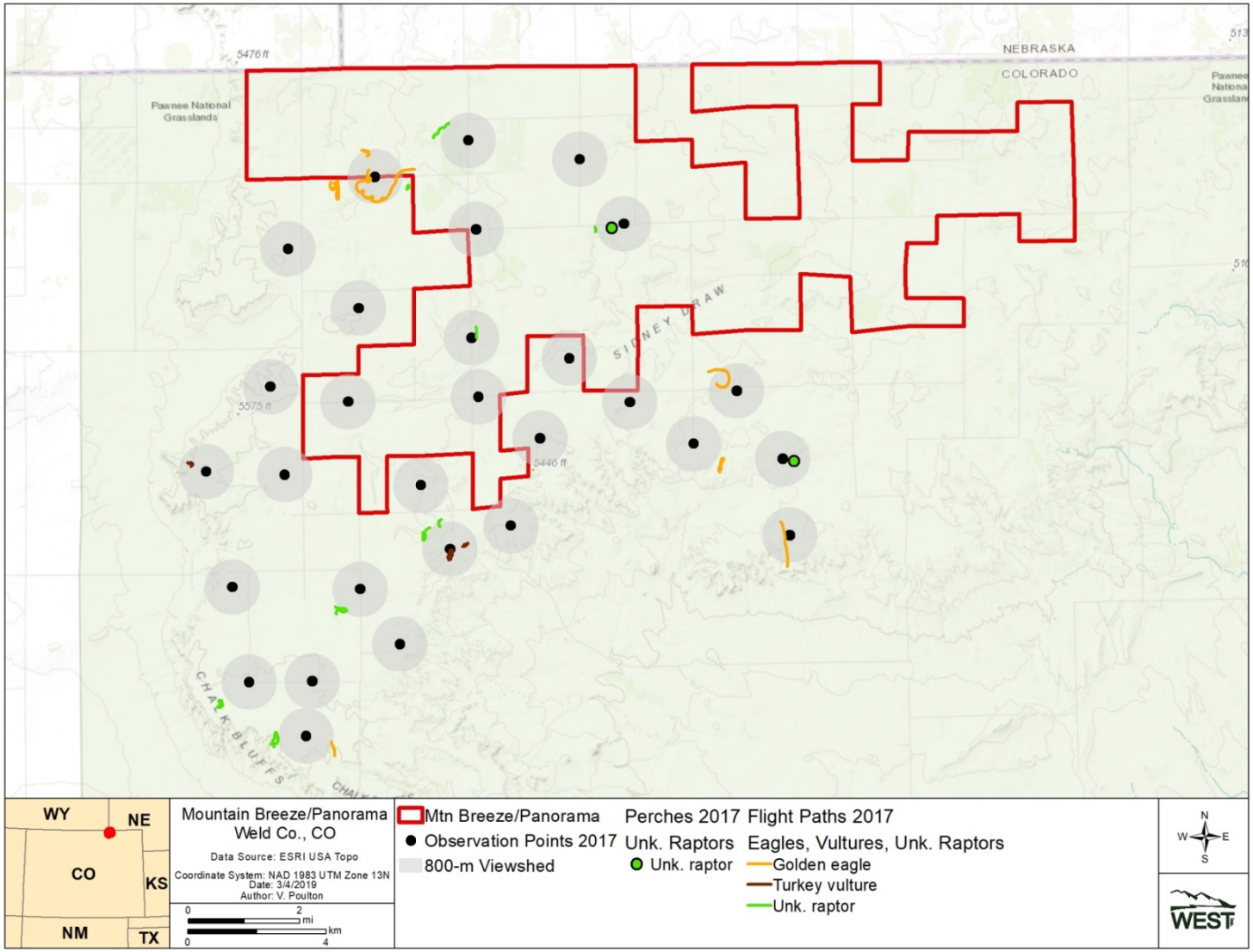


Figure 4.2.c. Flight paths for eagles and vultures during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

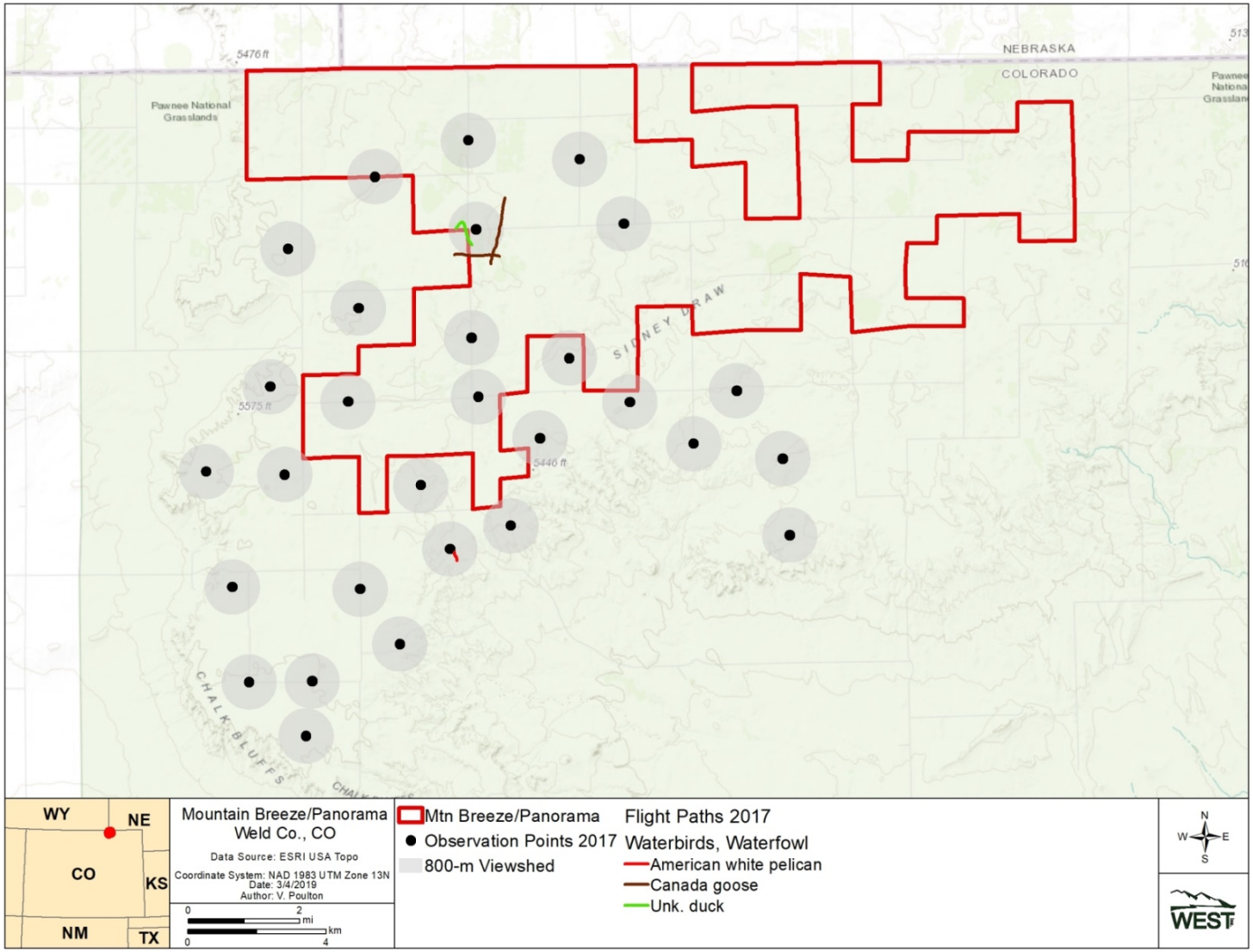


Figure 4.2.d. Flight paths for waterbirds and waterfowl during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

4.1.6 Eagle Minutes

During 346.8 eagle/large bird use survey hours in 2017, 10 golden eagle observations were recorded, and there was one observation that may have been an eagle, but for which identification was not confirmed due to clouds. For the 10 golden eagle observations, there were a total of 40 eagle use minutes recorded. A total of 15 golden eagle risk minutes (eagles flying within 800 m of the surveyor and 200 m of ground level) were documented. An additional risk minute was recorded for the unconfirmed eagle observation. The highest number of eagle risk minutes per month was recorded during March 2017 (eight eagle risk minutes), followed by October, with four eagle risk minutes, January 2017 with two eagle risk minutes, and August with one eagle risk minute (Table 4.5). No golden eagle observations were recorded during other months (Table 4.5). Eagle risk minutes per survey hour ranged from 0.08 to 0.75 at the four survey locations where they were recorded (Figure 4.3).

Table 4.5. Golden eagle risk minutes documented during large bird use surveys in the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Month	Survey Hours	Number of Eagle Observations	Number of Eagle Use Minutes	Number of Eagle Risk* Minutes	Eagle Risk Minutes per Survey Hour
January	29.00	1	2	2	0.07
February	29.00	0	0	0	0
March	29.00	2	10	8	0.28
April	25.00	0	0	0	0
May	32.00	0	0	0	0
June	29.00	0	0	0	0
July	29.02	0	0	0	0
August	29.00	1	3	1	0.03
September	28.83	0	0	0	0
October	28.97	3	11	4	0.14
November	29.00	0	0	0	0
December	29.00	3	14	0	0
Total	346.82	10	40	15	0.04

*Eagles flying within 800 meters (m; 2,625 feet [ft] of the surveyor and 200 m (656 ft) of ground level.

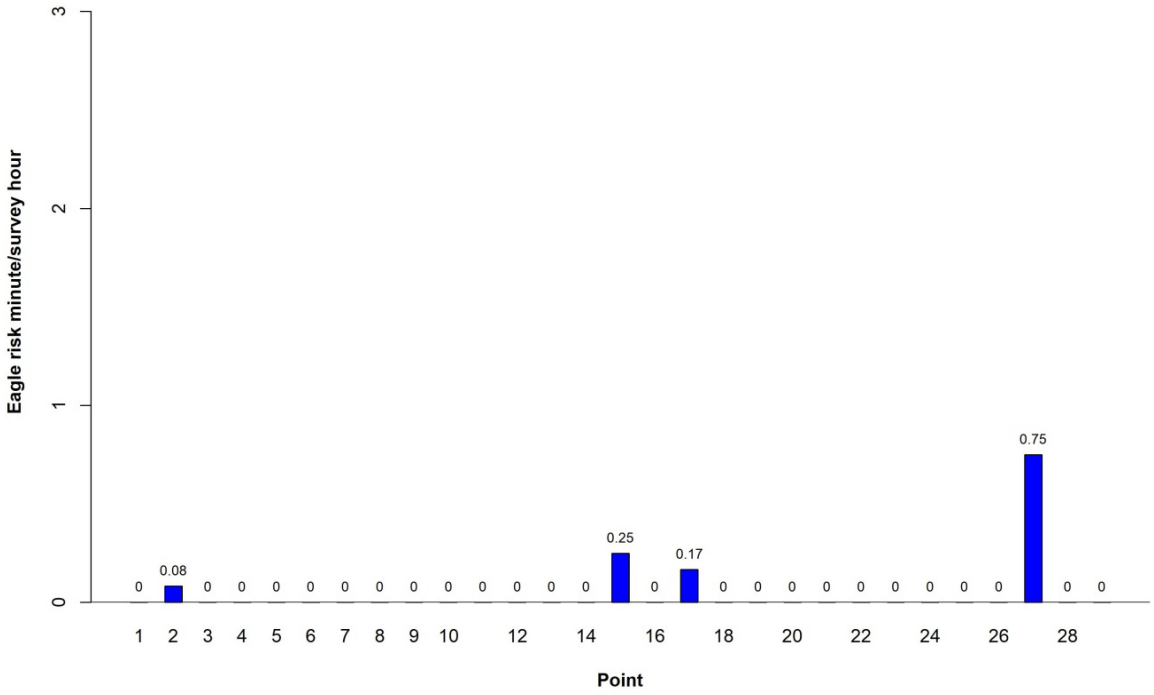


Figure 4.3. Number of eagle risk minutes per survey hour by observation point during large bird use surveys in the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

4.2 Incidental Observations 2017

Incidental observations were recorded in the Project area outside of standardized survey periods during 2017. Surveyors observed 12 bird species incidentally in the Project, totaling 94 observations within 86 separate groups (Table 4.6). One species, plains sharp-tailed grouse, was not recorded during bird use surveys. Surveyors also observed one mammal species, swift fox (*Vulpes velox*), incidentally in the Project (Table 4.6).

Table 4.6. Incidental observations recorded outside of standardized bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species	Scientific Name	# grps	# obs
Birds			
red-tailed hawk	*Buteo jamaicensis*	14	15
rough-legged hawk	*Buteo lagopus*	15	16
ferruginous hawk	*Buteo regalis*	2	2
unidentified buteo	*Buteo* spp.	3	4
Swainson's hawk	*Buteo swainsoni*	21	22
northern harrier	*Circus hudsonius*	18	19
prairie falcon	*Falco mexicanus*	1	1
American kestrel	*Falco sparverius*	4	4
unidentified raptor		1	1

Table 4.6. Incidental observations recorded outside of standardized bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species	Scientific Name	# grps	# obs
turkey vulture	*Cathartes aura*	3	3
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	1	3
common nighthawk	*Chordeiles minor*	1	2
grasshopper sparrow	*Ammodramus savannarum*	1	1
McCown's longspur	*Rhynchophanes mccownii*	1	1
Total Birds	**12 Species**	**86**	**94**
Mammals			
swift fox	*Vulpes velox*	1	1
Total Mammals	**1 species**	**87**	**95**

Note: grps = groups, obs = observations.

4.3 Special Status Species Observations 2017

Surveyors recorded seven special status bird species and one special status mammal in the Project in 2017 (Table 4.7). This tally may represent repeated observations of the same individual(s). Golden eagle is protected under the federal Bald and Golden Eagle Protection Act (BGEPA) and also is considered a Bird of Conservation Concern (BCC) by the USFWS in Bird Conservation Region 18 (Table 4.7). Prairie falcon (*Falco mexicanus*), chestnut-collared longspur (*Calcarius ornatus*), lark bunting, and McCown's longspur (*Rhynchophanes mccownii*) also are BCC species. Lark bunting also is the Colorado State Bird. Plains sharp-tailed grouse is listed as endangered by CPW, while ferruginous hawk (*Buteo regalis*) and swift fox are State Special Concern (SC) species. BCC species and SC species receive no regulatory protections with these special status designations.

Table 4.7. Special status species observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from January 25 to December 22, 2017.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
golden eagle	*Aquila chrysaetos*	BGEPA, BCC	10	10	0	0	10	10
ferruginous hawk	*Buteo regalis*	SC	2	2	2	2	4	4
prairie falcon	*Falco mexicanus*	BCC	4	4	1	1	5	5
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	SE	0	0	1	3	1	3
Large Birds Overall 4 species			**16**	**16**	**4**	**6**	**20**	**22**

Table 4.7. Special status species observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from January 25 to December 22, 2017.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
chestnut-collared longspur	*Calcarius ornatus*	BCC	1	1	0	0	1	1
lark bunting	*Calamospiza melanocorys*	BCC	118	211	0	0	118	211
McCown's longspur	*Rhynchophanes mccownii*	BCC	10	15	1	1	11	16
Small Birds Overall	**3 species**		**129**	**227**	**1**	**1**	**130**	**228**
swift fox	*Vulpes velox*	SC	0	0	1	1	1	1
Mammals Overall	**1 Species**		**0**	**0**	**1**	**1**	**1**	**1**

BGEPA = Bald and Golden Eagle Protection Act; BCC = USFWS Bird of Conservation Concern in Bird Conservation Region 18; SE = State-listed Endangered; SC = State Special Concern.

Note: obs = observations; grps = groups.

4.4 Bird Use Surveys 2018

During 2018, eagle/large bird and small bird fixed-point bird use surveys were conducted within the Project between January 29 and December 27 (Tables 4.8.a and 4.8.b). Survey results are summarized below, supplemented by the appendices, which present species-level detail on the numbers of bird groups and individuals observed during each season (Appendices A3 and A4), species-level detail on seasonal use statistics (Appendices B3 and B4), and species-level detail on exposure index values based on in-flight observations (Appendices C3 and C4). Due to different survey methods, results for large and small birds are not directly comparable.

During the 60-min eagle/large bird surveys at the Project in 2018, 1,054 large bird observations were recorded within 587 separate groups (Appendix A3). Mourning dove (*Zenaida macroura*) was the most commonly recorded large bird species, with 367 observations in 234 groups recorded during spring, summer, and fall (Appendix A3). Rock pigeon was the next most commonly recorded large bird, with 252 observations recorded in 60 groups throughout the survey year (Appendix A3). Sandhill crane (*Antigone canadensis*) and Swainson's hawk were the third most commonly recorded large bird species, with 72 observations each (Appendix A3). Ten raptor species were recorded totaling 260 observations (Appendix A3). Swainson's hawk and northern harrier were the most commonly recorded raptor species, with 72 and 62 observations, respectively (Appendix A3).

During small bird surveys in 2018, 1,504 small bird observations were recorded in 735 separate groups (Appendix A4). All small bird observations were of passerines. The same three small bird species that dominated observations in 2017 did so again in 2018 making up 73.8% of all small bird observations: horned lark (710 observations), western meadowlark (214), and lark bunting (186; Appendix A4).

4.4.1 Species Richness and Index to Species Richness

Twenty-one large bird species were recorded over the course of all 60-min eagle/large bird use surveys (Table 4.8.a, Appendix A3). Large bird species richness (the total number of species identified) was highest during fall (16 species), followed by spring (13), summer (10), and winter (five; Table 4.8.a). The large bird species richness index (the average number of species identified within the observer viewshed per plot per visit within seasons) was highest during spring (1.44 species/800-m plot/60-min survey) and summer (1.41), and lower during winter (0.85) and fall (0.83; Table 4.8.a).

During all 10-min small bird surveys, 23 species were recorded. (Table 4.8.b, Appendix A4). Small bird species richness was highest during spring and summer (12 species identified in each season), followed by fall (10), and was much lower in winter (one; Table 4.8.b). The small bird species richness index was highest during spring (2.69 species/100-m plot/10-min survey), followed by summer (1.82), fall (0.84), and winter (0.24; Table 4.8.b).

Table 4.8.a. Summary of large bird species richness (total number of species identified) and the species richness index (average number of species observed within the 800-m viewshed/plot/visit/season) during large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Season	# Visits	# Surveys Conducted	Species Richness	Species Richness index*
Winter	2	34	5	0.85
Spring	4	68	13	1.44
Summer	2	44	10	1.41
Fall	4	88	16	0.83
Overall	**12**	**234**	**21**	

*Cannot be calculated for the year due to changes in number of survey points

Table 4.8.b. Summary of small bird species richness (total number of species identified) and the species richness index (average number of species observed within the 100-m viewshed/plot/visit/season) during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Season	# Visits	# Surveys Conducted	Species Richness	Species Richness index*
Winter	2	34	1	0.24
Spring	4	68	12	2.69
Summer	2	44	12	1.82
Fall	4	88	10	0.84
Overall	**12**	**234**	**23**	

*Cannot be calculated for the year due to changes in number of survey points

4.4.2 Bird Use, Percent of Use, and Frequency of Occurrence

Mean bird use, percent of use, and frequency of occurrence were calculated by season for large and small bird types (Tables 4.9.a and 4.9.b) and species (Appendices B3 and B4). Large bird use was highest during spring (6.09 birds/800-m plot/60-min survey), followed by summer (4.93), fall (3.70), and winter (1.74; Table 4.9.a). Small bird use was highest in summer (7.23 birds/100-m plot/10-min survey), followed by spring (6.66), fall (5.81), and winter (2.24; Table 4.9.b).

4.4.2.1 Waterbirds and Waterfowl

Waterbirds were observed in spring and fall, with one great blue heron (*Ardea herodias*) and two American white pelicans recorded in spring, and three groups totaling 72 sandhill cranes recorded in fall (Table 4.9.a, Appendix A3, Appendix B3). Waterbirds made up 21.5% of all large bird observations in fall, but were observed during only about 1% of surveys (Table 4.9.a). The only waterfowl species identified was Canada goose, though an unidentified duck also was recorded in spring (Table 4.9.a, Appendix B3). Waterfowl had the second highest use of all large bird types in winter, and represented 28.8% of large bird observations, but were observed during fewer than 6% of winter surveys (Table 4.9.a).

4.4.2.2 Diurnal Raptors

A total of 260 diurnal raptor observations were recorded within the Project area, representing 10 identified species (Appendix A3). Diurnal raptor use was fairly consistent throughout the year, ranging from 1.14 birds/800-m plot/60-min survey in fall, followed by 1.07 in spring, 1.03 in winter, and 0.80 in summer (Table 4.9.a). Raptors had the highest use of all large bird types during winter, and second highest use of all large bird types during spring, summer, and fall (Table 4.9.a). High use during fall was due largely to use by northern harrier, winter use was due primarily to rough-legged hawk and northern harrier, while use in spring and summer was due mostly to Swainson's hawk (Appendix B3). Raptors made up 59.3% of all large bird use in winter, 30.7% in fall, 17.6% in spring, and 16.1% in summer (Table 4.9.a). Raptors were observed during 42.6% to 52.9% of surveys, seasonally (Table 4.9.a).

4.4.2.3 Doves/Pigeons

Doves/pigeons were observed throughout the year, and had the highest use of all large bird species during spring, summer, and fall (Table 4.9.a). Dove/pigeon use was highest in spring (4.79 birds/800-m plot/60-min survey), followed by summer (3.98), fall (1.53), and winter (0.03; Table 4.9.a). Most dove/pigeon use during spring and summer was due to mourning dove, while use in fall and winter was dominated by rock pigeon, which is a non-protected species (Appendix B3). Doves/pigeons represented most large bird observations in summer (80.6%) and spring (78.7%), they made up 41.4% of large bird observations in fall, and just 1.7% in winter (Table 4.9.a). Doves/pigeons were observed during 2.9% to 63.6% of all large bird surveys, seasonally (Table 4.9.a).

4.4.2.4 Goatsuckers

Common nighthawk was again the only goatsucker, or nightjar, species identified in the Project in 2018 (Appendix B3). Common nighthawk use was recorded in summer (0.09 bird/800-m plot/60-min survey) and spring (0.03; Table 4.9.a, Appendix B3). Common nighthawks made up less than 2% of large bird use in summer and spring, and were recorded during fewer than 5% of surveys, seasonally (Table 4.9.a, Appendix B3).

4.4.2.5 Small Birds

Passerines were the only small bird species type recorded during the study again in 2018 (Table 4.9.b). Horned lark was the passerine with the highest use during winter, spring, and fall (Appendix B4). During summer, lark bunting had the highest use of all small birds (Appendix B4). Passerines were commonly seen during surveys in spring (94.1% of surveys) and summer (81.8%) and were less frequency observed in fall (59.1%), and winter (23.5%; Table 4.9.b).

Table 4.9.a. Large bird mean use (number of birds/800-m plot/60-minute survey), percent of total use (%), and frequency of occurrence (%) for each bird type and species by season during eagle/large bird fixed-point bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	**0**	**0.04**	**0**	**0.80**	**0**	**0.7**	**0**	**21.5**	**0**	**2.9**	**0**	**1.1**
Waterfowl	**0.50**	**0.01**	**0**	**0.23**	**28.8**	**0.2**	**0**	**6.1**	**5.9**	**1.5**	**0**	**1.1**
Shorebirds	**0**	**0.13**	**0.05**	**0**	**0**	**2.2**	**0.9**	**0**	**0**	**4.4**	**2.3**	**0**
Diurnal Raptors	**1.03**	**1.07**	**0.80**	**1.14**	**59.3**	**17.6**	**16.1**	**30.7**	**52.9**	**42.6**	**45.5**	**46.6**
Accipiters	*0*	*0*	*0*	*0.01*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*1.1*
Buteos	*0.62*	*0.96*	*0.61*	*0.45*	*35.6*	*15.7*	*12.4*	*12.3*	*32.4*	*36.8*	*34.1*	*21.6*
Northern Harrier	*0.38*	*0.10*	*0.14*	*0.41*	*22.0*	*1.7*	*2.8*	*11.0*	*32.4*	*7.4*	*11.4*	*25.0*
Eagles	*0*	*0.01*	*0*	*0.16*	*0*	*0.2*	*0*	*4.3*	*0*	*1.5*	*0*	*6.8*
Falcons	*0*	*0*	*0.05*	*0.09*	*0*	*0*	*0.9*	*2.5*	*0*	*0*	*4.5*	*9.1*
Other Raptors	*0.03*	*0*	*0*	*0.01*	*1.7*	*0*	*0*	*0.3*	*2.9*	*0*	*0*	*1.1*
Owls	**0.18**	**0**	**0**	**0**	**10.2**	**0**	**0**	**0**	**2.9**	**0**	**0**	**0**
Vultures	**0**	**0**	**0.02**	**0.01**	**0**	**0**	**0.5**	**0.3**	**0**	**0**	**2.3**	**1.1**
Doves/Pigeons	**0.03**	**4.79**	**3.98**	**1.53**	**1.7**	**78.7**	**80.6**	**41.4**	**2.9**	**57.4**	**63.6**	**9.1**
Goatsuckers	**0**	**0.03**	**0.09**	**0**	**0**	**0.5**	**1.8**	**0**	**0**	**1.5**	**4.5**	**0**
Large Birds Overall	**1.74**	**6.09**	**4.93**	**3.70**	**100**	**100**	**100**	**100**				

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Table 4.9.b. Mean small bird use (number of small birds/100-m plot/10-minute survey), percent of total use (%), and frequency of occurrence (%) for each small bird type by season during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	2.24	6.32	7.14	5.58	100	94.9	98.7	96.1	23.5	94.1	81.8	59.1
Unidentified Birds	0	0.34	0.09	0.23	0	5.1	1.3	3.9	0	17.6	6.8	6.8
Small Birds Overall	**2.24**	**6.66**	**7.23**	**5.81**	**100**	**100**	**100**	**100**				

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4.4.3 Bird Flight Height and Behavior

Flight height characteristics, based on initial flight height observations and estimated use, were estimated for bird types and species (Tables 4.10.a and 4.10.b, Appendix C3 and C4). During the eagle/large bird use surveys, 453 groups of large birds initially were observed flying within the 800-m survey plots, totaling 838 individual observations. Overall, 20.4% of flying large birds initially were recorded within the RSH, 65.2% were below the RSH, and 14.4% were flying above the RSH (Table 4.10.a). About half (50.7%) of flying diurnal raptors were observed below the RSH, 35.4% were within the RSH, and 13.9% were observed flying above the RSH, based on the initial observation (Table 4.10.a). Among the large bird types and raptor subtypes for which 10 or more groups initially were observed in flight, eagles were observed within the RSH during more than half of observations (73.3%), about half (48.9%) of buteos were within the RSH, and other large bird types and raptor subtypes (i.e., northern harrier, falcons, doves/pigeons) had the majority of initial observations below the RSH (Table 4.10.a).

Among small birds, 318 groups consisting of 896 individual observations of birds in flight were recorded (Table 4.10.b). All small bird flight activity occurred below the RSH (Table 4.10.b).

Table 4.10.a. Flight height characteristics by large bird type[a] and raptor subtype during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018. Flight heights are based on height at initial observation.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories 0 – <25 m	25 – 150 m[b]	>150 m
Waterbirds	**3**	**73**	**226.67**	**100**	**0**	**4.1**	**95.9**
Waterfowl	**4**	**38**	**130.00**	**100**	**0**	**47.4**	**52.6**
Shorebirds	**4**	**6**	**11.75**	**54.5**	**100**	**0**	**0**
Diurnal Raptors	**206**	**223**	**67.77**	**91.8**	**50.7**	**35.4**	**13.9**
Accipiters	*1*	*1*	*20.00*	*100*	*100*	*0*	*0*
Buteos	*118*	*133*	*101.97*	*86.9*	*29.3*	*48.9*	*21.8*
Northern Harrier	*60*	*62*	*5.45*	*100*	*100*	*0*	*0*
Eagles	*15*	*15*	*90.00*	*100*	*13.3*	*73.3*	*13.3*
Falcons	*10*	*10*	*18.80*	*100*	*80.0*	*20.0*	*0*
Other Raptors	*2*	*2*	*21.00*	*100*	*50.0*	*50.0*	*0*
Owls	**5**	**5**	**7.00**	**83.3**	**100**	**0**	**0**
Vultures	**2**	**2**	**42.50**	**100**	**50.0**	**50.0**	**0**
Doves/Pigeons	**225**	**487**	**8.61**	**76.5**	**86.4**	**13.6**	**0**
Goatsuckers	**4**	**4**	**52.50**	**66.7**	**0**	**100**	**0**
Large Birds Overall	**453**	**838**	**38.58**	**82.5**	**65.2**	**20.4**	**14.4**

[a] 800-meter (m; 2,625-foot [ft]) radius plot for large birds.

[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Note: obs = observations.

Table 4.10.b. Flight height characteristics by bird type[a] during small bird use surveys at the Mountain Breeze/Panorama Wind Project January 29 to December 27, 2018. Flight heights are based on height at initial observation.

Bird Type	# Groups Flying	# Obs Flying	Mean Flight Height (m)	% Obs Flying	% Within Flight Height Categories		
					0 – <25 m	25 – 150 m[b]	>150 m
Passerines	305	859	2.82	65.5	100	0	0
Unidentified Birds	13	37	4.69	78.7	100	0	0
Small Birds Overall	**318**	**896**	**2.90**	**66.0**	**100**	**0**	**0**

[a] 100-meter (m; 328-foot [ft]) radius plot for small birds.

[b] The likely "rotor-swept height" for potential collision with a turbine blade, or 25 to 150 m (82 to 492 ft) above ground level.

Note: obs = observations.

4.4.4 Bird Exposure Index

A relative exposure index based on initial flight height observations and relative abundance (defined as the use estimate) was calculated for each bird species (Appendices D3 and D4). Species having exposure to the RSH are listed in Table 4.11. Rock pigeon had the highest exposure index of all large bird species (0.20), followed by Swainson's hawk (0.16), rough-legged hawk (0.09), and Canada goose (0.08; Table 4.11). Fourteen other large bird species or unidentified bird types had exposure indices greater than zero, including golden and bald eagle (Table 4.11). Based on observations within 100-m survey plots, no small bird species had exposure indices greater than zero (Appendix D4).

Table 4.11. Relative exposure index and flight characteristics for bird species[c] during bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Species[a]	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial Obs	Exposure Index	% Within RSH at Anytime
rock pigeon	51	0.92	85.2	26.2	0.20	42.1
Swainson's hawk	51	0.30	87.1	59.0	0.16	70.5
rough-legged hawk	38	0.19	92.9	51.3	0.09	64.1
Canada goose	3	0.17	100	45.9	0.08	45.9
unidentified dove	7	0.07	100	50.0	0.04	50.0
red-tailed hawk	16	0.09	78.3	38.9	0.03	55.6
mourning dove	165	1.63	71.5	1.9	0.02	4.6
bald eagle	10	0.03	100	60.0	0.02	100
common nighthawk	4	0.03	66.7	100	0.02	100
golden eagle	5	0.02	100	100	0.02	100
unidentified buteo	11	0.07	81.2	15.4	<0.01	15.4
American white pelican	1	<0.01	100	100	<0.01	100
unidentified raptor	2	<0.01	100	50.0	<0.01	50.0
unidentified duck	1	<0.01	100	100	<0.01	100

Table 4.11. Relative exposure index and flight characteristics for bird species[c] during bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Species[a]	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH[b] based on Initial Obs	Exposure Index	% Within RSH at Anytime
great blue heron	1	<0.01	100	100	<0.01	100
turkey vulture	2	<0.01	100	50.0	<0.01	100
American kestrel	3	0.01	100	33.3	<0.01	33.3
prairie falcon	4	0.01	100	25.0	<0.01	75.0

[a] Only included species with exposure index values greater than zero.

[b.] The likely rotor-swept heights (RSH) for potential collision with a turbine blade or 25 to 150 meters (m; 85 to 492 feet [ft]) above ground level.

[c.] 800-m (2,625-ft) radius survey plot for large birds; 100-m (328-ft) radius survey plot for small birds.

Note: obs = observations.

4.4.5 Spatial Variation Across the Landscape

4.4.5.1 Mean Use by Point

Mean use for all large bird species combined was highest at Point 38 (24.33 birds/60-min survey; Figure 4.4.a, Appendix D3). Large bird use at other points ranged from 0.50 to 13.75 birds/60-min survey. The high mean use estimate for Point 38 was due to high use by doves/pigeons at this point (22.50 birds/60-min survey). Raptor use was highest at Point 36 with 2.33 birds/60-min survey, and raptor use ranged from 0.17 to 1.58 birds/60-min survey at other points (Figure 4.4.b). Buteos made up most raptor use, and the highest use by buteos was also observed at Point 36 (1.92 bird/60-min survey). Eagle use was recorded at seven points, ranging from 0.08 to 0.75 bird/60-min survey. Use by doves/pigeons was recorded at all points except for one, and ranged from 0.17 to 22.50 birds/60-min survey. Small bird use was highest at Point 40 (30.83 birds/10-min survey), and ranged from 0.50 to 13.67 birds/10-min survey at other points (Figure 4.4.c).

4.4.5.2 Flight Paths

Field data was used to digitize and map flight paths of large bird species (Figures 4.5.a-d). Raptor flight activity, including eagles, was recorded throughout the Project.

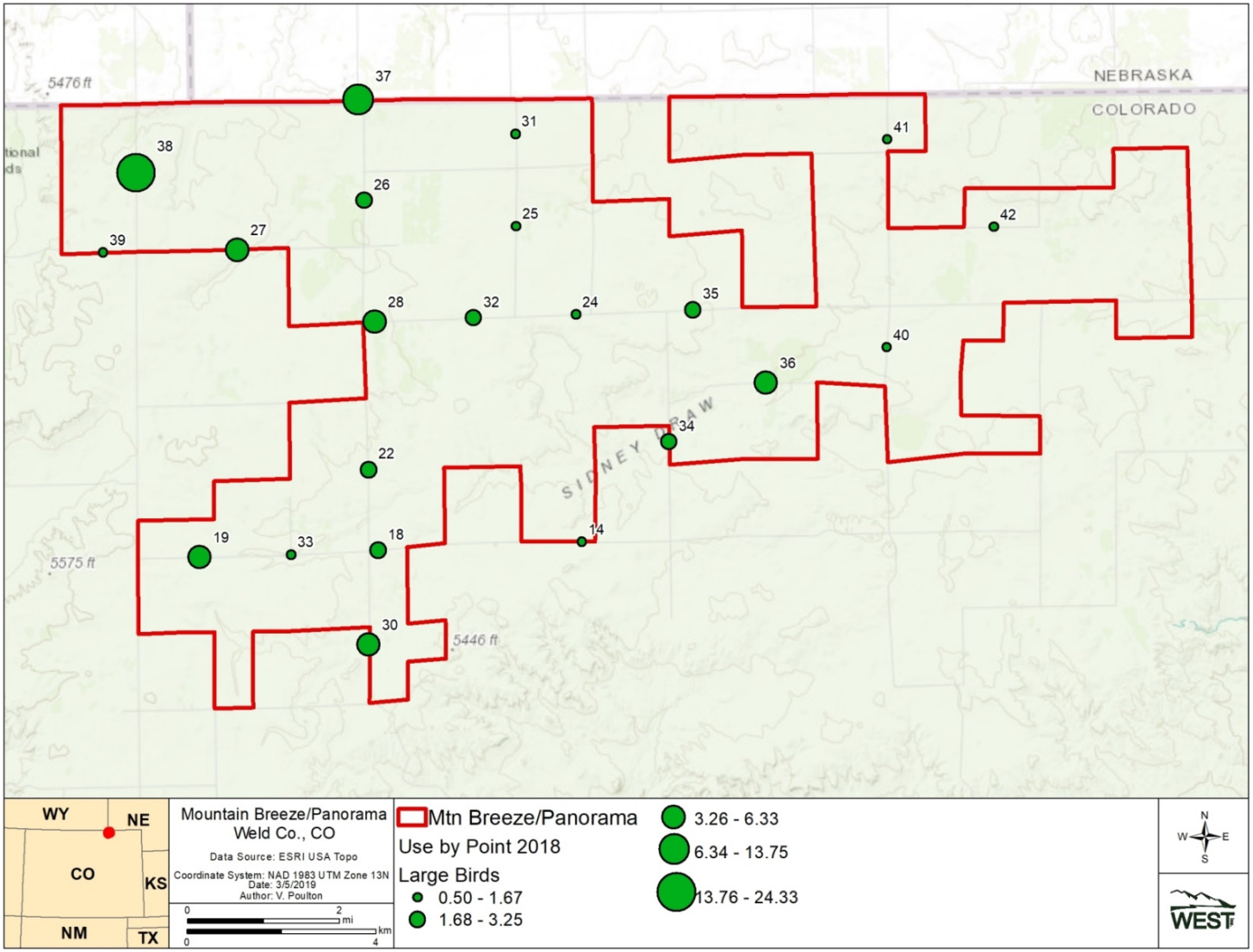


Figure 4.4.a. Mean use by observation point for all large birds during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

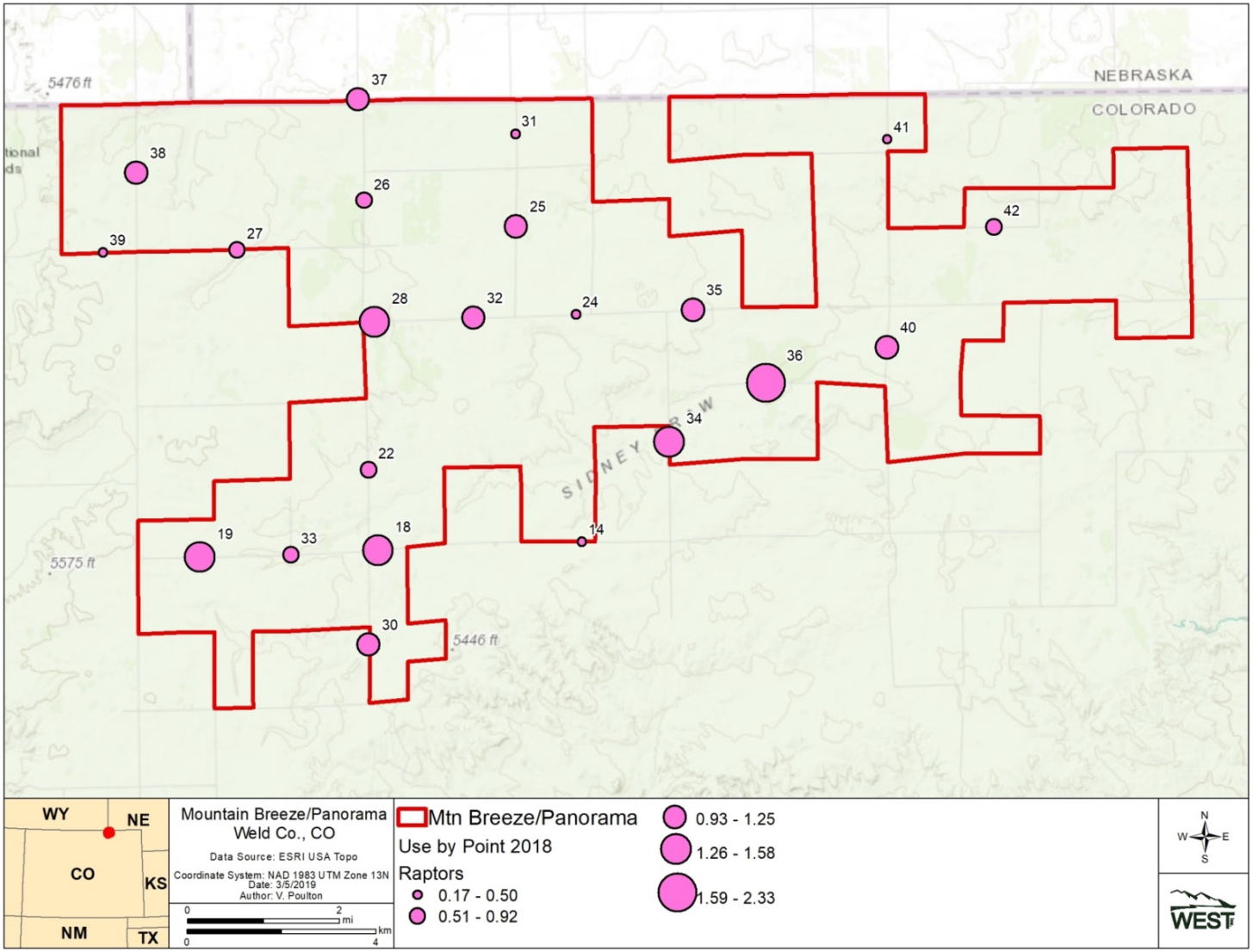


Figure 4.4.b. Mean use by observation point for all raptors during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

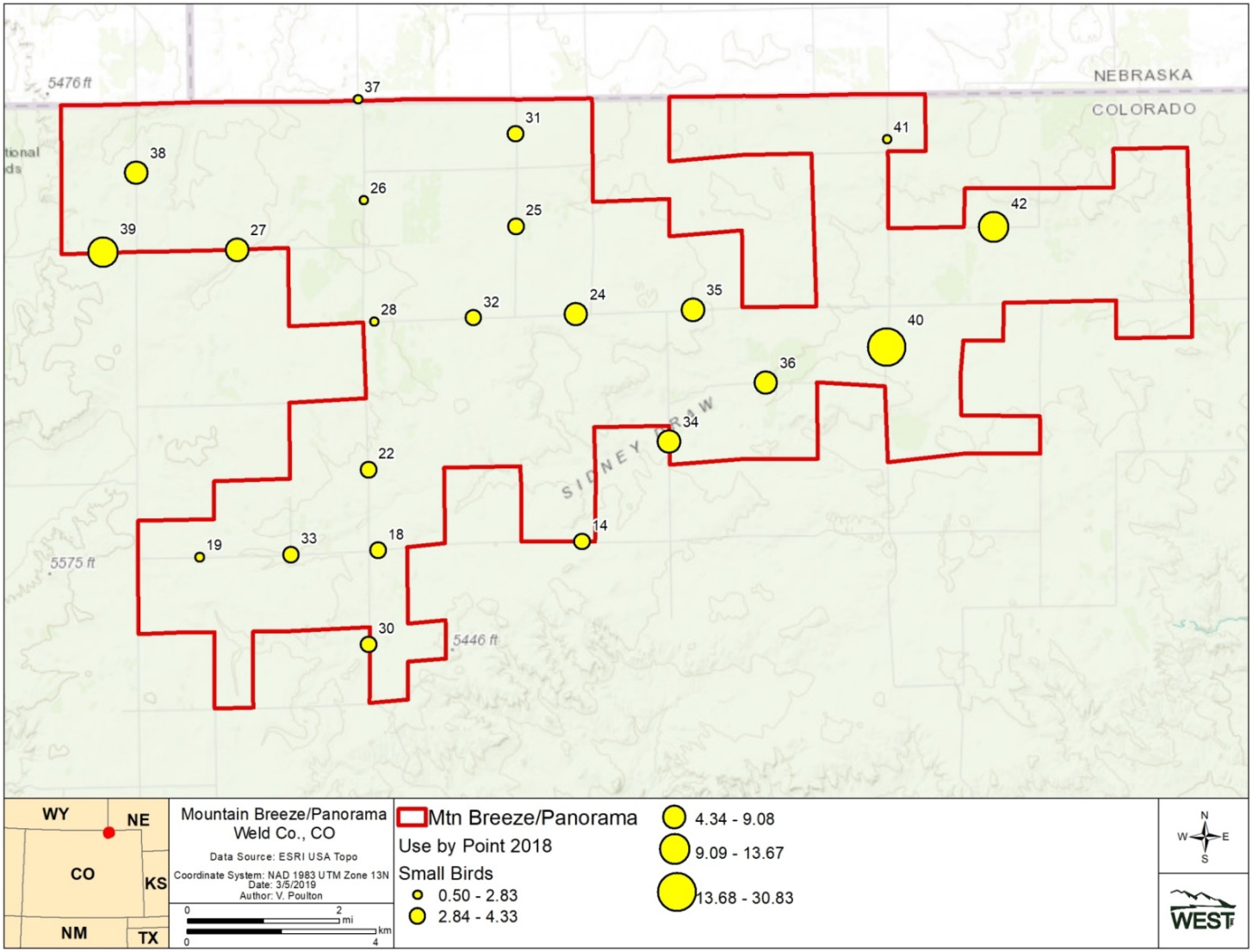


Figure 4.4.c. Mean use by observation point for all small birds during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

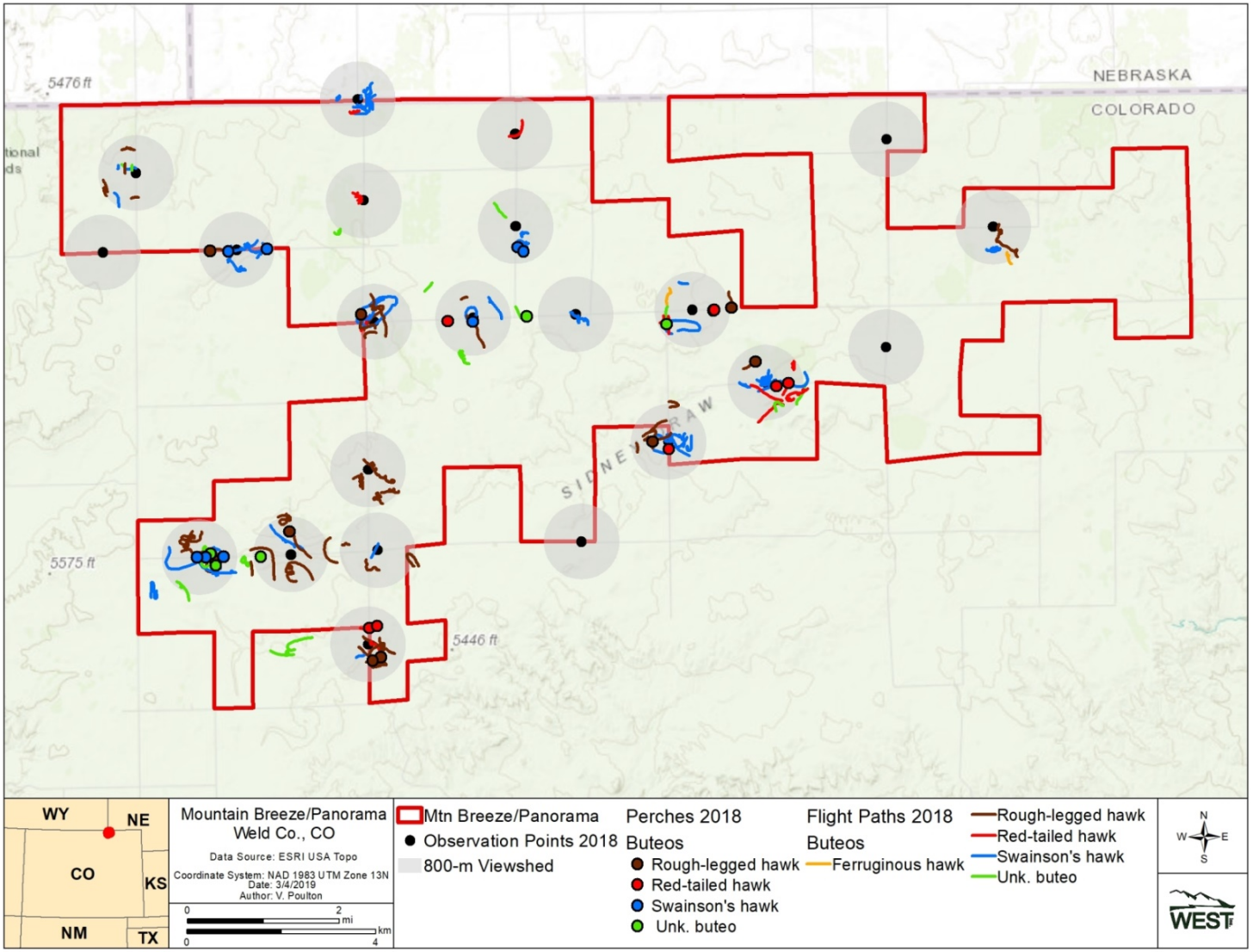


Figure 4.5.a. Flight paths for buteos during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

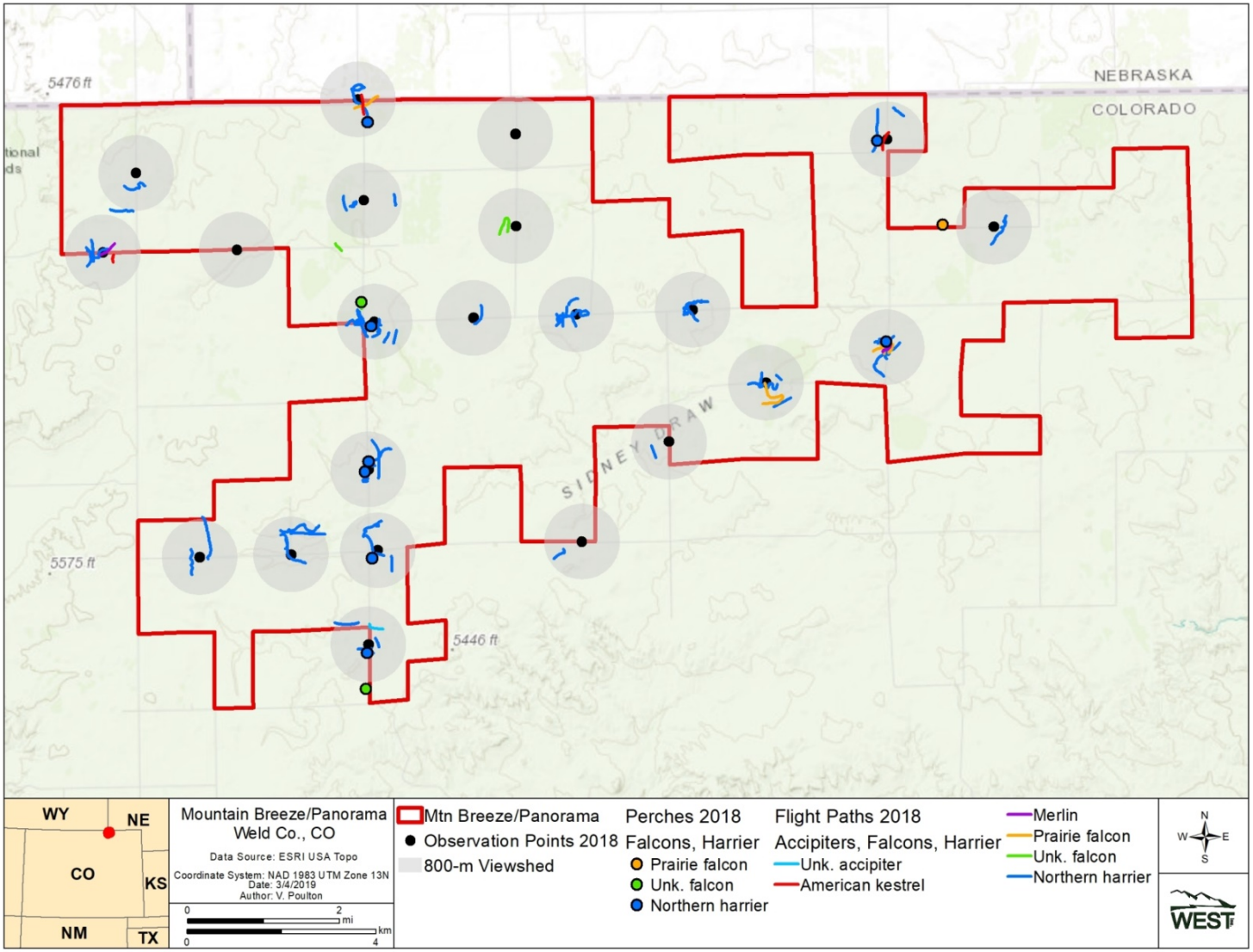


Figure 4.5.b. Flight paths for accipiters, falcons, and harriers during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

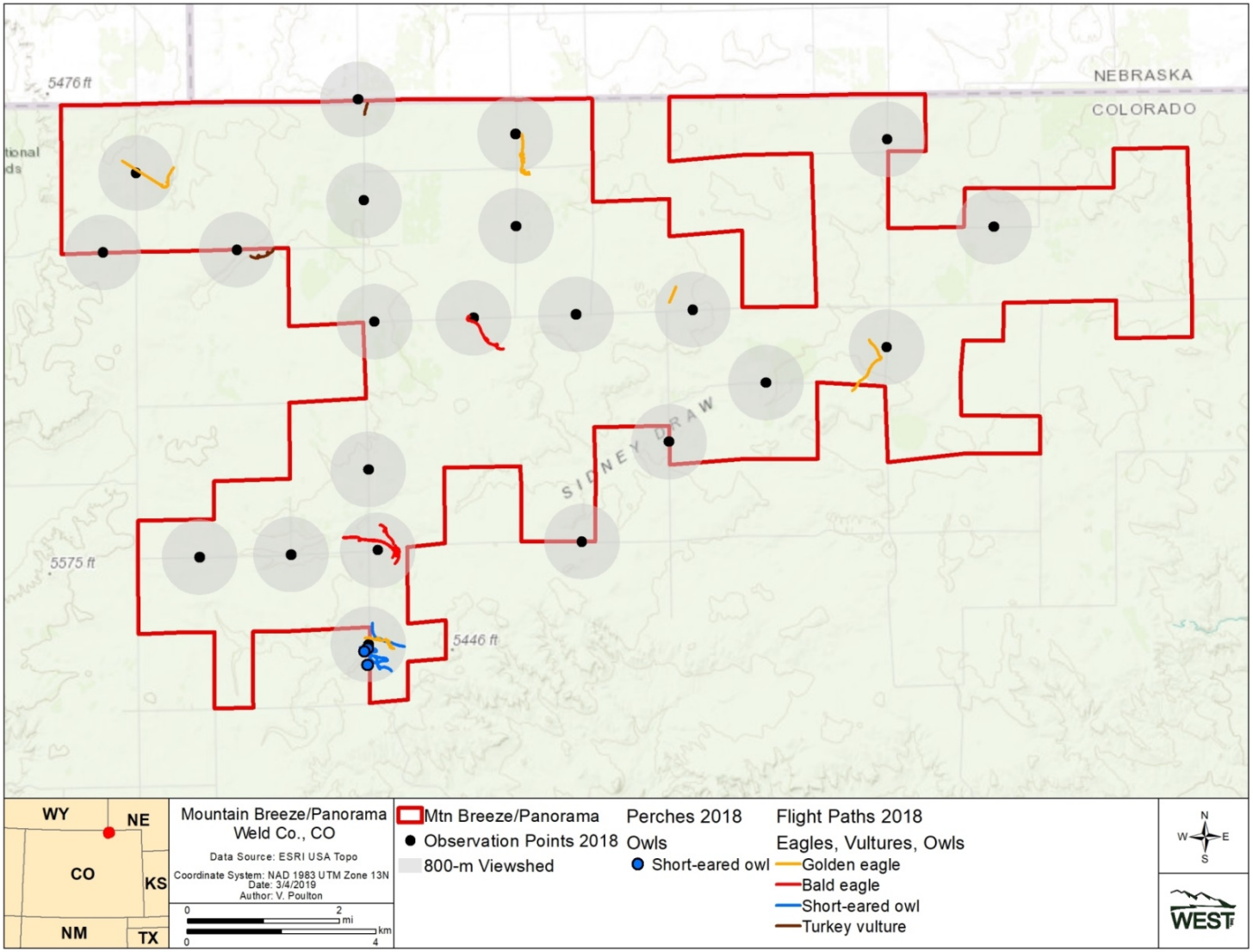


Figure 4.5.c. Flight paths for eagles, vultures, and owls during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

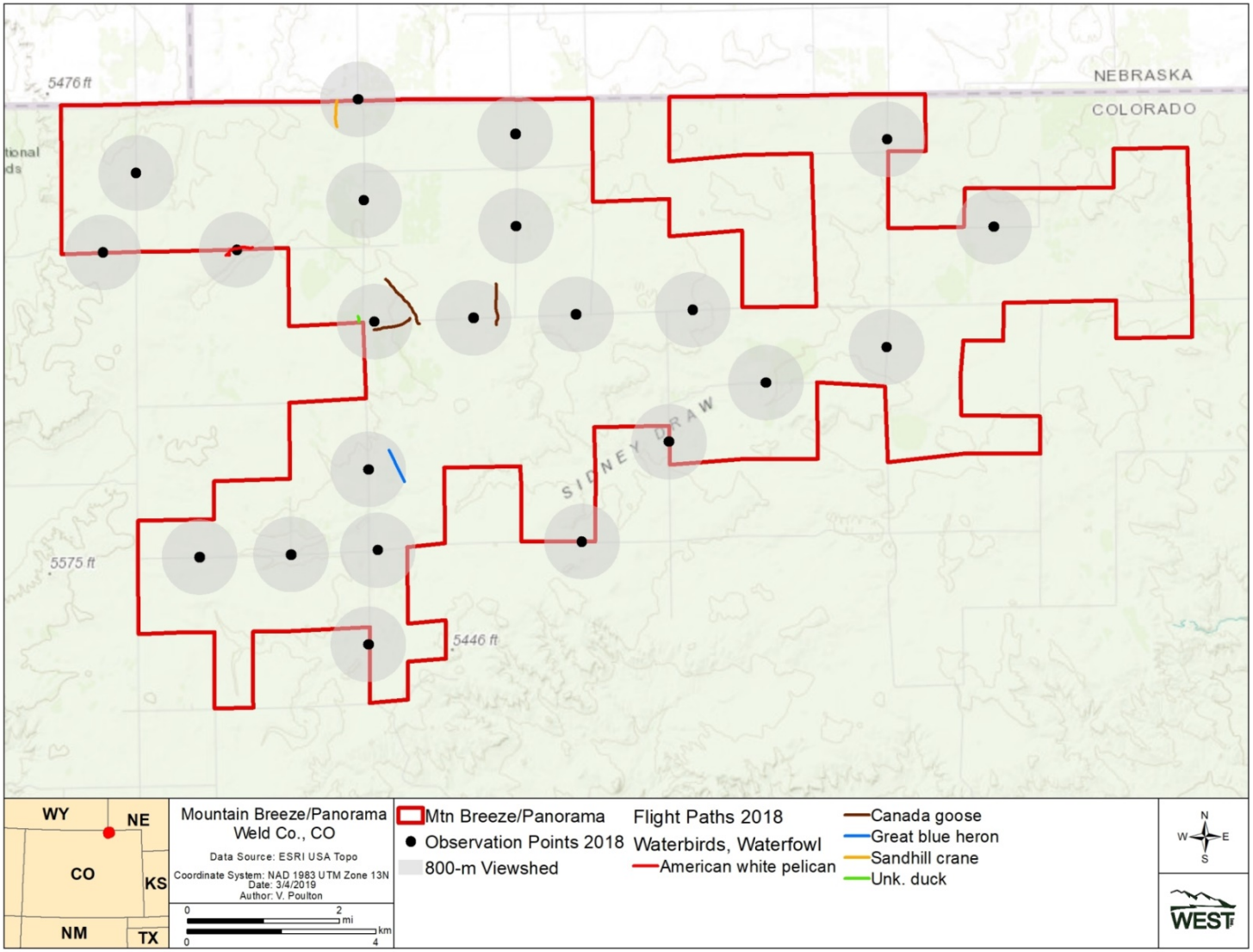


Figure 4.5.d. Flight paths for waterbirds and waterfowl during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

4.4.6 Eagle Minutes

During 234 large bird use survey hours, five golden eagle observations were recorded, and 16 golden eagle use minutes were recorded. A total of 14 golden eagle risk minutes (eagles flying within 800 m of the surveyor and 200 m of ground level) were documented. Twelve golden eagle risk minutes were recorded in October 2018, and two risk minutes were recorded in March 2018 (Table 4.12). No golden eagle observations were recorded during other months (Table 4.12). Golden eagle risk minutes per survey hour ranged from 0.17 to 0.33 at the five observation points where they were recorded (Figure 4.6.a).

For bald eagles, there were 10 observations recorded totaling 25 min (Table 4.12). Seventeen risk minutes were recorded for bald eagles, with 15 risk minutes recorded during September 2018, and two risk minutes recorded during November 2018 (Table 4.12). Bald eagle risk minutes per survey hour were 1.25 at Point 18 and 0.17 at Point 32 (Figure 4.6.b).

Table 4.12. Eagle risk minutes documented during eagle/large bird use surveys in the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Month	Survey Hours	Number of Eagle Observations	Number of Eagle Use Minutes	Number of Eagle Risk* Minutes	Eagle Risk Minutes per Survey Hour
Golden Eagles					
January	17	0	0	0	0
February	17	0	0	0	0
March	17	1	2	2	0.12
April	17	0	0	0	0
May	17	0	0	0	0
June	17	0	0	0	0
July	22	0	0	0	0
August	22	0	0	0	0
September	22	0	0	0	0
October	22	4	14	12	0.55
November	22	0	0	0	0
December	22	0	0	0	0
Total	**234**	**5**	**16**	**14**	**0.06**
Bald Eagles					
January	17	0	0	0	0
February	17	0	0	0	0
March	17	0	0	0	0
April	17	0	0	0	0
May	17	0	0	0	0
June	17	0	0	0	0
July	22	0	0	0	0
August	22	0	0	0	0
September	22	9	21	15	0.68
October	22	0	0	0	0
November	22	1	4	2	0.09
December	22	0	0	0	0
Total	**234**	**10**	**25**	**17**	**0.07**

*Eagles flying within 800 meters (m; 2,625 feet [ft]) of the surveyor and 200 m (328 ft) of ground level.

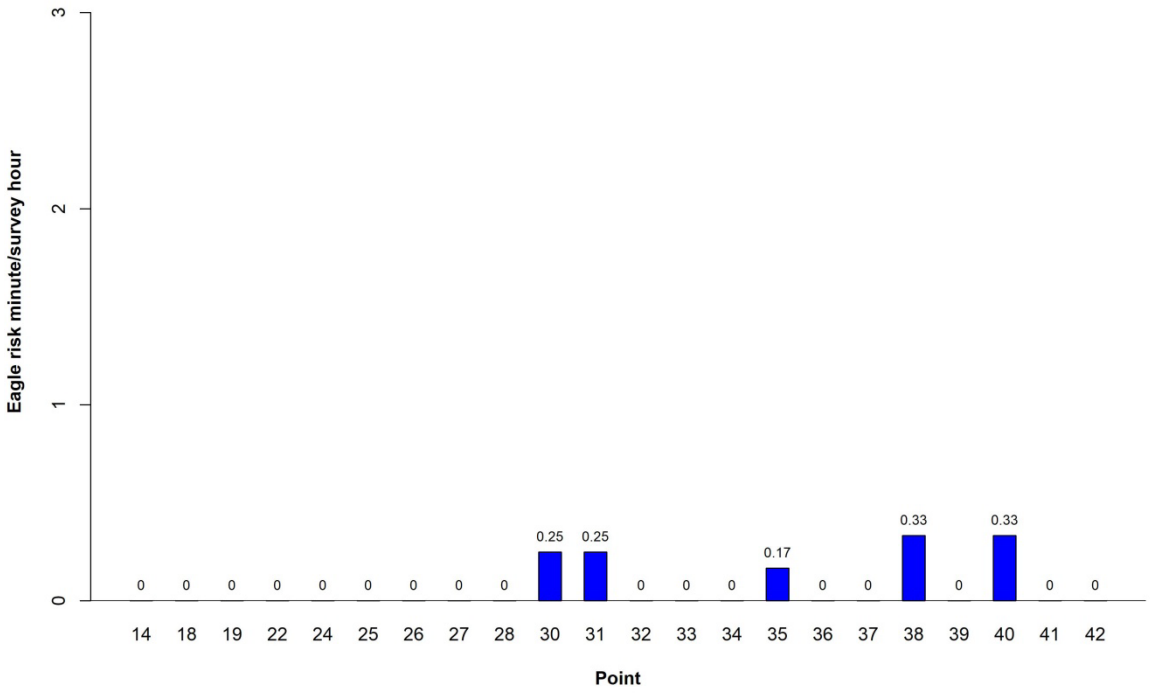


Figure 4.6.a. Number of golden eagle risk minutes per survey hour by observation point during large bird use surveys in the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

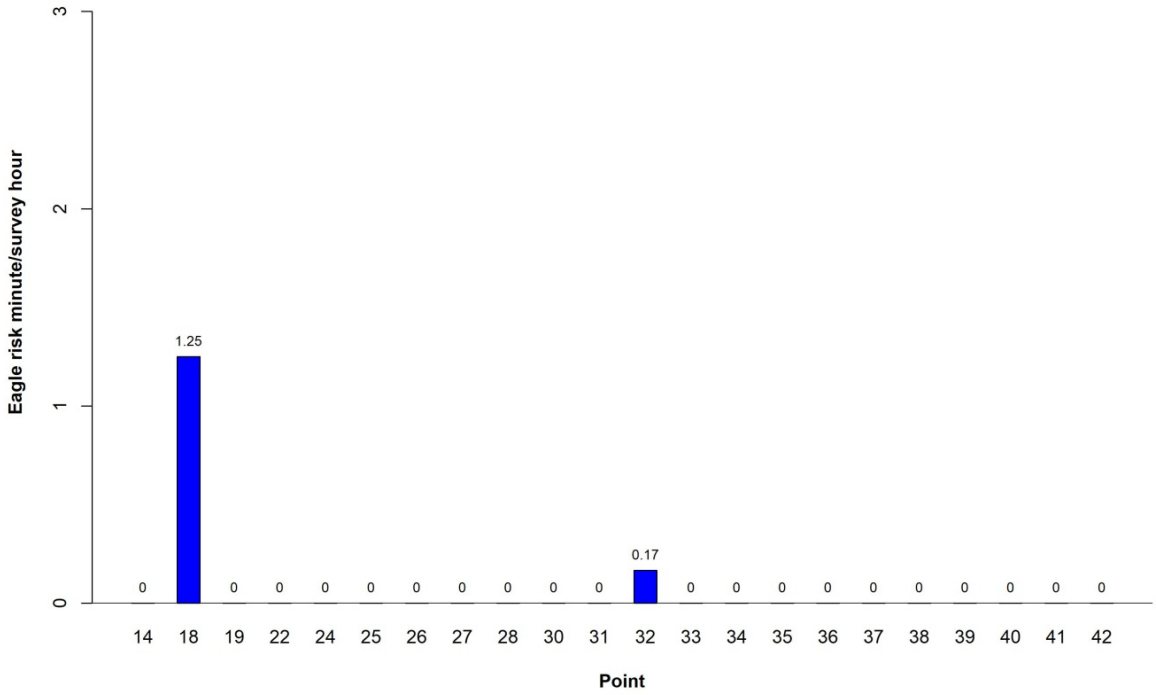


Figure 4.6.b. Number of bald eagle risk minutes per survey hour by observation point during large bird use surveys in the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

4.5 Incidental Observations 2018

During 2018, surveyors observed 14 bird species incidentally in the Project, totaling 187 observations within 151 separate groups (Table 4.13). Plains sharp-tailed grouse and domestic chickens (*Gallus gallus domesticus*) were species not recorded during bird use surveys. (Table 4.13).

Table 4.13. Incidental observations recorded outside of standardized bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Species	Scientific Name	# grps	# obs
unidentified grouse		1	5
sandhill crane	*Antigone canadensis*	1	1
red-tailed hawk	*Buteo jamaicensis*	24	24
rough-legged hawk	*Buteo lagopus*	47	52
ferruginous hawk	*Buteo regalis*	1	1
unidentified buteo	*Buteo* spp.	2	2
Swainson's hawk	*Buteo swainsoni*	23	27
northern harrier	*Circus hudsonius*	20	20
golden eagle	*Aquila chrysaetos*	3	4
unidentified eagle		1	2
prairie falcon	*Falco mexicanus*	9	9
American kestrel	*Falco sparverius*	4	4
unidentified falcon	*Falco* spp	1	1
unidentified raptor		1	1
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	5	26
grasshopper sparrow	*Ammodramus savannarum*	1	1
chestnut-collared longspur	*Calcarius ornatus*	3	3
loggerhead shrike	*Lanius ludovicianus*	1	1
domestic chicken	*Gallus gallus domesticus*	3	3
Total	**14 species**	**151**	**187**

Note: grps = groups, obs = observations.

4.6 Special Status Species Observations 2018

Surveyors recorded 10 special status bird species in the Project in 2018 (Table 4.14). This tally may represent repeated observations of the same individual(s). Golden eagle and bald eagle are protected under the federal BGEPA. Golden and bald eagles are also considered BCC by the USFWS in Bird Conservation Region 18 (Table 4.14). Prairie falcon, chestnut-collared longspur, lark bunting, loggerhead shrike (*Lanius ludovicianus*), and McCown's longspur also are BCC species. Lark bunting also is the Colorado State Bird. Plains sharp-tailed grouse is listed as endangered by CPW, while sandhill crane, ferruginous hawk, and bald eagle are SC species. BCC species and SC species receive no regulatory protections with these special status designations.

Table 4.14. Special status species observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys (FP) and as incidental wildlife observations (Inc.) from January 29 to December 27, 2018.

			FP		Inc.		Total	
Species	**Scientific Name**	**Status**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
sandhill crane	*Antigone canadensis*	SC	3	72	1	1	4	73
golden eagle	*Aquila chrysaetos*	BGEPA, BCC	5	5	3	4	8	9
ferruginous hawk	*Buteo regalis*	SC	2	2	1	1	3	3
prairie falcon	*Falco mexicanus*	BCC	5	5	9	9	14	14
bald eagle	*Haliaeetus leucocephalus*	BGEPA, SC, BCC	10	10	0	0	10	10
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	SE	0	0	5	26	5	26
Large Birds Overall	**6 species**		**25**	**94**	**19**	**41**	**44**	**135**
chestnut-collared longspur	*Calcarius ornatus*	BCC	6	10	3	3	9	13
lark bunting	*Calamospiza melanocorys*	BCC	75	186	0	0	75	186
loggerhead shrike	*Lanius ludovicianus*	BCC	1	1	1	1	2	2
McCown's longspur	*Rhynchophanes mccownii*	BCC	7	8	0	0	7	8
Small Birds Overall	**4 species**		**89**	**205**	**4**	**4**	**93**	**209**

BGEPA = Bald and Golden Eagle Protection Act; BCC = USFWS Bird of Conservation Concern in Bird Conservation Region 18; SE = State-listed Endangered; SC = State Special Concern.

Note: grps = groups; obs = observations.

5 DISCUSSION

This avian use study was designed to collect information about how eagles and other birds use the Project area, and to identify any spatial or temporal patterns in use that might be helpful in guiding Project development to avoid or minimize impacts.

5.1 Potential Impacts

Wind energy facilities can impact wildlife resources directly or indirectly. Direct impacts include fatalities from construction and operation of the wind energy facility and the loss of habitat where infrastructure is placed. Indirect impacts include the displacement of wildlife, either temporarily or permanently, during construction or the operational period of a wind energy facility and rendering habitat unsuitable through fragmentation of the landscape.

Mortality or injuries due to collisions with turbines or guy wires of meteorological towers are the most probable direct impact to birds from wind energy facilities. Project construction could affect birds through loss of habitat or fatalities from construction equipment, though collision risk with construction equipment is expected to be relatively low as equipment used in wind energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). Impacts from decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance, and equipment used. The highest risk of direct mortality to birds during construction is most likely the potential destruction of nests of ground- and shrub-nesting species during initial

site clearing. Current Project plans are to conduct ground-clearing activities outside of the nesting season to avoid impacts to birds that nest on or near the ground.

Post-construction fatality monitoring reports from the Midwest and Rocky Mountain regions show varying levels of bird mortality, and a range similar to results from publicly available mortality studies across western North America (Figure 5.1, Appendix E). The Wessington Springs facility in South Dakota had the highest estimated bird mortality rate in the Midwest and Rocky Mountains with 8.25 bird fatalities/megawatt (MW)/year, while the Prince Wind Farm in Ontario had the lowest reported bird fatality rate of 0.26 (Figure 5.1, Appendix E). To our knowledge, no fatality rates are publicly available from wind facilities in Colorado. The nearest wind facility with available bird fatality data from the Midwest and Rocky Mountains is in Wyoming (Foote Creek Rim I, 3.4 bird fatalities/MW/year).

Wind energy development indirectly affects wildlife by causing habitat loss due to infrastructure placement, through behavioral avoidance, and habitat fragmentation. Habitat loss to wind energy facility infrastructure (i.e., turbines, access roads, maintenance buildings, substations, and overhead transmission lines) can be long-term or temporary; however, long-term infrastructure generally occupies only 5% to 10% of the entire development area (Bureau of Land Management 2005). Estimates of temporary construction impacts range from 0.2 to 1.0 ha (0.5 to 2.5 ac) per turbine (Strickland and Johnson 2006, Denholm et al. 2009).

Some studies suggest displacement effects associated with wind energy may have a greater impact than collision mortality (Gill et al. 1996, Pearce-Higgins et al. 2012). The greatest concern about indirect impacts of wind energy facilities on wildlife is where these facilities have been constructed in native vegetation communities, such as grasslands or shrub-steppe that provide comparatively rare, high-quality habitat for some bird species and species of concern (USFWS 2012). Approximately 66% of the Project is grassland, while about 31% is used for cultivated agriculture. Siting facilities on cultivated lands and other disturbed lands would reduce the potential for fragmentation and displacement of wildlife from native grasslands.

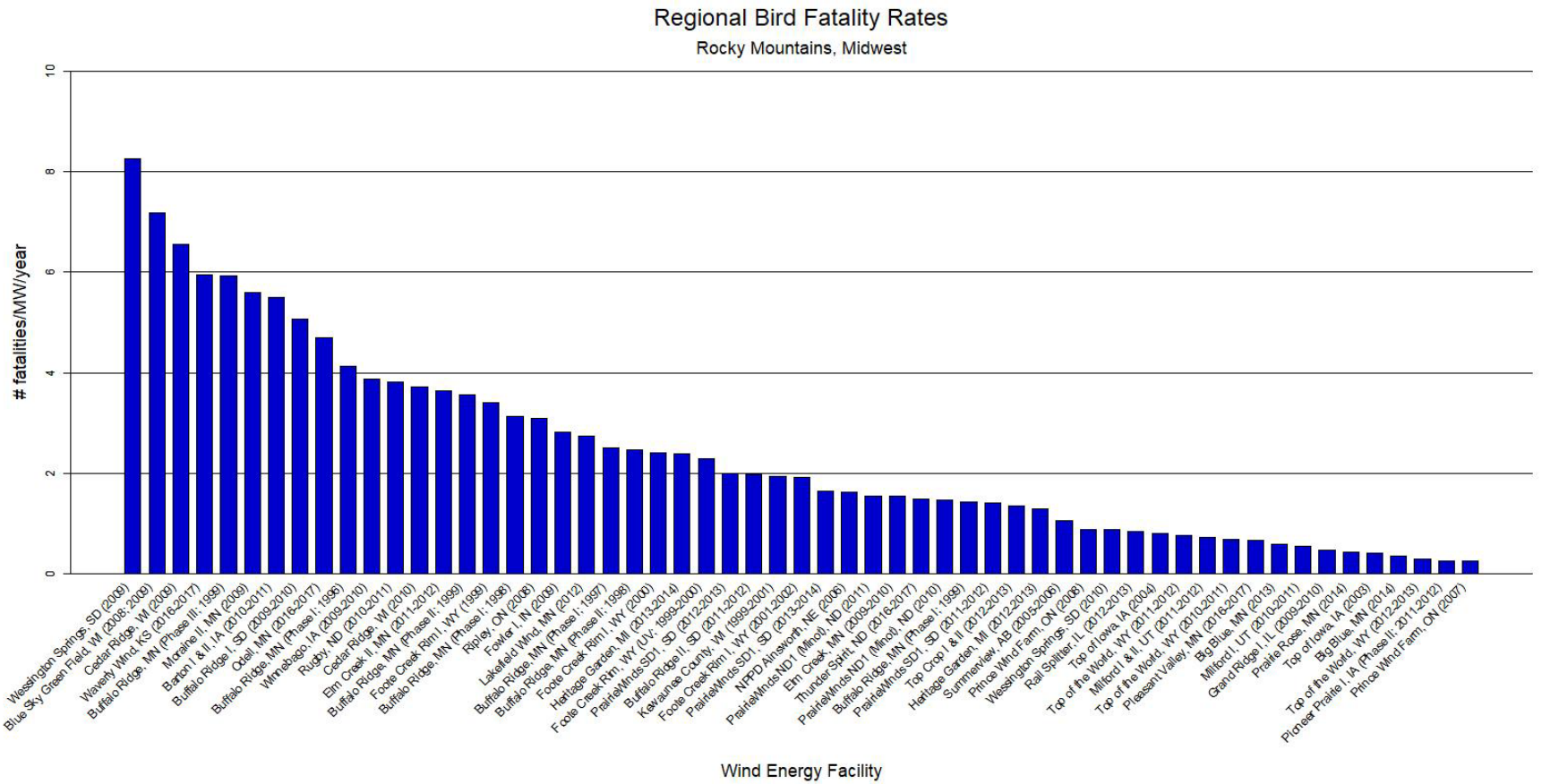


Figure 5.1. Fatality rates for all birds (number of birds per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountain regions in North America.

Figure 5.1 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountain regions in North America.

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Wessington Springs, SD (2009)	Derby et al. 2010d	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Cedar Ridge, WI (2009)	BHE Environ-mental 2010	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
Waverly Wind, KS (2016-2017)	Tetra Tech 2017a	Elm Creek, MN (2009-2010)	Derby et al. 2010f
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a	Thunder Spirit, ND (2016-2017)	Baerwald 2008
Moraine II, MN (2009)	Derby et al. 2010g	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d
Barton I & II, IA (2010-2011)	Derby et al. 2011b	Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010e	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Odell, MN (2016-2017)	Chodachek and Gustafson 2018	Top Crop I & II (2012-2013)	Good et al. 2013b
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a	Heritage Garden, MI (2012-2013)	Kerlinger et al. 2014
Winnebago, IA (2009-2010)	Derby et al. 2010a	Summerview, AB (2005-2006)	Brown and Hamilton 2006
Rugby, ND (2010-2011)	Derby et al. 2011c	Prince Wind Farm, ON (2008)	NRSI 2009
Cedar Ridge, WI (2010)	BHE Environ-mental 2011	Wessington Springs, SD (2010)	Derby et al. 2011a
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Rail Splitter, IL (2012-2013)	Good et al. 2013a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a	Top of Iowa, IA (2004)	Jain 2005
Foote Creek Rim I, WY (1999)	Young et al. 2003a	Top of the World, WY (2011-2012)	Rintz and Bay 2013
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a	Milford I & II, UT (2011-2012)	Stantec 2012
Ripley, ON (2008)	Jacques Whitford 2009	Top of the World, WY (2010-2011)	Rintz and Bay 2012
Fowler I, IN (2009)	Johnson et al. 2010	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Big Blue, MN (2013)	Fagen Engineering 2014
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a	Milford I, UT (2010-2011)	Stantec 2011b
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a	Grand Ridge I, IL (2009-2010)	Derby et al. 2010a

Figure 5.1 (*continued*). Fatality rates for all birds (number of birds per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountain regions in North America.

Wind Energy Facility	Estimate Reference	Wind Energy Facility	Estimate Reference
Foote Creek Rim I, WY (2000)	Young et al. 2003a	Prairie Rose, MN (2014)	Chodachek et al. 2015
Heritage Garden, MI (2013-2014)	Kerlinger et al. 2014	Top of Iowa, IA (2003)	Jain 2005
Foote Creek Rim, WY (UV; 1999-2000)	Young et al. 2003a	Big Blue, MN (2014)	Fagen Engineering 2015
PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a	Top of the World, WY (2012-2013)	Rintz and Bay 2014
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Prince Wind Farm, ON (2007)	NRSI 2008
Foote Creek Rim I, WY (2001-2002)	Young et al. 2003a		

5.2 Bird Types of Concern

The bird species most commonly observed during this study are not of conservation concern. During small bird surveys, passerines were the most commonly recorded bird type and most passerine species are unlikely to be impacted substantially by wind facilities (Arnold and Zink 2011, Erickson et al. 2014). During large bird surveys, doves/pigeons were also relatively abundant during the study, with rock pigeon and mourning dove among the most commonly recorded large bird species. Mourning doves have been documented regularly as a fatality at wind facilities; however, mourning doves are an abundant species in the US, and monitoring data suggest populations are not declining in the central US (Seamans 2015). Rock pigeon and Eurasian collared-dove are non-native, non-protected species.

Some bird types of concern, discussed below, have shown susceptibility to potentially adverse impacts from wind energy development or there are concerns due to behaviors or population sizes. Bird types of potential concern that were observed during the study include waterbirds, waterfowl, raptors, and some passerine species.

5.2.1 Waterbirds

Waterbirds, including sandhill cranes, do not appear to be particularly susceptible to collision with wind turbines. Waterbirds made up 0.2% of all bird fatalities (n = 4,975) in an analysis of 116 standardized monitoring studies conducted at over 70 wind energy facilities throughout the US and Canada (Erickson et al. 2014). According to the National Research Council (NRC 2007) cumulative effects report, waterbirds composed about 1% of documented fatalities at 14 wind energy facilities. Three sandhill crane fatalities have been documented from non-standardized searches (Smallwood and Karas 2009, Gerber et al. 2014, Navarrete and Griffis-Kyle 2014, Stehn 2011). No other sandhill crane fatalities are documented in publicly available reports (see Appendix E for a list of facilities and references).

5.2.2 Waterfowl

Based on available evidence, waterfowl also do not seem especially vulnerable to turbine collisions. In an analysis of 116 studies of bird mortality at over 70 facilities, waterfowl made up 2.7% of 4,975 fatalities found (Erickson et al. 2014). In a database of 172 publicly available fatality studies, 184 waterfowl fatalities out of 6,511 total fatalities (2.9%) were documented (see Appendix E for a list of facilities and references). Mallard (*Anas platyrhynchos*) was the most frequently found species (93 casualties). A review of 21 fatality monitoring studies conducted in western North America at modern wind energy facilities, where 1,247 avian fatalities representing 128 species were reported, indicated that waterfowl, primarily mallard (nine fatalities), were infrequently found (1.9% of all fatalities; Johnson and Stephens 2011). Site-specific studies where waterfowl were monitored near wind facilities in North Dakota and Minnesota also found that turbine collisions were rare (Gue et al. 2013, Johnson et al. 2002b). Waterfowl use at the Project was due mostly to Canada geese in the fall and winter, and most waterfowl observations were of flying birds that were moving through the area.

5.2.3 Diurnal Raptors

5.2.3.1 Use Comparison

Diurnal raptors occur in most areas with the potential for wind energy development (NRC 2007). Annual mean diurnal raptor use at the Project, standardized to 20 min, was 0.20 raptors/plot/20-min survey in 2017 and 0.31 in 2018. At 48 other wind energy facilities that implemented similar protocols and had data for three or four seasons, the annual mean diurnal raptor use ranged from 0.06 to 2.34 raptors/plot/20-min survey (Figure 5.2). A relative ranking of annual mean raptor use was developed based on the results from these wind energy facilities as low (zero – 0.5 raptors/plot/20-min survey), low to moderate (0.5 – 1.0), moderate (1.0 – 2.0), high (2.0 – 3.0), and very high (more than 3.0). Under this ranking, annual mean diurnal raptor use at the Project is considered to be relatively low (Figure 5.2).

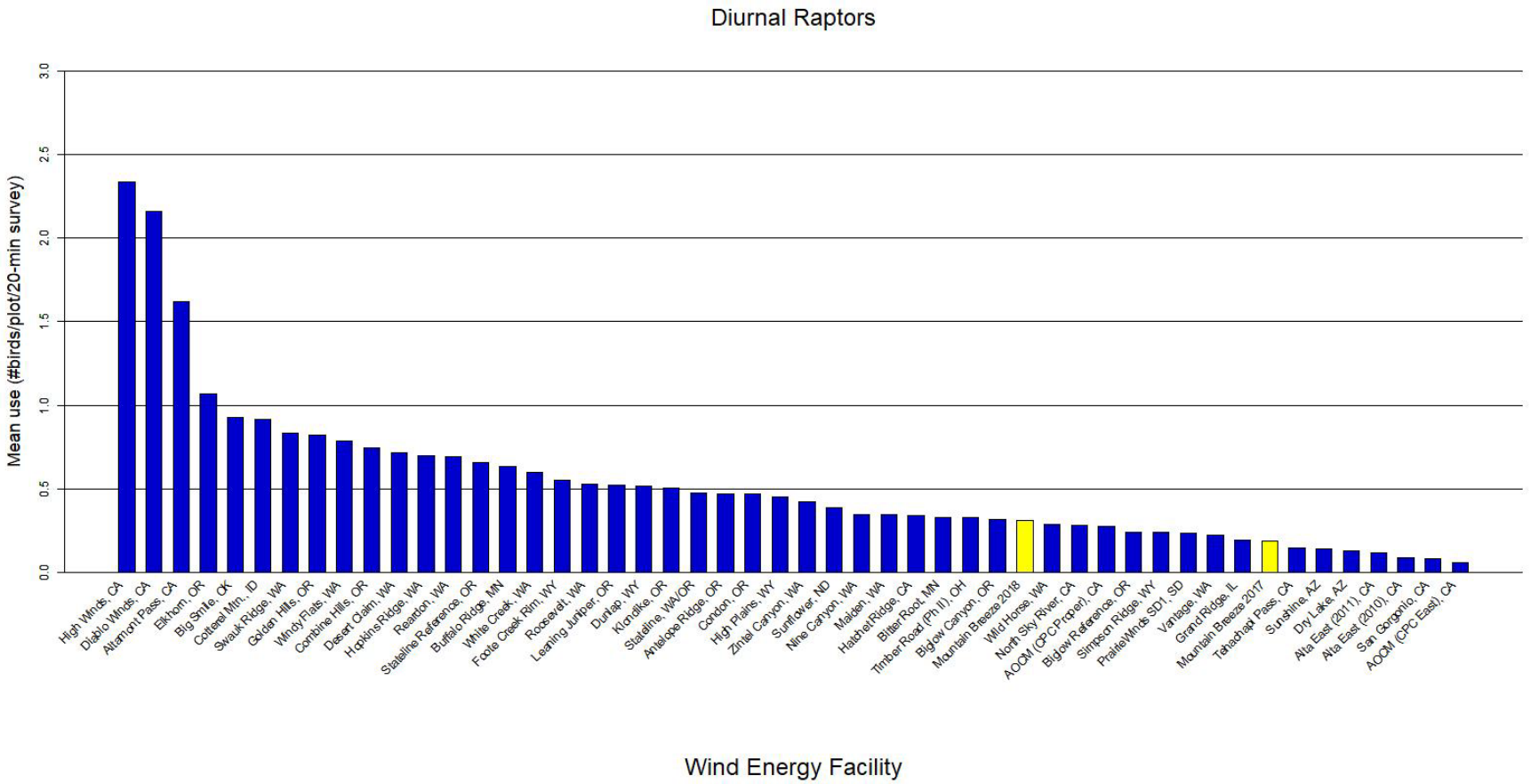


Figure 5.2. Comparison of estimated annual diurnal raptor use during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project during 2017 and 2018, and at other US wind resource areas with three or four other seasons of raptor use data.

Figure 5.2. (*continued*): Comparison of estimated annual diurnal raptor use during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project during 2017 and 2018, and at other US wind resource areas with three or four other seasons of raptor use data: Data from the following sources:

Study and Location	Reference	Study and Location	Reference
Mountain Breeze/ Panorama wind, CO	**This study.**		
High Winds, CA	Kerlinger et al. 2005	High Plains, WY	Johnson et al. 2009b
Diablo Winds, CA	WEST 2006	Zintel Canyon, WA	Erickson et al. 2002a; 2003a
Altamont Pass, CA	Orloff and Flannery 1992	Sunflower, WA/OR	Derby and Thorn 2013
Elkhorn, OR	WEST 2005a	Nine Canyon, WA	Erickson et al. 2001a
Big Smile (Dempsey), OK	Derby et al. 2010b	Maiden, WA	Young et al. 2002
Cotterel Mtn., ID	BLM 2006	Hatchet Ridge, CA	Young et al. 2007a
Swauk Ridge, WA	Erickson et al. 2003c	Bitter Root. MN	Derby and Dahl 2009
Golden Hills, OR	Jeffrey et al. 2008	Timber Road (Phase II), OH	Good et al. 2010
Windy Flats, WA	Johnson et al. 2007	Biglow Canyon, OR	WEST 2005c
Combine Hills, OR	Young et al. 2003c	Wild Horse, WA	Erickson et al. 2003d
Desert Claim, WA	Young et al. 2003d	North Sky River, CA	Erickson et al. 2011
Hopkins Ridge, WA	Young et al. 2003e	AOCM (CPC Proper), CA	Chatfield et al. 2010b
Reardon, WA	WEST 2005b	Biglow Reference, OR	WEST 2005c
Stateline Reference, OR	Erickson et al. 2003b	Simpson Ridge, WY	Johnson et al. 2000b
Buffalo Ridge, MN	Johnson et al. 2000a	Prairie Winds SD1, SD	Derby et al. 2010c
White Creek, WA	NWC and WEST 2005	Vantage, WA	Jeffrey et al. 2007
Foote Creek Rim, WY	Johnson et al. 2000b	Grand Ridge, IL	Derby et al. 2009
Roosevelt, WA	NWC and WEST 2004	Tehachapi Pass, CA	Anderson et al. 2000b, Erickson et al. 2002b
Leaning Juniper, OR	Kronner et al. 2005	Sunshine, AZ	WEST and the CPRS 2006
Dunlap, WY	Johnson et al. 2009a	Dry Lake, AZ	Thompson et al. 2011
Klondike, OR	Johnson et al. 2002a	Alta East (2011), CA	Chatfield et al. 2011
Stateline, WA/OR	Erickson et al. 2003b	Alta East (2010), CA	Chatfield et al. 2011
Antelope Ridge, OR	WEST 2009	San Gorgonio, CA	Anderson et al. 2000a, Erickson et al. 2002b
Condon, OR	Fishman Ecological Services LLC 2003	AOCM (CPC East), CA	Chatfield et al. 2010b

5.2.3.2 Exposure Index Analysis

Exposure index analysis, which considers relative probability of exposure based on abundance, proportion of observations flying (based on flight height at initial observation), and proportion of flight height for each species within the RSH, may provide some insight into which species would fly most often within RSH and potentially be the most likely turbine casualties. This index does not take into consideration behavior (e.g., foraging, courtship), flight speed, size of the bird, the ability to detect and avoid turbines, and other factors that may vary among species and can influence the likelihood of turbine collision. For these reasons, the exposure index is only a relative index of collision risk among species during this study. At the Project, the diurnal raptor species with the highest relative exposure index were Swainson's hawk and rough-legged hawk, influenced by relatively high use estimates and percentage of observations in the RSH for these

species. Red-tailed hawk (*Buteo jamaicensis*), bald eagle, golden eagle, ferruginous hawk, American kestrel (*Falco sparverius*), and prairie falcon ranked lower (exposure indices for all these species was 0.03 or less), primarily due to lower use estimates by these species or a relatively lower proportion of flight heights observed in the RSH. Swainson's hawks are present in the Project during spring through fall, while rough-legged hawks are present during fall through spring, and there is higher potential for fatalities of these species when they are present in the area.

5.2.3.3 Fatality Studies

Johnson and Stephens (2011) summarized mortality data recorded at wind energy facilities in western North America, which included facilities in Alberta, Canada, as well as the states of North and South Dakota, Nebraska, Kansas, Oklahoma, Texas, Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Nevada, Washington, Oregon, and California. Raw fatality counts were available at 21 facilities, while estimates of fatality rates were available at only 18 of these facilities. Eighteen facilities reported raptor fatality rates, which ranged from zero to 1.79 raptor fatalities/MW/year (mean: 0.19, median: 0.09 fatalities/MW/year; Johnson and Stephens 2011). The raptor fatality rates at two facilities were high relative to the remaining 16 facilities: Diablo Winds (1.79 raptor fatalities/MW/year) and SMUD (0.53 raptor fatalities/MW/year) facilities, both located in California. Estimates of raptor fatality rates at the remaining 16 facilities ranged from zero to 0.15 raptor fatalities/MW/year, with a mean of 0.07 fatalities/MW/year (median: 0.09 fatalities/MW/year).

In 2007, the NRC released a report regarding the cumulative effects of wind energy. Raptor fatality estimates were compared among 14 facilities across the United States, excluding California; combined, the raptor fatality estimate was 0.04 raptor fatalities/MW/year, and regional raptor fatality estimates ranged from 0.02 (eastern US; Tennessee and West Virginia) to 0.07 (Pacific Northwest; Oregon and Washington). Across the US, raptors and vultures accounted for about 6% of fatalities at these 14 facilities (NRC 2007).

A comparison of raptor fatality rates in the Midwest and Rocky Mountains is illustrated in Figure 5.3, and a complete list of all publicly available and comparable raptor fatality rates from North American projects can be found in Appendix E.

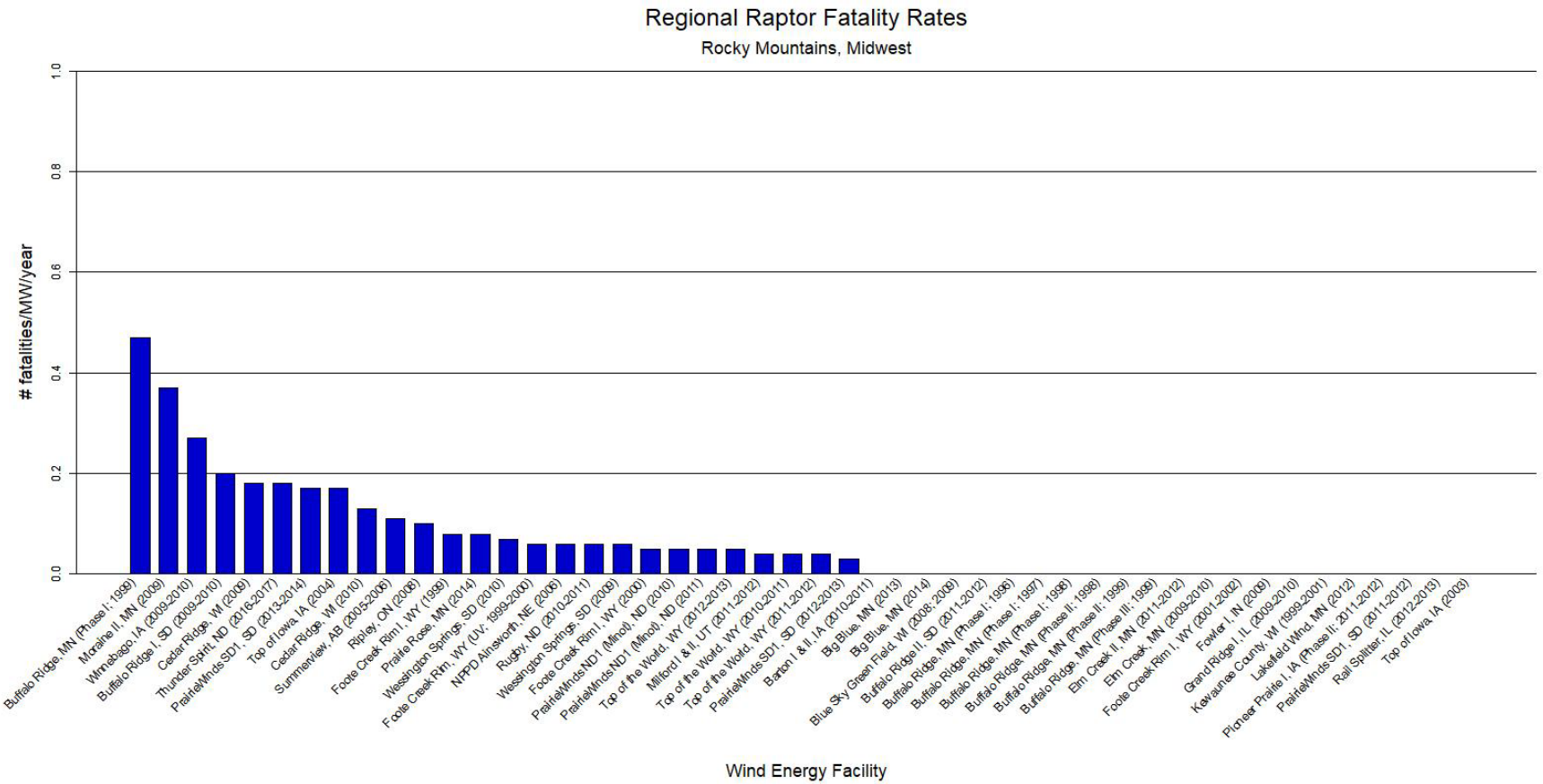


Figure 5.3. Fatality rates for raptors (number of raptors per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountains regions of North America.

Figure 5.3 (*continued*). Fatality rates for raptors (number of raptors per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountains regions of North America. Data from the following sources:

Facility, Location	Fatality Reference	Facility, Location	Fatality Reference
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a	Top of the World, WY (2011-2012)	Rintz and Bay 2013
Moraine II, MN (2009)	Derby et al. 2010g	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Winnebago, IA (2009-2010)	Derby et al. 2010a	Barton I & II, IA (2010-2011)	Derby et al. 2011b
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010e	Big Blue, MN (2013)	Fagen Engineering 2014
Cedar Ridge, WI (2009)	BHE Environ-mental 2010	Big Blue, MN (2014)	Fagen Engineering 2015
Thunder Spirit, ND (2016-2017)	Baerwald 2008	Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009
PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014	Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a
Top of Iowa, IA (2004)	Jain 2005	Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a
Cedar Ridge, WI (2010)	BHE Environ-mental 2011	Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a
Summerview, AB (2005-2006)	Brown and Hamilton 2006	Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a
Ripley, ON (2008)	Jacques Whitford 2009	Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a
Foote Creek Rim I, WY (1999)	Young et al. 2003a	Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a
Prairie Rose, MN (2014)	Chodachek et al. 2015	Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a
Wessington Springs, SD (2010)	Derby et al. 2011a	Elm Creek II, MN (2011-2012)	Derby et al. 2012b
Foote Creek Rim, WY (UV; 1999-2000)	Young et al. 2003b	Elm Creek, MN (2009-2010)	Derby et al. 2010f
NPPD Ainsworth, NE (2006)	Derby et al. 2007	Foote Creek Rim I, WY (2001-2002)	Young et al. 2003a
Rugby, ND (2010-2011)	Derby et al. 2011c	Fowler I, IN (2009)	Johnson et al. 2010
Wessington Springs, SD (2009)	Derby et al. 2010d	Grand Ridge I, IL (2009-2010)	Derby et al. 2010a
Foote Creek Rim I, WY (2000)	Young et al. 2003a	Kewaunee County, WI (1999-2001)	Howe et al. 2002
PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d	Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012
PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Top of the World, WY (2012-2013)	Rintz and Bay 2014	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c

Figure 5.3 (*continued*). Fatality rates for raptors (number of raptors per megawatt per year) reported in publicly available studies at wind energy facilities in Midwest and Rocky Mountains regions of North America. Data from the following sources:

Facility, Location	Fatality Reference	Facility, Location	Fatality Reference
Milford I & II, UT (2011-2012)	Stantec 2012	Rail Splitter, IL (2012-2013)	Good et al. 2013a
Top of the World, WY (2010-2011)	Rintz and Bay 2012	Top of Iowa, IA (2003)	Jain 2005

5.2.3.4 Use Versus Fatality Rates

Comparable pre-construction raptor use and post-construction raptor mortality data are available for several studies at new-generation wind energy facilities, resulting in 34 pairs of raptor use with fatality data (see Appendix E2). Of these, 16 pairings were from studies at facilities classified as having relatively low raptor use (less than 0.5 raptors/plot/20-min survey), 13 were classified as having low to moderate raptor use (between 0.5 and 1.0), and five were classified as having moderate or high raptor use (greater than 1.0). Due to the relatively low sample size and other biological factors that can influence raptor fatality rates it is not known if the relationship between raptor use and fatality rates is a simple linear relationship. Additionally, mortality estimation for wind resource areas with moderate to high raptor use is subject to greater uncertainty due to a lack of available data, as few wind resource areas have had moderate or high pre-construction raptor use estimates. Variation in species composition also is likely to influence overall raptor mortality.

Assuming a relationship with raptor use and fatality rates, WEST used the available data to assess risk to raptors by examining the mean and range of mortality for wind energy facilities considered to have low raptor use. The proposed Project is classified as having low raptor use, and raptor fatality rates for this project may occur within the range of other wind energy facilities that also have low raptor use (i.e., a mean of 0.05 and a range of zero to 0.09 raptors/MW/year).

Raptor mortality for some species is not necessarily related to abundance, and the relationship can vary widely between facilities. For example, American kestrel use at High Winds Energy Center in California was nearly seven times higher than that recorded at Altamont Pass Wind Farm (Kerlinger et al. 2005), yet American kestrel mortality at Altamont was nearly seven times higher than at High Winds (Kerlinger et al. 2006, Altamont Pass Avian Monitoring Team 2008). Northern harriers typically fly close to the ground (MacWhirter and Bildstein 1996), with some studies reporting up to 97% of flights below 20 m (66 ft; Whitfield and Madders 2006); therefore, risk of collision with turbine blades is considered low for this species (Whitfield and Madders 2005, 2006), even though they are commonly observed at some wind facilities. Raptor mortality rates at two wind energy facilities in Spain were not correlated with raptor abundance; possibly due to species-specific flight behaviors (de Lucas et al. 2008). However, results from another study of 34 wind energy facilities in Spain showed year-round mortality of griffon vultures (*Gyps fulvus*; a large bird with a soaring-gliding flight pattern similar to raptors) was higher at turbines located in areas with larger griffon vulture breeding colonies than for turbines in more sparsely populated

areas (Carrete et al. 2012). While abundance is intuitively connected to raptor fatality risk, it is likely other factors are also important in predicting fatality risk for individual species.

5.2.3.5 Migratory Behavior

There is some evidence that migrating raptors are more vulnerable to turbine collision than residents (Orloff and Flannery 1993, de Lucas et al. 2004). Although they differ tremendously in distances traveled and tactics employed, most diurnal raptor species in North America exhibit some degree of migration during the spring and fall seasons (Bildstein 2006). Due to their large size and long migration distances, most raptor species are unable to use flapping flight as their primary strategy to travel across the landscape (Bohrer et al. 2012). Over large migration distances, these birds rely on vertical lift to promote soaring and gliding flight; this strategy allows migrants to conserve energy (Kerlinger 1989, Bildstein 2006). However, this tactic may also make migrant raptors more vulnerable to turbine collisions (Barrios and Rodríguez 2004, Hoover and Morrison 2005). Migrating raptors are also known to concentrate in rather narrow streams along linear topographic features such as coastlines, rivers, and ridges. This is particularly true where linear features are oriented within approximately 45 degrees of the optimal flight direction (Richardson 2000), resulting in higher raptor density, and possibly more risk of collision. However, various environmental factors such as cloud height, visibility, pressure, and temperature can also influence flight strategies of hawks (Richardson 2000, Yates et al. 2001, Goodrich and Smith 2008, Tholin 2011), thereby influencing risk of turbine collision. There is a pronounced escarpment along the eastern and southern portions of the Project; however, raptor use was not observed to be higher close to this feature.

5.2.3.6 Population-Level Effects

Bird collision mortality is well documented at most wind energy facilities, and population level effects attributable to collisions have not been detected (Pearce-Higgins et al. 2012); however, population-level effects of wind energy development on raptors are poorly understood in the US. A cumulative assessment of turbine-related raptor fatalities in the Columbia Plateau Ecoregion concluded raptor species fatalities were unlikely to have population level effects (Johnson and Erickson 2011). A 6-year radiotelemetry study of golden eagles, and occupancy studies five and 13 years after the telemetry study, at the Altamont Pass wind resource area in California found the resident golden eagle population appeared to be self-sustaining despite sustaining high levels of fatalities (Hunt 2002, 2017). For bird populations that are less robust, wind energy facility-related effects may be more impactful – in Europe, modeling of wind turbine impacts on some sensitive raptor and vulture species population numbers has indicated some potential for wind development to have substantial negative effects (Carrete et al. 2009, Bellebaum et al. 2013).

5.2.3.7 Displacement

Raptors displaced from wind energy facilities may move to lower quality habitat with fewer disturbances; however, most studies on raptor displacement at wind energy facilities indicate displacement effects to be negligible (Howell and Noone 1992; Johnson et al. 2000a, 2003; Madders and Whitfield 2006). Notable exceptions include a study in Scotland that described territorial golden eagles avoiding the entire wind energy facility area, except when intercepting non-territorial birds (Walker et al. 2005). Hen harriers (also known as northern harriers) and

buzzards (*Buteo buteo*) showed reduced flight activity around turbines at a wind energy facility in Europe (Pearce-Higgins et al. 2009). A study in Wisconsin found raptor abundance was 47% less post-development compared to pre-construction levels; however, whether this possible displacement effect will remain constant over time was unknown (Garvin et al. 2011). In Minnesota, there was evidence of northern harriers avoiding turbines on both a small scale (less than 100 m from turbines) and a larger scale (105 – 5,364 m [344 – 17,589 ft]) in the year following construction, but they appeared to habituate to the facility, with no large-scale displacement detected two years after the facility was built (Johnson et al. 2002b).

5.2.4 Passerines

Small-sized passerines composed about 62.5% of wind turbine fatalities in 116 studies included in a recent analysis (Erickson et al. 2014). A total of 3,110 fatalities represented by 156 species of small passerines were found during the studies, and it was estimated that about 134,000 to 230,000 small passerine fatalities occurred each year in the US and Canada combined, corresponding to a rate of 2.10 to 3.35 small birds/MW of installed capacity (Erickson et al. 2014). The highest effect for individual species was for black-throated blue warbler (*Setophaga caerulescens*) and tree swallow (*Tachycineta bicolor*), both with an estimated 0.043% of their respective continental populations suffering mortality each year from collisions with wind turbines. Values for other species ranged from 0.008 to 0.038%. In comparison, researchers estimated over six million passerines were killed annually from collisions with communication towers (passerines composed 97% of all fatalities), and annual mortality for individual species ranged from 1.2% to 9.0% of their estimated total populations for the twenty species most affected (Longcore et al. 2012, 2013).

Wind energy facility construction appears to cause small-scale local displacement of some grassland passerines, which may be due to the birds avoiding turbine noise and maintenance activities (Drewitt and Langston 2006). Construction may also reduce habitat effectiveness due to the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000a). Density or measured use by grassland bird species was reduced within 50 to 400 m of wind turbines during studies in North Dakota, South Dakota, Oregon, Washington, Minnesota, and Texas (Osborn et al. 1998, Leddy et al. 1999, Johnson et al. 2000a, Erickson et al. 2004, Young et al. 2006, Stevens et al. 2013, Shaffer and Buhl 2016). Some species have not shown evidence of displacement by turbines (Stevens et al. 2013, Gillespie and Dinsmore 2014). Horned larks showed significant increases in use of areas near turbines at both the Stateline and Combine Hills facilities, possibly because the cleared turbine pads and access roads provided habitat preferred by this species Young et al. 2006.

Passerines at the Project likely will experience impacts to individuals due to turbine collisions and displacement. Population-level impacts are not likely due to turbine collisions. Direct impacts to nesting birds, eggs, and young largely can be avoided by timing most ground-clearing and digging activities to occur in the non-breeding season (generally mid-July to mid-March). Displacement impacts can be reduced by placing wind turbines in previously disturbed landscapes such as cultivated fields and along existing roads.

5.3 Special Status Species

No federal listed species were observed in the Project during surveys or incidentally. Plains sharp-tailed grouse, which is state-listed as endangered, was observed incidentally during both survey years. Eagles are protected by the BGEPA; golden eagles were observed during both survey years, while bald eagles were observed during the second survey year only. Three additional state species of concern and five USFWS BCC species were recorded.

5.3.1 Golden Eagle

Golden eagles were documented during surveys at the Project in 2017, with 10 observations, and in 2018, with five observations. Observations occurred throughout the year, during January, March, August, October, and December. Golden eagle nests have been documented along the escarpment within 16 kilometers (10 miles) of the Project during nest surveys for this Project and for the neighboring Cedar Creek Wind Project.

Eagle mortalities at wind energy facilities in the contiguous US (excluding the Altamont Pass Wind Resource Area in California) were summarized from public domain data by Pagel et al. (2013). Based on the summary, 32 wind energy facilities reported eagle fatalities (85 total fatalities – six bald eagles and 79 golden eagles [Pagel et al. 2013]). Five of the golden eagle fatalities were found at wind energy facilities in Colorado. There is some risk to golden eagles posed by development of the Project. For a thorough discussion of the potential effects of wind energy development on eagles, please see the ECPG (USFWS 2013).

5.3.2 Bald Eagle

Bald eagles are present in Colorado year-round, and are known to nest near larger rivers and reservoirs. Nesting records in the state have increased consistently since the 1970s (https://cpw.state.co.us/learn/Pages/SpeciesProfiles.aspx?species=hare). Bald eagles were observed in the Project on two dates in September and November, totaling 10 observations during fall of 2018.

While reports of bald eagle fatalities at wind facilities have increased in recent years, possibly due to increasing populations and better reporting, no bald eagle fatalities have been reported for Colorado (USFWS 2018). Based on relatively few bald eagle observations within the Project during surveys and lack of attractive hunting or roosting habitat, collision risk likely would be low. For a thorough discussion of the potential effects of wind energy development on eagles, please see the USFWS ECPG (USFWS 2013).

5.3.3 Plains Sharp-tailed Grouse

The Project occurs at the eastern edge of the range of plains sharp-tailed grouse, which is listed as endangered at the state level, but does not have special regulatory protection at the federal level. The grouse are known to lek and breed in the Project. Individuals were observed incidentally during both survey years, and targeted lek surveys in spring of 2018 documented leks. The Project has taken lek locations into consideration and worked with CPW to minimize habitat impacts and conserve available habitat.

6 CONCLUSIONS

Tier 3 studies are used to address questions regarding impacts that could not be sufficiently addressed using available literature (i.e., during Tier 1 and 2 desktop analyses). These studies provide additional data that, when combined with available literature reviewed in previous tiers, allow for a better-informed assessment of the risk of significant adverse impacts to species of concern at the Project area. Raptor use at the Project was relatively low compared to use levels recorded at other wind energy facilities in North America, and diurnal raptor fatality rates are expected to be within the range of fatality rates observed at other facilities where raptor use levels are lower. Golden eagles were observed in the Project during both study years, and bald eagles were observed in 2018; there is some risk to eagles posed by the Project. Land cover in much of the Project is grassland, and Project development in native grassland habitats could reduce habitat value for some species. Impact to grassland bird species can be reduced by timing ground-disturbing construction activities to occur outside of the breeding season, and by siting facilities in previously disturbed landscapes.

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Appendix A. All Bird Types and Species Observed at the Mountain Breeze/Panorama Project during Avian Use Surveys, 2017-2018

Appendix A1. Summary of eagle and large bird individuals and group observations by bird type and species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**0**	**0**	**1**	**12**	**0**	**0**	**0**	**0**	**1**	**12**
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	12	0	0	0	0	1	12
Waterfowl		**2**	**180**	**0**	**0**	**0**	**0**	**2**	**4**	**4**	**184**
Canada goose	*Branta canadensis*	2	180	0	0	0	0	0	0	2	180
unidentified duck		0	0	0	0	0	0	2	4	2	4
Shorebirds		**0**	**0**	**2**	**3**	**0**	**0**	**1**	**4**	**3**	**7**
killdeer	*Charadrius vociferus*	0	0	2	3	0	0	0	0	2	3
unidentified dowitcher	*Limnodromus* spp	0	0	0	0	0	0	1	4	1	4
Diurnal Raptors		**28**	**28**	**74**	**84**	**46**	**53**	**69**	**75**	**217**	**240**
Accipiters		*0*	*0*	*2*	*3*	*0*	*0*	*0*	*0*	*2*	*3*
Cooper's hawk	*Accipiter cooperii*	0	0	1	1	0	0	0	0	1	1
unidentified accipiter	*Accipiter* spp.	0	0	1	2	0	0	0	0	1	2
Buteos		*16*	*16*	*54*	*63*	*31*	*35*	*42*	*46*	*143*	*160*
red-tailed hawk	*Buteo jamaicensis*	0	0	9	9	2	2	6	6	17	17
rough-legged hawk	*B. lagopus*	16	16	0	0	0	0	27	31	43	47
ferruginous hawk	*B. regalis*	0	0	2	2	0	0	0	0	2	2
unidentified buteo	*Buteo* spp.	0	0	4	5	3	3	7	7	14	15
Swainson's hawk	*B. swainsoni*	0	0	39	47	26	30	2	2	67	79
Northern Harrier		*4*	*4*	*7*	*7*	*8*	*8*	*15*	*16*	*34*	*35*
northern harrier	*Circus hudsonius*	4	4	7	7	8	8	15	16	34	35
Eagles		*1*	*1*	*2*	*2*	*1*	*1*	*6*	*6*	*10*	*10*
golden eagle	*Aquila chrysaetos*	1	1	2	2	1	1	6	6	10	10
Falcons		*3*	*3*	*5*	*5*	*3*	*3*	*4*	*5*	*15*	*16*
prairie falcon	*Falco mexicanus*	1	1	1	1	0	0	2	2	4	4
American kestrel	*F. sparverius*	1	1	3	3	2	2	0	0	6	6
unidentified falcon	*Falco* spp.	1	1	1	1	1	1	2	3	5	6
Other Raptors		*4*	*4*	*4*	*4*	*3*	*6*	*2*	*2*	*13*	*16*
unidentified raptor		4	4	4	4	3	6	2	2	13	16
Vultures		**0**	**0**	**3**	**4**	**0**	**0**	**1**	**1**	**4**	**5**
turkey vulture	*Cathartes aura*	0	0	3	4	0	0	1	1	4	5
Upland Game Birds		**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**1**	**4**
unidentified gamebird		0	0	0	0	0	0	1	4	1	4
Doves/Pigeons		**2**	**27**	**5**	**10**	**5**	**10**	**4**	**18**	**16**	**65**
rock pigeon	*Columba livia*	2	27	4	9	1	2	4	18	11	56
Eurasian collared-dove	*Streptopelia decaocto*	0	0	1	1	0	0	0	0	1	1
mourning dove	*Zenaida macroura*	0	0	0	0	4	8	0	0	4	8

Appendix A1. Summary of eagle and large bird individuals and group observations by bird type and species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Large Corvids		**2**	**4**	**1**	**1**	**0**	**0**	**2**	**2**	**5**	**7**
common raven	*Corvus corax*	2	4	1	1	0	0	2	2	5	7
Goatsuckers		**0**	**0**	**21**	**40**	**9**	**12**	**1**	**1**	**31**	**53**
common nighthawk	*Chordeiles minor*	0	0	21	40	9	12	1	1	31	53
Unidentified Birds		**1**	**3**	**1**	**1**	**2**	**3**	**1**	**16**	**5**	**23**
unidentified large bird		1	3	1	1	2	3	1	16	5	23
Overall		**35**	**242**	**108**	**155**	**62**	**78**	**82**	**125**	**287**	**600**

Note: grps = groups; obs = observations

Appendix A2. Summary of small bird individuals and group observations by bird type and species during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**47**	**75**	**412**	**631**	**174**	**327**	**82**	**379**	**715**	**1,412**
red-winged blackbird	*Agelaius phoeniceus*	0	0	6	9	1	3	0	0	7	12
Brewer's blackbird	*Euphagus cyanocephalus*	0	0	3	11	0	0	0	0	3	11
brown-headed cowbird	*Molothrus ater*	0	0	2	4	1	5	0	0	3	9
common grackle	*Quiscalus quiscula*	0	0	1	12	0	0	0	0	1	12
western meadowlark	*Sturnella neglecta*	0	0	135	166	26	50	8	11	169	227
European starling	*Sturnus vulgaris*	0	0	2	2	1	2	0	0	3	4
unidentified blackbird		0	0	4	34	1	1	0	0	5	35
house finch	*Haemorhous mexicanus*	0	0	1	1	0	0	0	0	1	1
Say's phoebe	*Sayornis saya*	0	0	0	0	1	1	1	1	2	2
unidentified kingbird	*Tyrannus* spp.	0	0	0	0	1	1	0	0	1	1
western kingbird	*T. verticalis*	0	0	2	3	6	12	0	0	8	15
grasshopper sparrow	*Ammodramus savannarum*	0	0	14	14	10	10	0	0	24	24
lark bunting	*Calamospiza melanocorys*	0	0	63	100	55	111	0	0	118	211
chestnut-collared longspur	*Calcarius ornatus*	0	0	1	1	0	0	0	0	1	1
unidentified longspur	*Calcarius* spp.	0	0	1	2	0	0	0	0	1	2
horned lark	*Eremophila alpestris*	47	75	147	222	34	61	68	357	296	715
house sparrow	*Passer domesticus*	0	0	1	2	0	0	0	0	1	2
Savannah sparrow	*Passerculus sandwichensis*	0	0	1	1	0	0	0	0	1	1
vesper sparrow	*Pooecetes gramineus*	0	0	0	0	1	1	1	3	2	4
McCown's longspur	*Rhynchophanes mccownii*	0	0	10	15	0	0	0	0	10	15
chipping sparrow	*Spizella passerina*	0	0	0	0	1	1	0	0	1	1
unidentified sparrow		0	0	4	6	6	10	1	1	11	17
barn swallow	*Hirundo rustica*	0	0	6	16	21	46	3	6	30	68
cliff swallow	*Petrochelidon pyrrhonota*	0	0	1	1	1	1	0	0	2	2
violet-green swallow	*Tachycineta thalassina*	0	0	0	0	1	1	0	0	1	1
unidentified swallow		0	0	3	3	4	7	0	0	7	10
loggerhead shrike	*Lanius ludovicianus*	0	0	3	4	1	1	0	0	4	5
American robin	*Turdus migratorius*	0	0	1	2	1	2	0	0	2	4
Unidentified Birds		**1**	**2**	**9**	**10**	**5**	**5**	**13**	**27**	**28**	**44**
unidentified bird (small)		1	2	9	10	5	5	13	27	28	44
Overall		**48**	**77**	**421**	**641**	**179**	**332**	**95**	**406**	**743**	**1,456**

Note: grps = groups; obs = observations.

Appendix A3. Summary of eagle and large bird individuals and group observations by bird type and species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Waterbirds		**0**	**0**	**2**	**3**	**0**	**0**	**3**	**72**	**5**	**75**
sandhill crane	*Antigone canadensis*	0	0	0	0	0	0	3	72	3	72
great blue heron	*Ardea herodias*	0	0	1	1	0	0	0	0	1	1
American white pelican	*Pelecanus erythrorhynchos*	0	0	1	2	0	0	0	0	1	2
Waterfowl		**2**	**17**	**2**	**2**	**0**	**0**	**2**	**21**	**6**	**40**
Canada goose	*Branta canadensis*	2	17	1	1	0	0	2	21	5	39
unidentified duck		0	0	1	1	0	0	0	0	1	1
Shorebirds		**0**	**0**	**7**	**9**	**1**	**2**	**0**	**0**	**8**	**11**
unidentified sandpiper	*Calidris* spp.	0	0	0	0	1	2	0	0	1	2
killdeer	*Charadrius vociferus*	0	0	7	9	0	0	0	0	7	9
Diurnal Raptors		**39**	**40**	**64**	**77**	**37**	**39**	**100**	**104**	**240**	**260**
Accipiters		*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*	*1*
unidentified accipiter	*Accipiter* spp.	0	0	0	0	0	0	1	1	1	1
Buteos		*24*	*25*	*56*	*69*	*27*	*29*	*40*	*42*	*147*	*165*
red-tailed hawk	*Buteo jamaicensis*	0	0	7	8	6	6	8	9	21	23
rough-legged hawk	*B. lagopus*	18	19	3	3	0	0	21	21	42	43
ferruginous hawk	*B. regalis*	0	0	1	1	0	0	1	1	2	2
unidentified buteo	*Buteo* spp.	6	6	6	8	4	5	6	6	22	25
Swainson's hawk	*B. swainsoni*	0	0	39	49	17	18	4	5	60	72
Northern Harrier		*13*	*13*	*7*	*7*	*6*	*6*	*34*	*36*	*60*	*62*
northern harrier	*Circus hudsonius*	13	13	7	7	6	6	34	36	60	62
Eagles		*0*	*0*	*1*	*1*	*0*	*0*	*14*	*14*	*15*	*15*
golden eagle	*Aquila chrysaetos*	0	0	1	1	0	0	4	4	5	5
bald eagle	*Haliaeetus leucocephalus*	0	0	0	0	0	0	10	10	10	10
Falcons		*1*	*1*	*0*	*0*	*2*	*2*	*10*	*10*	*13*	*13*
merlin	*Falco columbarius*	0	0	0	0	0	0	1	1	1	1
prairie falcon	*F. mexicanus*	0	0	0	0	1	1	4	4	5	5
American kestrel	*F. sparverius*	0	0	0	0	1	1	2	2	3	3
unidentified falcon	*Falco* spp.	1	1	0	0	0	0	3	3	4	4
Other Raptors		*1*	*1*	*0*	*0*	*2*	*2*	*1*	*1*	*4*	*4*
unidentified raptor		1	1	0	0	2	2	1	1	4	4
Owls		**6**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**6**
short-eared owl	*Asio flammeus*	6	6	0	0	0	0	0	0	6	6
Vultures		**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**2**	**2**
turkey vulture	*Cathartes aura*	0	0	0	0	1	1	1	1	2	2

Appendix A3. Summary of eagle and large bird individuals and group observations by bird type and species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Doves/Pigeons		**1**	**1**	**188**	**328**	**100**	**175**	**25**	**150**	**314**	**654**
rock pigeon	*Columba livia*	1	1	28	84	11	34	20	133	60	252
unidentified dove	*Columbidae genus*	0	0	6	13	1	3	0	0	7	16
Eurasian collared-dove	*Streptopelia decaocto*	0	0	10	10	2	2	1	7	13	19
mourning dove	*Zenaida macroura*	0	0	144	221	86	136	4	10	234	367
Goatsuckers		**0**	**0**	**2**	**2**	**4**	**4**	**0**	**0**	**6**	**6**
common nighthawk	*Chordeiles minor*	0	0	2	2	4	4	0	0	6	6
Overall		**48**	**64**	**265**	**421**	**143**	**221**	**131**	**348**	**587**	**1,054**

Note: grps = groups; obs = observations.

Appendix A4. Summary of small bird individuals and group observations by bird type and species during small bird fixed-point surveys at the Mountain Breeze Wind/Panorama Wind Project from January 29, 2018 to December 27, 2018.

		Winter		Spring		Summer		Fall		Total	
Type/Species	**Scientific Name**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**
Passerines		**16**	**77**	**402**	**504**	**141**	**323**	**142**	**502**	**701**	**1,406**
red-winged blackbird	*Agelaius phoeniceus*	0	0	4	6	0	0	0	0	4	6
brown-headed cowbird	*Molothrus ater*	0	0	0	0	1	1	0	0	1	1
common grackle	*Quiscalus quiscula*	0	0	7	11	0	0	0	0	7	11
western meadowlark	*Sturnella neglecta*	0	0	135	155	30	42	14	17	179	214
European starling	*Sturnus vulgaris*	0	0	0	0	0	0	3	9	3	9
unidentified blackbird		0	0	3	16	1	1	0	0	4	17
Say's phoebe	*Sayornis saya*	0	0	0	0	1	2	0	0	1	2
western kingbird	*Tyrannus verticalis*	0	0	7	9	6	6	0	0	13	15
unidentified flycatcher		0	0	0	0	2	4	0	0	2	4
grasshopper sparrow	*Ammodramus savannarum*	0	0	30	33	13	13	0	0	43	46
lark bunting	*Calamospiza melanocorys*	0	0	55	70	19	115	1	1	75	186
Lapland longspur	*Calcarius lapponicus*	0	0	0	0	0	0	8	9	8	9
chestnut-collared longspur	*C. ornatus*	0	0	6	10	0	0	0	0	6	10
unidentified longspur	*Calcarius* spp.	0	0	0	0	1	2	0	0	1	2
lark sparrow	*Chondestes grammacus*	0	0	0	0	2	7	0	0	2	7
horned lark	*Eremophila alpestris*	16	77	124	146	46	90	81	397	267	710
dark-eyed junco	*Junco hyemalis*	0	0	0	0	0	0	1	2	1	2
vesper sparrow	*Pooecetes gramineus*	0	0	6	9	0	0	9	11	15	20
McCown's longspur	*Rhynchophanes mccownii*	0	0	6	7	1	1	0	0	7	8
dickcissel	*Spiza americana*	0	0	2	2	0	0	0	0	2	2
white-crowned sparrow	*Zonotrichia leucophrys*	0	0	0	0	0	0	1	1	1	1
unidentified sparrow		0	0	6	11	3	3	12	23	21	37
barn swallow	*Hirundo rustica*	0	0	10	18	11	30	1	1	22	49
cliff swallow	*Petrochelidon pyrrhonota*	0	0	0	0	1	2	0	0	1	2
unidentified swallow		0	0	1	1	2	3	0	0	3	4
loggerhead shrike	*Lanius ludovicianus*	0	0	0	0	1	1	0	0	1	1
mountain bluebird	*Sialia currucoides*	0	0	0	0	0	0	11	31	11	31
Unidentified Birds		**1**	**1**	**18**	**29**	**7**	**18**	**8**	**50**	**34**	**98**
unidentified bird (small)		1	1	18	29	7	18	8	50	34	98
Overall		**17**	**78**	**420**	**533**	**148**	**341**	**150**	**552**	**735**	**1,504**

Note: grps = groups; obs = observations.

Appendix B. Bird Use, Percent of Use, and Frequency of Occurrence for Birds Observed during Avian Use Surveys at the Mountain Breeze/Panorama Project, 2017 – 2018

Appendix B1. Mean large bird use[a], percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	**0**	**0.10**	**0**	**0**	**0**	**8.0**	**0**	**0**	**0**	**0.9**	**0**	**0**
American white pelican	0	0.10	0	0	0	8.0	0	0	0	0.9	0	0
Waterfowl	**3.10**	**0**	**0**	**0.03**	**76.6**	**0**	**0**	**2.9**	**1.7**	**0**	**0**	**0.9**
Canada goose	3.10	0	0	0	76.6	0	0	0	1.7	0	0	0
unidentified duck	0	0	0	0.03	0	0	0	2.9	0	0	0	0.9
Shorebirds	**0**	**0.03**	**0**	**0.03**	**0**	**2.0**	**0**	**3.9**	**0**	**1.7**	**0**	**0.9**
killdeer	0	0.03	0	0	0	2.0	0	0	0	1.7	0	0
unidentified dowitcher	0	0	0	0.03	0	0	0	3.9	0	0	0	0.9
Diurnal Raptors	**0.41**	**0.68**	**0.84**	**0.59**	**10.2**	**53.1**	**69.0**	**67.6**	**29.3**	**34.8**	**44.8**	**31.9**
Accipiters	*0*	*0.03*	*0*	*0*	*0*	*2.0*	*0*	*0*	*0*	*1.8*	*0*	*0*
Cooper's hawk	0	<0.01	0	0	0	0.7	0	0	0	0.9	0	0
unidentified accipiter	0	0.02	0	0	0	1.3	0	0	0	0.9	0	0
Buteos	*0.24*	*0.50*	*0.60*	*0.38*	*6.0*	*39.0*	*49.3*	*43.1*	*20.7*	*22.6*	*29.3*	*21.6*
red-tailed hawk	0	0.07	0.03	0.05	0	5.4	2.8	5.9	0	6.1	3.4	5.2
rough-legged hawk	0.24	0	0	0.27	6.0	0	0	30.4	20.7	0	0	12.1
ferruginous hawk	0	0.02	0	0	0	1.4	0	0	0	1.8	0	0
unidentified buteo	0	0.02	0.05	0.04	0	1.3	4.2	4.9	0	1.7	5.2	3.4
Swainson's hawk	0	0.40	0.52	0.02	0	30.8	42.3	2.0	0	15.5	25.9	1.7
Northern Harrier	*0.07*	*0.06*	*0.14*	*0.14*	*1.7*	*4.7*	*11.3*	*15.7*	*6.9*	*5.2*	*12.1*	*9.5*
northern harrier	0.07	0.06	0.14	0.14	1.7	4.7	11.3	15.7	6.9	5.2	12.1	9.5
Eagles	*0.02*	*0.02*	*0.02*	*0.02*	*0.4*	*1.3*	*1.4*	*2.0*	*1.7*	*1.7*	*1.7*	*0.9*
golden eagle	0.02	0.02	0.02	0.02	0.4	1.3	1.4	2.0	1.7	1.7	1.7	0.9
Falcons	*0.03*	*0.04*	*0.05*	*0.04*	*0.9*	*3.4*	*4.2*	*4.9*	*3.4*	*4.4*	*5.2*	*2.6*
prairie falcon	0.02	<0.01	0	0.02	0.4	0.7	0	2.0	1.7	0.9	0	1.7
American kestrel	0.02	0.03	0.03	0	0.4	2.0	2.8	0	1.7	2.6	3.4	0
unidentified falcon	0	<0.01	0.02	0.03	0	0.7	1.4	2.9	0	0.9	1.7	0.9
Other Raptors	*0.05*	*0.03*	*0.03*	*0.02*	*1.3*	*2.7*	*2.8*	*2.0*	*5.2*	*3.5*	*1.7*	*1.7*
unidentified raptor	0.05	0.03	0.03	0.02	1.3	2.7	2.8	2.0	5.2	3.5	1.7	1.7
Vultures	**0**	**0.03**	**0**	**<0.01**	**0**	**2.7**	**0**	**1.0**	**0**	**1.7**	**0**	**0.9**
turkey vulture	0	0.03	0	<0.01	0	2.7	0	1.0	0	1.7	0	0.9
Upland Game Birds	**0**	**0**	**0**	**0.03**	**0**	**0**	**0**	**3.9**	**0**	**0**	**0**	**0.9**
unidentified gamebird	0	0	0	0.03	0	0	0	3.9	0	0	0	0.9

Appendix B1. Mean large bird use[a], percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Doves/Pigeons	**0.47**	**0.09**	**0.17**	**0.16**	**11.5**	**6.7**	**14.1**	**17.6**	**3.4**	**3.5**	**5.2**	**3.4**
rock pigeon	0.47	0.08	0.03	0.16	11.5	6.1	2.8	17.6	3.4	2.6	1.7	3.4
Eurasian collared-dove	0	<0.01	0	0	0	0.7	0	0	0	0.9	0	0
mourning dove	0	0	0.14	0	0	0	11.3	0	0	0	3.4	0
Large Corvids	**0.07**	**<0.01**	**0**	**0.02**	**1.7**	**0.7**	**0**	**2.0**	**1.7**	**0.9**	**0**	**0.9**
common raven	0.07	<0.01	0	0.02	1.7	0.7	0	2.0	1.7	0.9	0	0.9
Goatsuckers	**0**	**0.34**	**0.21**	**<0.01**	**0**	**26.7**	**16.9**	**1.0**	**0**	**3.4**	**5.2**	**0.9**
common nighthawk	0	0.34	0.21	<0.01	0	26.7	16.9	1.0	0	3.4	5.2	0.9
Overall[b]	**4.05**	**1.29**	**1.22**	**0.88**	**100**	**100**	**100**	**100**				

[a.] Number of large birds/800-meter (2,625-foot) plot/60-minute survey.

[b.] Sums may not equal total values shown due to rounding.

Appendix B2. Mean small bird use[a], percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	**1.29**	**4.84**	**5.29**	**3.20**	**100**	**98.8**	**99.4**	**95.4**	**46.6**	**91.4**	**84.5**	**40.5**
red-winged blackbird	0	0.06	0.05	0	0	1.2	1.0	0	0	3.4	1.7	0
Brewer's blackbird	0	0.09	0	0	0	1.9	0	0	0	2.6	0	0
brown-headed cowbird	0	0.03	0.09	0	0	0.7	1.6	0	0	1.7	1.7	0
western meadowlark	0	1.34	0.86	0.09	0	27.4	16.2	2.8	0	68.1	32.8	4.3
European starling	0	0.02	0.03	0	0	0.4	0.6	0	0	1.7	1.7	0
unidentified blackbird	0	0.02	0.02	0	0	0.4	0.3	0	0	1.7	1.7	0
house finch	0	<0.01	0	0	0	0.2	0	0	0	0.9	0	0
Say's phoebe	0	0	0.02	<0.01	0	0	0.3	0.3	0	0	1.7	0.9
western kingbird	0	0.03	0.16	0	0	0.5	2.9	0	0	1.7	5.2	0
grasshopper sparrow	0	0.12	0.17	0	0	2.5	3.2	0	0	10.3	12.1	0
lark bunting	0	0.84	1.88	0	0	17.0	35.3	0	0	31.9	43.1	0
chestnut-collared longspur	0	<0.01	0	0	0	0.2	0	0	0	0.9	0	0
unidentified longspur	0	0.02	0	0	0	0.4	0	0	0	0.9	0	0
horned lark	1.29	1.88	1.05	3.01	100	38.3	19.7	89.7	46.6	78.4	44.8	35.3
house sparrow	0	0.02	0	0	0	0.4	0	0	0	0.9	0	0
Savannah sparrow	0	<0.01	0	0	0	0.2	0	0	0	0.9	0	0
vesper sparrow	0	0	0.02	0.03	0	0	0.3	0.8	0	0	1.7	0.9
McCown's longspur	0	0.13	0	0	0	2.6	0	0	0	4.3	0	0
chipping sparrow	0	0	0.02	0	0	0	0.3	0	0	0	1.7	0
unidentified sparrow	0	0.03	0.10	<0.01	0	0.7	1.9	0.3	0	2.6	6.9	0.9
barn swallow	0	0.14	0.62	0.05	0	2.8	11.7	1.5	0	3.4	15.5	2.6
cliff swallow	0	<0.01	0.02	0	0	0.2	0.3	0	0	0.9	1.7	0
violet-green swallow	0	0	0.02	0	0	0	0.3	0	0	0	1.7	0
unidentified swallow	0	<0.01	0.12	0	0	0.2	2.3	0	0	0.9	5.2	0
loggerhead shrike	0	0.03	0.02	0	0	0.7	0.3	0	0	1.7	1.7	0
American robin	0	0	0.03	0	0	0	0.6	0	0	0	1.7	0
Unidentified Birds	**0**	**0.06**	**0.03**	**0.16**	**0**	**1.2**	**0.6**	**4.6**	**0**	**5.2**	**3.4**	**8.6**
unidentified bird (small)	0	0.06	0.03	0.16	0	1.2	0.6	4.6	0	5.2	3.4	8.6
Overall[b]	**1.29**	**4.91**	**5.33**	**3.35**	**100**	**100**	**100**	**100**				

[a]. number of small birds/100-meter (328-foot) plot/10-minute survey

[b]Sums may not add to the total values shown due to rounding.

Appendix B3. Mean large birds use[a], percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29, 2018 to December 27, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Waterbirds	**0**	**0.04**	**0**	**0.80**	**0**	**0.7**	**0**	**21.5**	**0**	**2.9**	**0**	**1.1**
sandhill crane	0	0	0	0.80	0	0	0	21.5	0	0	0	1.1
great blue heron	0	0.01	0	0	0	0.2	0	0	0	1.5	0	0
American white pelican	0	0.03	0	0	0	0.5	0	0	0	1.5	0	0
Waterfowl	**0.50**	**0.01**	**0**	**0.23**	**28.8**	**0.2**	**0**	**6.1**	**5.9**	**1.5**	**0**	**1.1**
Canada goose	0.50	0	0	0.23	28.8	0	0	6.1	5.9	0	0	1.1
unidentified duck	0	0.01	0	0	0	0.2	0	0	0	1.5	0	0
Shorebirds	**0**	**0.13**	**0.05**	**0**	**0**	**2.2**	**0.9**	**0**	**0**	**4.4**	**2.3**	**0**
unidentified sandpiper	0	0	0.05	0	0	0	0.9	0	0	0	2.3	0
killdeer	0	0.13	0	0	0	2.2	0	0	0	4.4	0	0
Diurnal Raptors	**1.03**	**1.07**	**0.80**	**1.14**	**59.3**	**17.6**	**16.1**	**30.7**	**52.9**	**42.6**	**45.5**	**46.6**
Accipiters	*0*	*0*	*0*	*0.01*	*0*	*0*	*0*	*0.3*	*0*	*0*	*0*	*1.1*
unidentified accipiter	0	0	0	0.01	0	0	0	0.3	0	0	0	1.1
Buteos	*0.62*	*0.96*	*0.61*	*0.45*	*35.6*	*15.7*	*12.4*	*12.3*	*32.4*	*36.8*	*34.1*	*21.6*
red-tailed hawk	0	0.12	0.14	0.10	0	1.9	2.8	2.8	0	7.4	9.1	4.5
rough-legged hawk	0.53	0.04	0	0.24	30.5	0.7	0	6.4	29.4	4.4	0	13.6
ferruginous hawk	0	0.01	0	0.01	0	0.2	0	0.3	0	1.5	0	1.1
unidentified buteo	0.09	0.07	0.09	0.05	5.1	1.2	1.8	1.2	8.8	4.4	4.5	4.5
Swainson's hawk	0	0.71	0.39	0.06	0	11.6	7.8	1.5	0	27.9	25.0	2.3
Northern Harrier	*0.38*	*0.10*	*0.14*	*0.41*	*22.0*	*1.7*	*2.8*	*11.0*	*32.4*	*7.4*	*11.4*	*25.0*
northern harrier	0.38	0.10	0.14	0.41	22.0	1.7	2.8	11.0	32.4	7.4	11.4	25.0
Eagles	*0*	*0.01*	*0*	*0.16*	*0*	*0.2*	*0*	*4.3*	*0*	*1.5*	*0*	*6.8*
golden eagle	0	0.01	0	0.05	0	0.2	0	1.2	0	1.5	0	4.5
bald eagle	0	0	0	0.11	0	0	0	3.1	0	0	0	2.3
Falcons	*0*	*0*	*0.05*	*0.09*	*0*	*0*	*0.9*	*2.5*	*0*	*0*	*4.5*	*9.1*
merlin	0	0	0	0.01	0	0	0	0.3	0	0	0	1.1
prairie falcon	0	0	0.02	0.03	0	0	0.5	0.9	0	0	2.3	3.4
American kestrel	0	0	0.02	0.02	0	0	0.5	0.6	0	0	2.3	2.3
unidentified falcon	0	0	0	0.02	0	0	0	0.6	0	0	0	2.3
Other Raptors	*0.03*	*0*	*0*	*0.01*	*1.7*	*0*	*0*	*0.3*	*2.9*	*0*	*0*	*1.1*
unidentified raptor	0.03	0	0	0.01	1.7	0	0	0.3	2.9	0	0	1.1
Owls	**0.18**	**0**	**0**	**0**	**10.2**	**0**	**0**	**0**	**2.9**	**0**	**0**	**0**
short-eared owl	0.18	0	0	0	10.2	0	0	0	2.9	0	0	0

Appendix B3. Mean large birds use[a], percent of total use (%), and frequency of occurrence (%) for each large bird type and species by season during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29, 2018 to December 27, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Vultures	**0**	**0**	**0.02**	**0.01**	**0**	**0**	**0.5**	**0.3**	**0**	**0**	**2.3**	**1.1**
turkey vulture	0	0	0.02	0.01	0	0	0.5	0.3	0	0	2.3	1.1
Doves/Pigeons	**0.03**	**4.79**	**3.98**	**1.53**	**1.7**	**78.7**	**80.6**	**41.4**	**2.9**	**57.4**	**63.6**	**9.1**
rock pigeon	0.03	1.24	0.77	1.34	1.7	20.3	15.7	36.2	2.9	8.8	11.4	5.7
unidentified dove	0	0.19	0.07	0	0	3.1	1.4	0	0	8.8	2.3	0
Eurasian collared-dove	0	0.15	0.05	0.08	0	2.4	0.9	2.1	0	7.4	2.3	1.1
mourning dove	0	3.22	3.09	0.11	0	52.9	62.7	3.1	0	54.4	61.4	3.4
Goatsuckers	**0**	**0.03**	**0.09**	**0**	**0**	**0.5**	**1.8**	**0**	**0**	**1.5**	**4.5**	**0**
common nighthawk	0	0.03	0.09	0	0	0.5	1.8	0	0	1.5	4.5	0
Overall[b]	**1.74**	**6.09**	**4.93**	**3.70**	**100**	**100**	**100**	**100**				

[a.] number of large birds/800-meter (2,625-foot) plot/60-minute survey

[b.] Sums of values may not add to the total values shown due to rounding.

Appendix B4. Mean small birds use[a], percent of total use (%), and frequency of occurrence (%) for each small bird type and species by season during small bird fixed-point bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29, 2018 to December 27, 2018.

	Mean Use				% of Use				% Frequency			
Type/Species	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
Passerines	**2.24**	**6.32**	**7.14**	**5.58**	**100**	**94.9**	**98.7**	**96.1**	**23.5**	**94.1**	**81.8**	**59.1**
red-winged blackbird	0	0.07	0	0	0	1.1	0	0	0	4.4	0	0
brown-headed cowbird	0	0	0.02	0	0	0	0.3	0	0	0	2.3	0
common grackle	0	0.15	0	0	0	2.2	0	0	0	4.4	0	0
western meadowlark	0	1.71	0.93	0.18	0	25.6	12.9	3.1	0	69.1	34.1	9.1
European starling	0	0	0	0.10	0	0	0	1.8	0	0	0	1.1
unidentified blackbird	0	0.01	0	0	0	0.2	0	0	0	1.5	0	0
Say's phoebe	0	0	0.05	0	0	0	0.6	0	0	0	2.3	0
western kingbird	0	0.13	0.09	0	0	2.0	1.3	0	0	8.8	9.1	0
unidentified flycatcher	0	0	0.09	0	0	0	1.3	0	0	0	2.3	0
grasshopper sparrow	0	0.47	0.30	0	0	7.1	4.1	0	0	22.1	20.5	0
lark bunting	0	0.94	2.61	0.01	0	14.1	36.2	0.2	0	27.9	22.7	1.1
Lapland longspur	0	0	0	0.10	0	0	0	1.8	0	0	0	4.5
chestnut-collared longspur	0	0.15	0	0	0	2.2	0	0	0	4.4	0	0
lark sparrow	0	0	0.16	0	0	0	2.2	0	0	0	4.5	0
horned lark	2.24	2.01	2.02	4.45	100	30.2	28.0	76.7	23.5	77.9	45.5	44.3
dark-eyed junco	0	0	0	0.02	0	0	0	0.4	0	0	0	1.1
vesper sparrow	0	0.13	0	0.12	0	2.0	0	2.2	0	5.9	0	5.7
McCown's longspur	0	0.09	0.02	0	0	1.3	0.3	0	0	4.4	2.3	0
dickcissel	0	0.03	0	0	0	0.4	0	0	0	2.9	0	0
white-crowned sparrow	0	0	0	0.01	0	0	0	0.2	0	0	0	1.1
unidentified sparrow	0	0.15	0.07	0.23	0	2.2	0.9	3.9	0	7.4	6.8	6.8
barn swallow	0	0.26	0.68	0.01	0	4.0	9.4	0.2	0	8.8	15.9	1.1
cliff swallow	0	0	0.05	0	0	0	0.6	0	0	0	2.3	0
unidentified swallow	0	0.01	0.02	0	0	0.2	0.3	0	0	1.5	2.3	0
loggerhead shrike	0	0	0.02	0	0	0	0.3	0	0	0	2.3	0
mountain bluebird	0	0	0	0.33	0	0	0	5.7	0	0	0	1.1
Unidentified Birds	**0**	**0.34**	**0.09**	**0.23**	**0**	**5.1**	**1.3**	**3.9**	**0**	**17.6**	**6.8**	**6.8**
unidentified bird (small)	0	0.34	0.09	0.23	0	5.1	1.3	3.9	0	17.6	6.8	6.8
Overall[b]	**2.24**	**6.66**	**7.23**	**5.81**	**100**	**100**	**100**	**100**				

[a.] number of small birds/100-meter (328-foot) plot/10-minute survey

[b.] Sums may not add to the total values shown due to rounding.

Appendix C. Species Exposure Indices for Birds during Avian Use Surveys at the Mountain Breeze/Panorama Project, 2017-2018

Appendix C1. Relative exposure index and flight characteristics for large bird species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index[a]	% Within RSH at anytime
Swainson's hawk	63	0.23	94.9	66.2	0.14	79.7
rough-legged hawk	39	0.13	95.6	72.1	0.09	86.0
common nighthawk	29	0.15	96.2	23.5	0.03	49.0
American white pelican	1	0.03	100	100	0.03	100
unidentified buteo	9	0.03	90.0	66.7	0.02	77.8
red-tailed hawk	14	0.04	87.5	42.9	0.02	71.4
turkey vulture	4	0.01	100	100	0.01	100
rock pigeon	9	0.17	91.1	7.8	0.01	7.8
unidentified raptor	8	0.03	72.7	37.5	<0.01	37.5
golden eagle	6	0.02	100	50.0	<0.01	100
unidentified falcon	4	0.01	100	40.0	<0.01	60.0
ferruginous hawk	2	<0.01	100	100	<0.01	100
unidentified accipiter	1	<0.01	100	100	<0.01	100
common raven	5	0.02	100	14.3	<0.01	85.7
prairie falcon	4	0.01	100	25.0	<0.01	25.0
mourning dove	4	0.03	100	0	0	0
unidentified gamebird	1	<0.01	100	0	0	0
American kestrel	6	0.02	100	0	0	16.7
northern harrier	33	0.10	97.1	0	0	5.9
Cooper's hawk	1	<0.01	100	0	0	0
unidentified dowitcher	1	<0.01	100	0	0	0
killdeer	1	<0.01	66.7	0	0	0
Canada goose	2	0.65	100	0	0	0
unidentified duck	1	<0.01	100	0	0	100
Eurasian collared-dove	0	<0.01	0			

[a] The likely "rotor-swept height" (RSH) for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level.

Appendix C2. Relative exposure index and flight characteristics for small bird species during small bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index[a]	% Within RSH at anytime
horned lark	165	1.91	77.1	0.2	<0.01	0.2
unidentified bird (small)	10	0.07	66.7	5.6	<0.01	5.6
loggerhead shrike	4	0.01	100	0	0	0
violet-green swallow	1	<0.01	100	0	0	0
cliff swallow	2	<0.01	100	0	0	0
barn swallow	28	0.19	91.4	0	0	0
unidentified swallow	5	0.03	100	0	0	0
McCown's longspur	3	0.04	46.7	0	0	0
vesper sparrow	1	0.01	25.0	0	0	0
lark bunting	79	0.64	68.0	0	0	0
unidentified sparrow	5	0.03	54.5	0	0	0
western kingbird	3	0.04	33.3	0	0	0
Say's phoebe	1	<0.01	50.0	0	0	0
house finch	1	<0.01	100	0	0	0
European starling	2	0.01	50.0	0	0	0
western meadowlark	60	0.60	42.9	0	0	0
brown-headed cowbird	2	0.03	77.8	0	0	0
Brewer's blackbird	1	0.03	18.2	0	0	0
red-winged blackbird	4	0.03	90.0	0	0	0
unidentified blackbird	3	<0.01	100	0	0	0
American robin	0	<0.01	0			
chipping sparrow	0	<0.01	0			
Savannah sparrow	0	<0.01	0			
house sparrow	0	<0.01	0			
unidentified longspur	0	<0.01	0			
chestnut-collared longspur	0	<0.01	0			
grasshopper sparrow	0	0.07	0			

[a] The likely "rotor-swept height" (RSH) for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level.

Appendix C3. Relative exposure index and flight characteristics for large bird species during eagle/large bird use surveys at the Mountain Breeze/Panorama Wind Project from January 29 to December 27, 2018.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index[a]	% Within RSH at anytime
rock pigeon	51	0.92	85.2	26.2	0.20	42.1
Swainson's hawk	51	0.30	87.1	59.0	0.16	70.5
rough-legged hawk	38	0.19	92.9	51.3	0.09	64.1
Canada goose	3	0.17	100	45.9	0.08	45.9
unidentified dove	7	0.07	100	50.0	0.04	50.0
red-tailed hawk	16	0.09	78.3	38.9	0.03	55.6
mourning dove	165	1.63	71.5	1.9	0.02	4.6
bald eagle	10	0.03	100	60.0	0.02	100
common nighthawk	4	0.03	66.7	100	0.02	100
golden eagle	5	0.02	100	100	0.02	100
unidentified buteo	11	0.07	81.2	15.4	<0.01	15.4
American white pelican	1	<0.01	100	100	<0.01	100
unidentified raptor	2	<0.01	100	50.0	<0.01	50.0
unidentified duck	1	<0.01	100	100	<0.01	100
great blue heron	1	<0.01	100	100	<0.01	100
turkey vulture	2	<0.01	100	50.0	<0.01	100
American kestrel	3	0.01	100	33.3	<0.01	33.3
prairie falcon	4	0.01	100	25.0	<0.01	75.0
Eurasian collared-dove	2	0.08	42.1	0	0	0
short-eared owl	5	0.04	83.3	0	0	0
unidentified falcon	2	<0.01	100	0	0	50.0
merlin	1	<0.01	100	0	0	0
northern harrier	60	0.26	100	0	0	14.5
ferruginous hawk	2	<0.01	100	0	0	50.0
unidentified accipiter	1	<0.01	100	0	0	0
killdeer	3	0.04	44.4	0	0	50.0
unidentified sandpiper	1	<0.01	100	0	0	0
sandhill crane	1	0.23	100	0	0	0

[a] The likely "rotor-swept height" (RSH) for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level.

Note: obs = observations.

Appendix C4. Relative exposure index and flight characteristics for small bird species during fixed-point bird use surveys at the Mountain Breeze/Panorama Wind Project from January 25 to December 22, 2017.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying within RSH based on initial obs	Exposure Index[a]	% Within RSH at anytime
unidentified bird (small)	13	0.18	78.7	0	0	0
mountain bluebird	6	0.09	79.3	0	0	0
cliff swallow	1	<0.01	100	0	0	0
barn swallow	20	0.23	95.9	0	0	0
unidentified swallow	2	<0.01	100	0	0	0
vesper sparrow	9	0.07	65.0	0	0	0
horned lark	142	2.76	70.6	0	0	0
lark sparrow	2	0.03	100	0	0	0
chestnut-collared longspur	1	0.04	30.0	0	0	0
Lapland longspur	2	0.03	33.3	0	0	0
lark bunting	44	0.84	83.3	0	0	0
grasshopper sparrow	2	0.20	8.9	0	0	0
unidentified sparrow	12	0.12	78.8	0	0	0
western kingbird	7	0.06	69.2	0	0	0
unidentified flycatcher	1	0.02	50.0	0	0	0
European starling	1	0.03	33.3	0	0	0
western meadowlark	43	0.75	34.1	0	0	0
common grackle	6	0.04	100	0	0	0
red-winged blackbird	3	0.02	100	0	0	0
unidentified blackbird	1	<0.01	100	0	0	0
loggerhead shrike	0	<0.01	0			
white-crowned sparrow	0	<0.01	0			
dickcissel	0	<0.01	0			
McCown’s longspur	0	0.03	0			
dark-eyed junco	0	<0.01	0			
Say’s phoebe	0	<0.01	0			
brown-headed cowbird	0	<0.01	0			

[a] The likely “rotor-swept height” (RSH) for potential collision with a turbine blade, or 25 to 150 meters (82 to 492 feet) above ground level.

Note: obs = observations

Appendix D. Spatial Use by Point for All Birds, Major Bird Types, and Diurnal Raptor Subtypes during Avian Use Surveys at the Mountain Breeze/Panorama Project, 2017 – 2018

Appendix D1. Mean use[a] by point for all large bird types and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25 to December 22, 2017.

	Survey Point									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Waterbirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.00**	**0**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Shorebirds	**0**	**0**	**0.25**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diurnal Raptors	**0.25**	**0.50**	**0.50**	**0.64**	**0.33**	**0.17**	**1.00**	**1.08**	**1.08**	**0.25**
Accipiters	*0.08*	*0*	*0*	*0.18*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*0*	*0.17*	*0.42*	*0.27*	*0.17*	*0*	*1.00*	*0.67*	*0.83*	*0.17*
Northern Harrier	*0*	*0.08*	*0.08*	*0.18*	*0.08*	*0.08*	*0*	*0.33*	*0*	*0*
Eagles	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Falcons	*0.17*	*0.08*	*0*	*0*	*0.08*	*0.08*	*0*	*0*	*0.08*	*0.08*
Other Raptors	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0.17*	*0*
Vultures	**0**	**0**	**0**	**0**	**0**	**0.08**	**0**	**0**	**0.33**	**0**
Upland Game Birds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Doves/Pigeons	**0**	**0.25**	**0**	**0.82**	**0.75**	**0**	**0.42**	**0**	**0.33**	**0**
Large Corvids	**0**	**0.33**	**0.08**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Goatsuckers	**0**	**0**	**0**	**0.09**	**0**	**0**	**0.25**	**0**	**0.08**	**0**
All Large Birds	**0.25**	**1.08**	**0.83**	**1.55**	**1.08**	**0.25**	**1.67**	**1.08**	**2.83**	**0.25**

[a] number of birds/60-minute survey

Appendix D1 (*continued*). Mean use[a] by point for all large bird types and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25 to December 22, 2017.

	Survey Point								
Bird Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Waterbirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Shorebirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diurnal Raptors	**0.25**	**0.08**	**0.42**	**0.50**	**1.00**	**0.58**	**0.25**	**1.08**	**1.00**
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.17*	*0*	*0.33*	*0.42*	*0.67*	*0.42*	*0.17*	*0.67*	*0.67*
Northern Harrier	*0.08*	*0.08*	*0.08*	*0.08*	*0*	*0*	*0*	*0.33*	*0.25*
Eagles	*0*	*0*	*0*	*0*	*0.08*	*0*	*0.08*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0.25*	*0*	*0*	*0*	*0.08*
Other Raptors	*0*	*0*	*0*	*0*	*0*	*0.17*	*0*	*0.08*	*0*

Appendix D1 (*continued*). Mean use[a] by point for all large bird types and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25 to December 22, 2017.

	Survey Point								
Bird Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Vultures	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Upland Game Birds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Doves/Pigeons	**0.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.08**
Large Corvids	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Goatsuckers	**1.67**	**0**	**1.75**	**0**	**0**	**0**	**0.50**	**0**	**0**
All Large Birds	**2.25**	**0.08**	**2.17**	**0.50**	**1.00**	**0.58**	**0.75**	**1.08**	**1.08**

[a.] number of birds/60-minute survey)

Appendix D1 (*continued*). Mean use[a] by point for all large bird types and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25 to December 22, 2017.

	Survey Point									
Bird Type	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Waterbirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**15.25**	**0**
Shorebirds	**0**	**0**	**0.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Diurnal Raptors	**1.00**	**0.92**	**0.83**	**0.25**	**0.67**	**0.17**	**0.58**	**1.25**	**0.75**	**1.08**
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*1.00*	*0.83*	*0.33*	*0.25*	*0.33*	*0*	*0.50*	*0.92*	*0.67*	*0.58*
Northern Harrier	*0*	*0.08*	*0.42*	*0*	*0*	*0.08*	*0*	*0.08*	*0.08*	*0.42*
Eagles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.25*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0.17*	*0.08*	*0*	*0*	*0*	*0.08*
Other Raptors	*0*	*0*	*0.08*	*0*	*0.17*	*0*	*0.08*	*0*	*0*	*0*
Vultures	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Upland Game Birds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.33**
Doves/Pigeons	**0**	**0**	**0**	**0**	**0**	**0.17**	**0.17**	**2.17**	**0**	**0**
Large Corvids	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.17**
Goatsuckers	**0**	**0**	**0.08**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All Large Birds	**1.00**	**0.92**	**1.25**	**0.25**	**0.67**	**0.33**	**0.75**	**3.42**	**16.00**	**1.58**

[a.] number of birds/60-minute survey

Appendix D2. Mean use[a] by point for all small bird types observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25, 2017 to December 22, 2017.

	Survey Point									
Bird Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Passerines	5.08	6.17	7.33	2.33	6.50	3.67	3.50	12.58	1.42	1.42
Unidentified Birds	0	0.17	0	0.08	0.17	0.50	0.08	0	0	0
All Small Birds	**5.08**	**6.33**	**7.33**	**2.42**	**6.67**	**4.17**	**3.58**	**12.58**	**1.42**	**1.42**

[a.] number of birds/10-minute survey

Appendix D2 (*continued*). Mean use[a] by point for all small bird types observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25, 2017 to December 22, 2017.

	Survey Point								
Bird Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Passerines	1.25	3.17	4.67	1.92	6.17	1.92	2.17	2.58	1.83
Unidentified Birds	0.08	0	0.08	0	0	0.08	0.17	0	0
All Small Birds	**1.33**	**3.17**	**4.75**	**1.92**	**6.17**	**2.00**	**2.33**	**2.58**	**1.83**

[a.] number of birds/10-minute survey

Appendix D2 (*continued*). Mean use[a] by point for all small bird types observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 25, 2017 to December 22, 2017.

	Survey Point									
Bird Type	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Passerines	2.17	2.92	3.42	4.08	5.17	3.08	3.00	5.25	3.17	1.67
Unidentified Birds	0	0	0	0	0.25	0.25	0	0.08	0	0.25
All Small Birds	**2.17**	**2.92**	**3.42**	**4.08**	**5.42**	**3.33**	**3.00**	**5.33**	**3.17**	**1.92**

[a.] number of birds/10-minute survey

Appendix D3. Mean use[a] by point for all large birds and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 29, 2018 to December 27, 2018.

	Survey Point										
Bird Type	**14**	**18**	**19**	**22**	**24**	**25**	**26**	**27**	**28**	**30**	**31**
Waterbirds	**0**	**0**	**0**	**0.08**	**0**	**0**	**0**	**0.17**	**0**	**0**	**0**
Waterfowl	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.17**	**0**	**0**
Shorebirds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.17**	**0**
Diurnal Raptors	**0.17**	**1.50**	**1.42**	**0.83**	**0.50**	**1.00**	**0.67**	**0.83**	**1.58**	**1.25**	**0.17**
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*
Buteos	*0*	*0.33*	*1.25*	*0.33*	*0.08*	*0.92*	*0.42*	*0.83*	*0.50*	*0.75*	*0.08*
Northern Harrier	*0.17*	*0.42*	*0.17*	*0.42*	*0.42*	*0*	*0.25*	*0*	*1.00*	*0.33*	*0*
Eagles	*0*	*0.75*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.08*	*0.08*
Falcons	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0*	*0.08*	*0*	*0*
Other Raptors	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Owls	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.50**	**0**
Vultures	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.08**	**0**	**0**	**0**
Doves/Pigeons	**0.33**	**1.25**	**2.17**	**2.25**	**0.25**	**0**	**2.33**	**2.67**	**1.83**	**1.83**	**0.58**
Goatsuckers	**0**	**0**	**0.25**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All Large Birds	**0.50**	**2.75**	**3.83**	**3.17**	**0.75**	**1.00**	**3.00**	**3.75**	**5.58**	**3.75**	**0.75**

[a.] number of birds/60-minute survey.

Appendix D3 (*continued*). Mean use[a] by point for all large birds and diurnal raptor subtypes observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 29, 2018 to December 27, 2018.

	Survey Point										
Bird Type	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**
Waterbirds	**0**	**0**	**0**	**0**	**0**	**5.83**	**0**	**0**	**0**	**0**	**0**
Waterfowl	**1.00**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Shorebirds	**0**	**0**	**0**	**0**	**0**	**0**	**0.75**	**0**	**0**	**0**	**0**
Diurnal Raptors	**1.17**	**0.92**	**1.33**	**1.00**	**2.33**	**1.17**	**1.08**	**0.50**	**1.17**	**0.50**	**0.67**
Accipiters	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Buteos	*0.92*	*0.58*	*1.25*	*0.75*	*1.92*	*0.75*	*0.83*	*0*	*0*	*0*	*0.50*
Northern Harrier	*0.17*	*0.33*	*0.08*	*0.17*	*0.33*	*0.17*	*0.17*	*0.33*	*0.50*	*0.33*	*0.17*
Eagles	*0.08*	*0*	*0*	*0.08*	*0*	*0*	*0.08*	*0*	*0.17*	*0*	*0*
Falcons	*0*	*0*	*0*	*0*	*0.08*	*0.17*	*0*	*0.17*	*0.50*	*0.17*	*0*
Other Raptors	*0*	*0*	*0*	*0*	*0*	*0.08*	*0*	*0*	*0*	*0*	*0*
Owls	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Vultures	**0**	**0**	**0**	**0**	**0**	**0.08**	**0**	**0**	**0**	**0**	**0**
Doves/Pigeons	**0.75**	**0.50**	**1.92**	**0.92**	**4.00**	**6.42**	**22.50**	**0.67**	**0.50**	**0.17**	**0.17**
Goatsuckers	**0**	**0**	**0**	**0**	**0**	**0.25**	**0**	**0**	**0**	**0**	**0**
All Large Birds	**2.92**	**1.42**	**3.25**	**1.92**	**6.33**	**13.75**	**24.33**	**1.17**	**1.67**	**0.67**	**0.83**

[a.] number of birds/60-minute survey.

Appendix D4. Mean use[a] by point for all small bird types observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 29, 2018 to December 27, 2018.

	Survey Point										
Bird Type	**14**	**18**	**19**	**22**	**24**	**25**	**26**	**27**	**28**	**30**	**31**
Passerines	3.17	3.50	2.50	3.58	8.50	4.17	2.42	6.33	2.50	4.25	3.67
Unidentified Birds	0.17	0.08	0.08	0.17	0.08	0.08	0	0.17	0	0.08	0
All Small Birds	**3.33**	**3.58**	**2.58**	**3.75**	**8.58**	**4.25**	**2.42**	**6.50**	**2.50**	**4.33**	**3.67**

[a.] number of birds/10-minute survey.

Appendix D4 (*continued*). Mean use[a] by point for all small bird types observed at the Mountain Breeze/Panorama Wind Project during fixed-point bird use surveys from January 29, 2018 to December 27, 2018.

	Survey Point										
Bird Type	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**
Passerines	4.17	2.58	8.17	5.83	8.50	2.83	5.25	13.50	30.17	0.50	13.67
Unidentified Birds	0	0.83	0.08	0.17	0.58	0	1.08	0	0.67	0	0
All Small Birds	**4.17**	**3.42**	**8.25**	**6.00**	**9.08**	**2.83**	**6.33**	**13.50**	**30.83**	**0.50**	**13.67**

[a.] number of birds/10-minute survey

Appendix E. North American Fatality Summary Tables

Appendix E1. Wind energy facilities in North America with comparable fatality data for birds, by geographic region. Fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bird Fatality Estimate	No. of Turbines	Total MW
	Midwest		
Wessington Springs, SD (2009)	8.25	34	51
Blue Sky Green Field, WI (2008; 2009)	7.17	88	145
Cedar Ridge, WI (2009)	6.55	41	67.6
Waverly Wind, KS (2016-2017)	5.95	95	199
Buffalo Ridge, MN (Phase III; 1999)	5.93	138	103.5
Moraine II, MN (2009)	5.59	33	49.5
Barton I & II, IA (2010-2011)	5.5	80	160
Buffalo Ridge I, SD (2009-2010)	5.06	24	50.4
Odell, MN (2016-2017)	4.69	100	200
Buffalo Ridge, MN (Phase I; 1996)	4.14	73	25
Winnebago, IA (2009-2010)	3.88	10	20
Rugby, ND (2010-2011)	3.82	71	149
Cedar Ridge, WI (2010)	3.72	41	68
Elm Creek II, MN (2011-2012)	3.64	62	148.8
Buffalo Ridge, MN (Phase II; 1999)	3.57	143	107.25
Buffalo Ridge, MN (Phase I; 1998)	3.14	73	25
Ripley, ON (2008)	3.09	38	76
Fowler I, IN (2009)	2.83	162	301
Lakefield Wind, MN (2012)	2.75	137	205.5
Buffalo Ridge, MN (Phase I; 1997)	2.51	73	25
Buffalo Ridge, MN (Phase II; 1998)	2.47	143	107.25
Heritage Garden, MI (2013-2014)	2.4	14	28
PrairieWinds SD1, SD (2012-2013)	2.01	108	162
Buffalo Ridge II, SD (2011-2012)	1.99	105	210
Kewaunee County, WI (1999-2001)	1.95	31	20.46
PrairieWinds SD1, SD (2013-2014)	1.66	108	162
NPPD Ainsworth, NE (2006)	1.63	36	20.5
PrairieWinds ND1 (Minot), ND (2011)	1.56	80	115.5
Elm Creek, MN (2009-2010)	1.55	67	100
Thunder Spirit, ND (2016-2017)	1.49	43	108
PrairieWinds ND1 (Minot), ND (2010)	1.48	80	115.5
Buffalo Ridge, MN (Phase I; 1999)	1.43	73	25
PrairieWinds SD1, SD (2011-2012)	1.41	108	162
Top Crop I & II, IL (2012-2013)	1.35	68 (Phase I) 132 (Phase II)	300 (102 Phase I, 198 Phase II)
Heritage Garden, MI (2012-2013)	1.3	14	28
Prince Wind Farm, ON (2008)	0.89	126	189
Wessington Springs, SD (2010)	0.89	34	51
Rail Splitter, IL (2012-2013)	0.84	67	100.5
Top of Iowa, IA (2004)	0.81	89	80
Pleasant Valley, MN (2016-2017)	0.68	100	200
Big Blue, MN (2013)	0.6	18	36
Grand Ridge I, IL (2009-2010)	0.48	66	99
Prairie Rose, MN (2014)	0.44	119	200
Top of Iowa, IA (2003)	0.42	89	80
Big Blue, MN (2014)	0.37	18	36
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	62	102.3
Prince Wind Farm, ON (2007)	0.26	126	189
	Rocky Mountains		
Foote Creek Rim I, WY (1999)	3.4	69	41.4

Appendix E1. Wind energy facilities in North America with comparable fatality data for birds, by geographic region. Fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bird Fatality Estimate	No. of Turbines	Total MW
Foote Creek Rim I, WY (2000)	2.42	69	41.4
Foote Creek Rim, WY (UV; 1999-2000)	2.3	105	67.95
Foote Creek Rim I, WY (2001-2002)	1.93	69	41.4
Summerview, AB (2005-2006)	1.06	39	70.2
Top of the World, WY (2011-2012)	0.77	110	200
Milford I & II, UT (2011-2012)	0.73	107	160.5 (58.5 Phase I, 102 Phase II)
Top of the World, WY (2010-2011)	0.69	110	200
Milford I, UT (2010-2011)	0.56	58	145
Top of the World, WY (2012-2013)	0.3	110	200
Southern Plains			
Buffalo Gap I, TX (2006)	1.32	67	134
Barton Chapel, TX (2009-2010)	1.15	60	120
Buffalo Gap II, TX (2007-2008)	0.15	155	233
Big Smile, OK (2012-2013)	0.09	66	132
Red Hills, OK (2012-2013)	0.08	82	123
Northeast			
Bull Hill, ME (2013)	8.65	19	34
Stetson Mountain I, ME (2013)	6.95	38	57
Criterion, MD (2011)	6.4	28	70
Steel Winds I & II, NY (2013)	6.2	14	35
Spruce Mountain Wind Project, ME (2014)	5.03	10	20
Mount Storm, WV (2011)	4.24	132	264
Oakfield, ME (2017)	4.23	48	148
Pinnacle, WV (2012)	3.99	23	55.2
Mount Storm, WV (2009)	3.85	132	264
Record Hill, ME (2012)	3.7	22	50.6
Criterion, MD (2013)	3.49	28	70
Bingham Wind Project, ME (2017)	3.46	56	185
Rollins, ME (2014)	3.43	40	60
Lempster, NH (2009)	3.38	12	24
Stetson Mountain II, ME (2012)	3.37	17	25.5
Stetson II, ME (2014)	3.25	17	26
Roth Rock, MD (2011)	3.12	20	50
Laurel Mountain, WV (2014)	3.1	61	98
Rollins, ME (2012)	2.9	40	60
Casselman, PA (2009)	2.88	23	34.5
Record Hill, ME (2016)	2.85	22	51
Mountaineer, WV (2003)	2.69	44	66
Stetson Mountain I, ME (2009)	2.68	38	57
Noble Ellenburg, NY (2009)	2.66	54	80
Lempster, NH (2010)	2.64	12	24
Mount Storm, WV (2010)	2.6	132	264
Groton, NH (2013)	2.45	24	48
Maple Ridge, NY (2007)	2.34	195	321.75
Noble Bliss, NY (2009)	2.28	67	100
Criterion, MD (2012)	2.14	28	70
Maple Ridge, NY (2007-2008)	2.07	195	321.75
Passadumkeag, ME (2016)	1.91	13	43
Record Hill, ME (2014)	1.84	22	50.6
Noble Altona, NY (2010)	1.84	65	97.5

Appendix E1. Wind energy facilities in North America with comparable fatality data for birds, by geographic region. Fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bird Fatality Estimate	No. of Turbines	Total MW
High Sheldon, NY (2010)	1.76	75	112.5
Mars Hill, ME (2008)	1.76	28	42
Noble Wethersfield, NY (2010)	1.7	84	126
Mars Hill, ME (2007)	1.67	28	42
Noble Chateaugay, NY (2010)	1.66	71	106.5
Noble Clinton, NY (2008)	1.59	67	100
Cohocton/Dutch Hill, NY (2013)	1.58	50	125
High Sheldon, NY (2011)	1.57	75	112.5
Hancock, ME (2017)	1.52	17	51
Casselman, PA (2008)	1.51	23	34.5
Groton, NH (2014)	1.5	24	48
Beech Ridge, WV (2013)	1.48	67	100.5
Munnsville, NY (2008)	1.48	23	34.5
Stetson Mountain II, ME (2010)	1.42	17	25.5
Cohocton/Dutch Hill, NY (2009)	1.39	50	125
Cohocton/Dutch Hills, NY (2010)	1.32	50	125
Noble Bliss, NY (2008)	1.3	67	100
Howard, NY (2012)	1.29	27	54
Beech Ridge, WV (2012)	1.19	67	100.5
Stetson Mountain I, ME (2011)	1.18	38	57
Noble Clinton, NY (2009)	1.11	67	100
Groton, NH (2015)	0.98	24	48
Locust Ridge, PA (Phase II; 2009)	0.84	51	102
Noble Ellenburg, NY (2008)	0.83	54	80
Locust Ridge, PA (Phase II; 2010)	0.76	51	102
Howard, NY (2013)	0.37	27	54
Southeast			
Buffalo Mountain, TN (2000-2003)	11.02	3	1.98
Buffalo Mountain, TN (2005)	1.1	18	28.98
Southwest			
Dry Lake I, AZ (2009-2010)	2.02	30	63
Dry Lake II, AZ (2011-2012)	1.57	31	65
Spring Valley, NV (2012-2013)	0.26	66	152
California			
Pine Tree, CA (2009-2010, 2011)	17.44	90	135
Alta I, CA (2013-2014)	12.05	290	720
Montezuma I, CA (2012)	8.91	16	36.8
Alta Wind I, CA (2011-2012)	7.07	100	150
Shiloh I, CA (2006-2009)	6.96	100	150
Windstar, CA (2012-2013)	6.65	53	106
Montezuma I, CA (2011)	5.19	16	36.8
Alta X, CA (2014-2015)	4.88	48	137
Dillon, CA (2008-2009)	4.71	45	45
Diablo Winds, CA (2005-2007)	4.29	31	20.46
Lower West, CA (2012-2013)	3.5	7	14
Shiloh III, CA (2012-2013)	3.3	50	102.5
Rising Tree, CA (2015-2016)	3.13	60	198
Shiloh II, CA (2010-2011)	2.8	75	150
Shiloh II, CA (2011-2012)	2.8	75	150
Alta II-V, CA (2013-2014)	2.79	290	720
Alta I, CA (2015-2016)	2.57	290	720

Appendix E1. Wind energy facilities in North America with comparable fatality data for birds, by geographic region. Fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bird Fatality Estimate	No. of Turbines	Total MW
Hatchet Ridge, CA (2011)	2.5	44	101
Alta X, CA (2015-2016)	2.17	48	137
Shiloh II, CA (2009-2010)	1.9	75	150
Mustang Hills, CA (2012-2013)	1.66	50	150
Alta Wind II-V, CA (2011-2012)	1.66	190	570
Rising Tree, CA (2017-2018)	1.63	60	198
High Winds, CA (2003-2004)	1.62	90	162
Solano III, CA (2012-2013)	1.6	55	128
Hatchet Ridge, CA (2012-2013)	1.22	44	NA
Pinyon Pines I & II, CA (2013-2014)	1.18	100	NA
High Winds, CA (2004-2005)	1.1	90	162
Montezuma II, CA (2012-2013)	1.08	34	78.2
Mustang Hills, CA (2014-2015)	0.97	100	300
Lower West, CA (2014-2015)	0.9	7	14
Hatchet Ridge, CA (2012)	0.83	44	101
Pacific Wind, CA (2015-2016)	0.77	70	144
Lower West, CA (2016-2017)	0.73	7	14
Alta VIII, CA (2012-2013)	0.66	50	150
Cameron Ridge/Section 15, CA (2015-2016)	0.57	34	102
Pinyon Pines I & II, CA (2017-2018)	0.56	100	300
Alite, CA (2009-2010)	0.55	8	24
Mustang Hills, CA (2016-2017)	0.54	100	300
Alta II-V, CA (2015-2016)	0.51	290	720
Pinyon Pines I & II, CA (2015-2016)	0.5	100	300
Cameron Ridge/Section 15, CA (2014-2015)	0.45	34	102
Alta VIII, CA (2014-2015)	0.38	100	300
Alta VIII, CA (2016-2017)	0.25	100	300
Pacific Wind, CA (2014-2015)	0.17	70	144
Pacific Northwest			
Windy Flats, WA (2010-2011)	8.45	114	262.2
Leaning Juniper, OR (2006-2008)	6.66	67	100.5
Linden Ranch, WA (2010-2011)	6.65	25	50
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	65	150
White Creek, WA (2007-2011)	4.05	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	3.2	62	136.6
Stateline, OR/WA (2001-2002)	3.17	454	299
Klondike II, OR (2005-2006)	3.14	50	75
Klondike III (Phase I), OR (2007-2009)	3.02	125	223.6
Hopkins Ridge, WA (2008)	2.99	87	156.6
Harvest Wind, WA (2010-2012)	2.94	43	98.9
Nine Canyon, WA (2002-2003)	2.76	37	48.1
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	65	150
Stateline, OR/WA (2003)	2.68	454	299
Klondike IIIa (Phase II), OR (2008-2010)	2.61	51	76.5
Combine Hills, OR (Phase I; 2004-2005)	2.56	41	41
Big Horn, WA (2006-2007)	2.54	133	199.5
Biglow Canyon, OR (Phase I; 2009)	2.47	76	125.4
Combine Hills, OR (2011)	2.33	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	76	174.8
Hay Canyon, OR (2009-2010)	2.21	48	100.8
Elkhorn, OR (2010)	1.95	61	101

Appendix E1. Wind energy facilities in North America with comparable fatality data for birds, by geographic region. Fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Bird Fatality Estimate	No. of Turbines	Total MW
Pebble Springs, OR (2009-2010)	1.93	47	98.7
Biglow Canyon, OR (Phase I; 2008)	1.76	76	125.4
Wild Horse, WA (2007)	1.55	127	229
Tucannon River, WA (2015)	1.5	116	267
Goodnoe, WA (2009-2010)	1.4	47	94
Vantage, WA (2010-2011)	1.27	60	90
Hopkins Ridge, WA (2006)	1.23	83	150
Stateline, OR/WA (2006)	1.23	454	299
Kittitas Valley, WA (2011-2012)	1.06	48	100.8
Klondike, OR (2002-2003)	0.95	16	24
Vansycle, OR (1999)	0.95	38	24.9
Palouse Wind, WA (2012-2013)	0.72	58	104.4
Elkhorn, OR (2008)	0.64	61	101
Marengo I, WA (2009-2010)	0.27	78	140.4
Marengo II, WA (2009-2010)	0.16	39	70.2

Appendix E1. (*continued*). Wind energy facilities in North America with comparable activity and fatality data for birds. Data from the following sources:

Study	Fatality Reference	Study	Fatality Reference
Mountain Breeze/Panorama, CO	**This Study**		
Alite, CA (2009-2010)	Chatfield et al. 2010a	Lower West, CA (2016-2017)	WEST 2017b
Alta I, CA (2013-2014)	Chatfield et al. 2014	Maple Ridge, NY (2007)	Jain et al. 2009a
Alta I, CA (2015-2016)	Thompson et al. 2016a	Maple Ridge, NY (2007-2008)	Jain et al. 2009b
Alta II-V, CA (2013-2014)	Chatfield et al. 2014	Marengo I, WA (2009-2010)	URS 2010b
Alta II-V, CA (2015-2016)	Thompson et al. 2016a	Marengo II, WA (2009-2010)	URS 2010c
Alta VIII, CA (2012-2013)	Chatfield and Bay 2014	Mars Hill, ME (2007)	Stantec 2008
Alta VIII, CA (2014-2015)	WEST 2016c	Mars Hill, ME (2008)	Stantec 2009a
Alta VIII, CA (2016-2017)	WEST 2018	Milford I, UT (2010-2011)	Stantec 2011b
Alta X, CA (2014-2015)	Chatfield et al. 2015	Milford I & II, UT (2011-2012)	Stantec 2012
Alta X, CA (2015-2016)	Thompson et al. 2016b	Montezuma I, CA (2011)	ICF International 2012
Alta Wind I, CA (2011-2012)	Chatfield et al. 2012	Montezuma I, CA (2012)	ICF International 2013
Alta Wind II-V, CA (2011-2012)	Chatfield et al. 2012	Montezuma II, CA (2012-2013)	Harvey & Associates 2013
Barton I & II, IA (2010-2011)	Derby et al. 2011b	Moraine II, MN (2009)	Derby et al. 2010g
Barton Chapel, TX (2009-2010)	WEST 2011	Mount Storm, WV (2009)	Young et al. 2009a, 2010b
Beech Ridge, WV (2012)	Tidhar et al. 2013a	Mount Storm, WV (2010)	Young et al. 2010a, 2011b
Beech Ridge, WV (2013)	Young et al. 2014a	Mount Storm, WV (2011)	Young et al. 2011a, 2012a
Big Blue, MN (2013)	Fagen Engineering 2014	Mountaineer, WV (2003)	Kerns and Kerlinger 2004
Big Blue, MN (2014)	Fagen Engineering 2015	Munnsville, NY (2008)	Stantec 2009b
Big Horn, WA (2006-2007)	Kronner et al. 2008	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014
Big Smile, OK (2012-2013)	Derby et al. 2013b	Mustang Hills, CA (2014-2015)	WEST 2016c
Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009b	Mustang Hills, CA (2016-2017)	WEST 2018
Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010	Nine Canyon, WA (2002-2003)	Erickson et al. 2003a
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011b	Noble Altona, NY (2010)	Jain et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b	Noble Bliss, NY (2008)	Jain et al.2009c
Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Noble Bliss, NY (2009)	Jain et al. 2010c
Bingham Wind Project, ME (2017)	TRC 2017a	Noble Chateaugay, NY (2010)	Jain et al. 2011b
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Noble Clinton, NY (2008)	Jain et al. 2009d
Buffalo Gap I, TX (2006)	Tierney 2007	Noble Clinton, NY (2009)	Jain et al. 2010a
Buffalo Gap II, TX (2007-2008)	Tierney 2009	Noble Ellenburg, NY (2008)	Jain et al. 2009e
Buffalo Mountain, TN (2000-2003)	Nicholson et al. 2005	Noble Ellenburg, NY (2009)	Jain et al. 2010b
Buffalo Mountain, TN (2005)	Fiedler et al. 2007	Noble Wethersfield, NY (2010)	Jain et al. 2011c
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a	Oakfield, ME (2017)	TRC 2018
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a	Odell, MN (2016-2017)	Chodachek and Gustafson 2018
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a	Pacific Wind, CA (2014-2015)	WEST 2016a
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a	Pacific Wind, CA (2015-2016)	WEST 2017a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a	Palouse Wind, WA (2012-2013)	Stantec 2013a

Appendix E1. (*continued*). Wind energy facilities in North America with comparable activity and fatality data for birds. Data from the following sources:

Study	Fatality Reference	Study	Fatality Reference
Mountain Breeze/Panorama, CO	**This Study**		
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a	Passadumkeag, ME (2016)	Ritzert et al. 2017
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010e	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Pine Tree, CA (2009-2010, 2011)	BioResource Consultants 2012
Bull Hill, ME (2013)	Stantec Consulting (Stantec) 2014a	Pinnacle, WV (2012)	Hein et al. 2013
Cameron Ridge/Section 15, CA (2014-2015)	WEST 2016b	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Cameron Ridge/Section 15, CA (2015-2016)	Rintz and Thompson 2017	Pinyon Pines I & II, CA (2015-2016)	Rintz and Starcevich 2016
Casselman, PA (2008)	Arnett et al. 2009	Pinyon Pines I & II, CA (2017-2018)	Rintz and Pham 2018
Casselman, PA (2009)	Arnett et al. 2010	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Cedar Ridge, WI (2009)	BHE Environ-mental 2010	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Cedar Ridge, WI (2010)	BHE Environ-mental 2011	Prairie Rose, MN (2014)	Chodachek et al. 2015
Cohocton/Dutch Hill, NY (2009)	Stantec 2010	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d
Cohocton/Dutch Hill, NY (2013)	Stantec 2014b	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
Cohocton/Dutch Hills, NY (2010)	Stantec 2011a	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Combine Hills, OR (2011)	Enz et al. 2012	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Criterion, MD (2011)	Young et al. 2012b	Prince Wind Farm, ON (2007)	NRSI 2008
Criterion, MD (2012)	Young et al. 2013	Prince Wind Farm, ON (2008)	NRSI 2009
Criterion, MD (2013)	Young et al. 2014b	Rail Splitter, IL (2012-2013)	Good et al. 2013a
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Record Hill, ME (2012)	Stantec 2013b
Dillon, CA (2008-2009)	Chatfield et al. 2009	Record Hill, ME (2014)	Stantec 2015b
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Record Hill, ME (2016)	Stantec 2017
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Red Hills, OK (2012-2013)	Derby et al. 2013c
Elkhorn, OR (2008)	Jeffrey et a. 2009a	Ripley, ON (2008)	Jacques Whitford 2009
Elkhorn, OR (2010)	Enk et al. 2011a	Rising Tree, CA (2015-2016)	Rintz et al. 2016
Elm Creek, MN (2009-2010)	Derby et al. 2010f	Rising Tree, CA (2017-2018)	Chatfield et al. 2018
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Rollins, ME (2012)	Stantec 2013c
Foote Creek Rim I, WY (1999)	Young et al. 2003a	Rollins, ME (2014)	Stantec 2015c
Foote Creek Rim I, WY (2000)	Young et al. 2003a	Roth Rock, MD (2011)	Atwell, LLC 2012
Foote Creek Rim I, WY (2001-2002)	Young et al. 2003a	Rugby, ND (2010-2011)	Derby et al. 2011c
Foote Creek Rim I, WY (UV; 1999-2000)	Young et al. 2003b	Shiloh I, CA (2006-2009)	Kerlinger et al. 2009
Fowler I, IN (2009)	Johnson et al. 2010	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010
Goodnoe, WA (2009-2010)	URS Corporation (URS) 2010a	Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a
Grand Ridge I, IL (2009-2010)	Derby et al. 2010a	Shiloh II, CA (2011-2012)	Kerlinger et al. 2013a
Groton, NH (2013)	Stantec and WEST 2014	Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b
Groton, NH (2014)	Stantec and WEST 2015a	Solano III, CA (2012-2013)	AECOM 2013
Groton, NH (2015)	Stantec and WEST 2015b	Spring Valley, NV (2012-2013)	WEST 2014
Hancock, ME (2017)	TRC 2017b	Spruce Mountain, ME (2012)	Tetra Tech 2013b
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Stateline, OR/WA (2001-2002)	Erickson et al. 2004

Appendix E1. (*continued*). Wind energy facilities in North America with comparable activity and fatality data for birds. Data from the following sources:

Study	Fatality Reference	Study	Fatality Reference
Mountain Breeze/Panorama, CO	**This Study**		
Hatchet Ridge, CA (2011)	Tetra Tech 2013a	Stateline, OR/WA (2003)	Erickson et al. 2004
Hatchet Ridge, CA (2012)	Tetra Tech 2013a	Stateline, OR/WA (2006)	Erickson et al. 2007
Hatchet Ridge, CA (2012-2013)	Tetra Tech 2014	Steel Winds I & II, NY (2013)	Stantec 2014c
Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a	Stetson II, ME (2014)	Stantec 2015d
Heritage Garden, MI (2012-2013)	Kerlinger et al. 2014	Stetson Mountain I, ME (2009)	Stantec 2009c
Heritage Garden, MI (2013-2014)	Kerlinger et al. 2014	Stetson Mountain I, ME (2011)	Normandeau Associates 2011
High Sheldon, NY (2010)	Tidhar et al. 2012a	Stetson Mountain I, ME (2013)	Stantec 2014d
High Sheldon, NY (2011)	Tidhar et al. 2012b	Stetson Mountain II, ME (2010)	Normandeau Associates 2010
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Stetson Mountain II, ME (2012)	Stantec 2013d
High Winds, CA (2004-2005)	Kerlinger et al. 2006	Summerview, AB (2005-2006)	Brown and Hamilton 2006
Hopkins Ridge, WA (2006)	Young et al. 2007b	Thunder Spirit, ND (2016-2017)	Baerwald 2008
Hopkins Ridge, WA (2008)	Young et al. 2009b	Top Crop I & II, IL (2012-2013)	Good et al. 2013b
Howard, NY (2012)	Tidhar et al. 2013b	Top of Iowa, IA (2003)	Jain 2005
Howard, NY (2013)	Lukins et al. 2014	Top of Iowa, IA (2004)	Jain 2005
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Top of the World, WY (2010-2011)	Rintz and Bay 2012
Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012	Top of the World, WY (2011-2012)	Rintz and Bay 2013
Klondike, OR (2002-2003)	Johnson et al. 2003	Top of the World, WY (2012-2013)	Rintz and Bay 2014
Klondike II, OR (2005-2006)	Northwest Wildlife Consultants (NWC) and WEST 2007	Tucannon River, WA (2015)	Hallingstad et al. 2016
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010
Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Vansycle, OR (1999)	Erickson et al. 2000
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012
Laurel Mountain, WV (2014)	Stantec 2015a	Waverly Wind, KS (2016-2017)	Tetra Tech 2017a
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Wessington Springs, SD (2009)	Derby et al. 2010d
Lempster, NH (2009)	Tidhar et al. 2010	Wessington Springs, SD (2010)	Derby et al. 2011a
Lempster, NH (2010)	Tidhar et al. 2011	White Creek, WA (2007-2011)	Downes and Gritski 2012b
Linden Ranch, WA (2010-2011)	Enz and Bay 2011	Wild Horse, WA (2007)	Erickson et al. 2008
Locust Ridge, PA (Phase II; 2009)	Arnett et al. 2011	Windstar, CA (2012-2013)	Levenstein and Bay 2013b
Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011	Windy Flats, WA (2010-2011)	Enz et al. 2011
Lower West, CA (2012-2013)	Levenstein and Bay 2013a	Winnebago, IA (2009-2010)	Derby et al. 2010a
Lower West, CA (2014-2015)	Levenstein and DiDonato 2015		

Appendix E2. Wind energy facilities in North America with comparable use and fatality data for diurnal raptors, by geographic region. Use estimate presented as number of raptor observations per 800-meter plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Mountain Breeze/Panorama, CO 2017	**0.20**			
Mountain Breeze/Panorama, CO 2018	**0.31**			
	Midwest			
Buffalo Ridge, MN (Phase I; 1999)	NA	0.47	73	25
Moraine II, MN (2009)	NA	0.37	33	49.5
Winnebago, IA (2009-2010)	NA	0.27	10	20
Buffalo Ridge I, SD (2009-2010)	NA	0.2	24	50.4
Thunder Spirit, ND (2016-2017)	NA	0.18	43	108
Cedar Ridge, WI (2009)	NA	0.18	41	67.6
PrairieWinds SD1, SD (2013-2014)	NA	0.17	108	162
Top of Iowa, IA (2004)	NA	0.17	89	80
Cedar Ridge, WI (2010)	NA	0.13	41	68
Ripley, ON (2008)	NA	0.1	38	76
Prairie Rose, MN (2014)	NA	0.08	119	200
Wessington Springs, SD (2010)	0.232	0.07	34	51
Rugby, ND (2010-2011)	NA	0.06	71	149
NPPD Ainsworth, NE (2006)	NA	0.06	36	20.5
Wessington Springs, SD (2009)	0.232	0.06	34	51
PrairieWinds ND1 (Minot), ND (2010)	NA	0.05	80	115.5
PrairieWinds ND1 (Minot), ND (2011)	NA	0.05	80	115.5
PrairieWinds SD1, SD (2012-2013)	NA	0.03	108	162
Elm Creek, MN (2009-2010)	NA	0	67	100
Rail Splitter, IL (2012-2013)	NA	0	67	100.5
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	0	62	102.3
Buffalo Ridge, MN (Phase III; 1999)	NA	0	138	103.5
Buffalo Ridge, MN (Phase II; 1998)	NA	0	143	107.25
Buffalo Ridge, MN (Phase II; 1999)	NA	0	143	107.25
Blue Sky Green Field, WI (2008; 2009)	NA	0	88	145
Elm Creek II, MN (2011-2012)	NA	0	62	148.8
Barton I & II, IA (2010-2011)	NA	0	80	160
PrairieWinds SD1, SD (2011-2012)	NA	0	108	162
Kewaunee County, WI (1999-2001)	NA	0	31	20.46
Lakefield Wind, MN (2012)	NA	0	137	205.5
Buffalo Ridge II, SD (2011-2012)	NA	0	105	210
Buffalo Ridge, MN (Phase I; 1996)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1997)	NA	0	73	25
Buffalo Ridge, MN (Phase I; 1998)	NA	0	73	25
Fowler I, IN (2009)	NA	0	162	301
Big Blue, MN (2013)	NA	0	18	36
Big Blue, MN (2014)	NA	0	18	36
Top of Iowa, IA (2003)	NA	0	89	80
Grand Ridge I, IL (2009-2010)	0.195	0	66	99

Appendix E2. Wind energy facilities in North America with comparable use and fatality data for diurnal raptors, by geographic region. Use estimate presented as number of raptor observations per 800-meter plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Rocky Mountains				
Summerview, AB (2005-2006)	NA	0.11	39	70.2
Foote Creek Rim I, WY (1999)	0.554	0.08	69	41.4
Foote Creek Rim, WY (UV; 1999-2000)	0.554	0.06	105	67.95
Top of the World, WY (2012-2013)	NA	0.05	110	200
Foote Creek Rim I, WY (2000)	0.554	0.05	69	41.4
Milford I & II, UT (2011-2012)	NA	0.04	107	160.5 (58.5 Phase I, 102 Phase II)
Top of the World, WY (2010-2011)	NA	0.04	110	200
Top of the World, WY (2011-2012)	NA	0.04	110	200
Foote Creek Rim I, WY (2001-2002)	0.554	0	69	41.4
Southern Plains				
Barton Chapel, TX (2009-2010)	NA	0.25	60	120
Buffalo Gap I, TX (2006)	NA	0.1	67	134
Red Hills, OK (2012-2013)	NA	0.04	82	123
Big Smile, OK (2012-2013)	NA	0	66	132
Buffalo Gap II, TX (2007-2008)	NA	0	155	233
Northeast				
Steel Winds I & II, NY (2013)	NA	0.83	14	35
Munnsville, NY (2008)	NA	0.59	23	34.5
Noble Ellenburg, NY (2009)	NA	0.25	54	80
Groton, NH (2015)	NA	0.22	24	48
Noble Clinton, NY (2009)	NA	0.16	67	100
Noble Wethersfield, NY (2010)	NA	0.13	84	126
Noble Bliss, NY (2009)	NA	0.12	67	100
Noble Ellenburg, NY (2008)	NA	0.11	54	80
Noble Bliss, NY (2008)	NA	0.1	67	100
Noble Clinton, NY (2008)	NA	0.1	67	100
Mount Storm, WV (2010)	NA	0.1	132	264
Noble Chateaugay, NY (2010)	NA	0.08	71	106.5
Cohocton/Dutch Hills, NY (2010)	NA	0.08	50	125
Mountaineer, WV (2003)	NA	0.07	44	66
High Sheldon, NY (2010)	NA	0.06	75	112.5
Groton, NH (2013)	NA	0.06	24	48
Mount Storm, WV (2011)	NA	0.03	132	264
Maple Ridge, NY (2007-2008)	NA	0.03	195	321.75
Criterion, MD (2011)	NA	0.02	28	70
Beech Ridge, WV (2012)	NA	0.01	67	100.5
Beech Ridge, WV (2013)	NA	0.01	67	100.5
Locust Ridge, PA (Phase II; 2009)	NA	0	51	102
Locust Ridge, PA (Phase II; 2010)	NA	0	51	102
High Sheldon, NY (2011)	NA	0	75	112.5
Cohocton/Dutch Hill, NY (2009)	NA	0	50	125
Lempster, NH (2009)	NA	0	12	24
Lempster, NH (2010)	NA	0	12	24
Stetson Mountain II, ME (2010)	NA	0	17	25.5
Stetson Mountain II, ME (2012)	NA	0	17	25.5
Mount Storm, WV (2009)	NA	0	132	264

Appendix E2. Wind energy facilities in North America with comparable use and fatality data for diurnal raptors, by geographic region. Use estimate presented as number of raptor observations per 800-meter plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Bull Hill, ME (2013)	NA	0	19	34
Casselman, PA (2008)	NA	0	23	34.5
Casselman, PA (2009)	NA	0	23	34.5
Mars Hill, ME (2007)	NA	0	28	42
Mars Hill, ME (2008)	NA	0	28	42
Groton, NH (2014)	NA	0	24	48
Pinnacle, WV (2012)	NA	0	23	55.2
Stetson Mountain I, ME (2009)	NA	0	38	57
Stetson Mountain I, ME (2011)	NA	0	38	57
Stetson Mountain I, ME (2013)	NA	0	38	57
Noble Altona, NY (2010)	NA	0	65	97.5
Southeast				
Buffalo Mountain, TN (2000-2003)	NA	0	3	1.98
Buffalo Mountain, TN (2005)	NA	0	18	28.98
Southwest				
Spring Valley, NV (2012-2013)	NA	0.05	66	152
Dry Lake I, AZ (2009-2010)	0.13	0	30	63
Dry Lake II, AZ (2011-2012)	NA	0	31	65
California				
Montezuma I, CA (2011)	NA	1.06	16	36.8
Shiloh II, CA (2011-2012)	NA	0.97	75	150
Solano III, CA (2012-2013)	NA	0.95	55	128
Montezuma I, CA (2012)	NA	0.79	16	36.8
High Winds, CA (2003-2004)	2.337	0.5	90	162
Montezuma II, CA (2012-2013)	NA	0.46	34	78.2
Shiloh II, CA (2010-2011)	NA	0.44	75	150
Shiloh I, CA (2006-2009)	NA	0.42	100	150
Diablo Winds, CA (2005-2007)	2.161	0.4	31	20.46
High Winds, CA (2004-2005)	2.337	0.28	90	162
Alta Wind I, CA (2011-2012)	0.19	0.27	100	150
Windstar, CA (2012-2013)	NA	0.18	53	106
Mustang Hills, CA (2016-2017)	NA	0.15	100	300
Alta I, CA (2013-2014)	NA	0.15	290	720
Alta I, CA (2015-2016)	NA	0.15	290	720
Rising Tree, CA (2017-2018)	NA	0.14	60	198
Alite, CA (2009-2010)	NA	0.12	8	24
Shiloh II, CA (2009-2010)	NA	0.11	75	150
Mustang Hills, CA (2012-2013)	NA	0.08	50	150
Pacific Wind, CA (2015-2016)	NA	0.07	70	144
Rising Tree, CA (2015-2016)	NA	0.06	60	198
Alta Wind II-V, CA (2011-2012)	0.04	0.05	190	570
Cameron Ridge/Section 15, CA (2014-2015)	NA	0.04	34	102
Alta X, CA (2014-2015)	NA	0.04	48	137
Alta VIII, CA (2014-2015)	NA	0.04	100	300
Hatchet Ridge, CA (2011)	NA	0.03	44	101
Mustang Hills, CA (2014-2015)	NA	0.03	100	300
Alta VIII, CA (2012-2013)	NA	0.02	50	150
Pinyon Pines I & II, CA (2015-2016)	NA	0.02	100	300
Pinyon Pines I & II, CA (2017-2018)	NA	0.01	100	300

Appendix E2. Wind energy facilities in North America with comparable use and fatality data for diurnal raptors, by geographic region. Use estimate presented as number of raptor observations per 800-meter plot per 20-minute survey. Raptor fatality estimate is number of fatalities per megawatt (MW) per year.

Wind Energy Facility	Use Estimate	Raptor Fatality Estimate	No. of Turbines	Total MW
Cameron Ridge/Section 15, CA (2015-2016)	NA	0	34	102
Alta X, CA (2015-2016)	NA	0	48	137
Lower West, CA (2012-2013)	NA	0	7	14
Lower West, CA (2014-2015)	NA	0	7	14
Lower West, CA (2016-2017)	NA	0	7	14
Dillon, CA (2008-2009)	NA	0	45	45
Alta II-V, CA (2013-2014)	NA	0	290	720
Alta II-V, CA (2015-2016)	NA	0	290	720
Pinyon Pines I & II, CA (2013-2014)	NA	0	100	NA
Hatchet Ridge, CA (2012-2013)	NA	0	44	NA
Pacific Northwest				
White Creek, WA (2007-2011)	NA	0.47	89	204.7
Tuolumne (Windy Point I), WA (2009-2010)	0.77	0.29	62	136.6
Vantage, WA (2010-2011)	NA	0.29	60	90
Linden Ranch, WA (2010-2011)	NA	0.27	25	50
Harvest Wind, WA (2010-2012)	NA	0.23	43	98.9
Goodnoe, WA (2009-2010)	NA	0.17	47	94
Leaning Juniper, OR (2006-2008)	0.522	0.16	67	100.5
Tucannon River, WA (2015)	NA	0.16	116	267
Klondike III (Phase I), OR (2007-2009)	NA	0.15	125	223.6
Hopkins Ridge, WA (2006)	0.698	0.14	83	150
Biglow Canyon, OR (Phase II; 2009-2010)	0.318	0.14	65	150
Big Horn, WA (2006-2007)	0.511	0.11	133	199.5
Stateline, OR/WA (2006)	0.478	0.11	454	299
Kittitas Valley, WA (2011-2012)	NA	0.09	48	100.8
Wild Horse, WA (2007)	0.291	0.09	127	229
Stateline, OR/WA (2001-2002)	0.478	0.09	454	299
Stateline, OR/WA (2003)	0.478	0.09	454	299
Elkhorn, OR (2010)	1.07	0.08	61	101
Hopkins Ridge, WA (2008)	0.698	0.07	87	156.6
Elkhorn, OR (2008)	1.07	0.06	61	101
Klondike II, OR (2005-2006)	0.504	0.06	50	75
Klondike IIIa (Phase II), OR (2008-2010)	NA	0.06	51	76.5
Combine Hills, OR (2011)	0.746	0.05	104	104
Biglow Canyon, OR (Phase III; 2010-2011)	0.318	0.05	76	174.8
Marengo II, WA (2009-2010)	NA	0.05	39	70.2
Windy Flats, WA (2010-2011)	NA	0.04	114	262.2
Pebble Springs, OR (2009-2010)	NA	0.04	47	98.7
Biglow Canyon, OR (Phase I; 2008)	0.318	0.03	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	0.318	0.03	65	150
Nine Canyon, WA (2002-2003)	0.35	0.03	37	48.1
Hay Canyon, OR (2009-2010)	NA	0	48	100.8
Biglow Canyon, OR (Phase I; 2009)	0.318	0	76	125.4
Marengo I, WA (2009-2010)	NA	0	78	140.4
Klondike, OR (2002-2003)	0.504	0	16	24
Vansycle, OR (1999)	0.66	0	38	24.9
Combine Hills, OR (Phase I; 2004-2005)	0.746	0	41	41

Appendix E2. (*continued*). Wind energy facilities in North America with comparable use and fatality data for diurnal raptors. Data from the following sources:

Study	Use Reference	Fatality Reference	Study	Use Reference	Fatality Reference
Mountain Breeze/Panorama, CO 2017, 2018	**This study.**	**This study.**			
Alite, CA (2009-2010)		Chatfield et al. 2010a	Linden Ranch, WA (2010-2011)		Enz and Bay 2011
Alta I, CA (2013-2014)		Chatfield et al. 2014	Locust Ridge, PA (Phase II; 2009)		Arnett et al. 2011
Alta I, CA (2015-2016)		Thompson et al. 2016a	Locust Ridge, PA (Phase II; 2010)		Arnett et al. 2011
Alta II-V, CA (2013-2014)		Chatfield et al. 2014	Lower West, CA (2012-2013)		Levenstein and Bay 2013a
Alta II-V, CA (2015-2016)		Thompson et al. 2016a	Lower West, CA (2014-2015)		Levenstein and DiDonato 2015
Alta VIII, CA (2012-2013)		Chatfield and Bay 2014	Lower West, CA (2016-2017)		WEST 2017b
Alta VIII, CA (2014-2015)		Western EcoSystems Technology, Inc. (WEST) 2016c	Maple Ridge, NY (2007-2008)		Jain et al. 2009b
Alta X, CA (2014-2015)		Chatfield et al. 2015	Marengo I, WA (2009-2010)		URS 2010b
Alta X, CA (2015-2016)		Thompson et al. 2016b	Marengo II, WA (2009-2010)		URS 2010c
Alta Wind I, CA (2011-2012)	Erickson et al. 2009	Chatfield et al. 2012	Mars Hill, ME (2007)		Stantec 2008
Alta Wind II-V, CA (2011-2012)	Erickson et al. 2009	Chatfield et al. 2012	Mars Hill, ME (2008)		Stantec 2009a
Barton I & II, IA (2010-2011)		Derby et al. 2011b	Milford I & II, UT (2011-2012)		Stantec 2012
Barton Chapel, TX (2009-2010)		WEST 2011	Montezuma I, CA (2011)		ICF International 2012
Beech Ridge, WV (2012)		Tidhar et al. 2013a	Montezuma I, CA (2012)		ICF International 2013
Beech Ridge, WV (2013)		Young et al. 2014a	Montezuma II, CA (2012-2013)		Harvey & Associates 2013
Big Blue, MN (2013)		Fagen Engineering 2014	Moraine II, MN (2009)		Derby et al. 2010g
Big Blue, MN (2014)		Fagen Engineering 2015	Mount Storm, WV (2009)		Young et al. 2009a, 2010b
Big Horn, WA (2006-2007)	Johnson and Erickson 2004	Kronner et al. 2008	Mount Storm, WV (2010)		Young et al. 2010a, 2011b
Big Smile, OK (2012-2013)		Derby et al. 2013b	Mount Storm, WV (2011)		Young et al. 2011a, 2012a
Biglow Canyon, OR (Phase I; 2008)	WEST 2005c	Jeffrey et al. 2009b	Mountaineer, WV (2003)		Kerns and Kerlinger 2004
Biglow Canyon, OR (Phase I; 2009)	WEST 2005c	Enk et al. 2010	Munnsville, NY (2008)		Stantec 2009b
Biglow Canyon, OR (Phase II; 2009-2010)	WEST 2005c	Enk et al. 2011b	Mustang Hills, CA (2012-2013)		Chatfield and Bay 2014
Biglow Canyon, OR (Phase II; 2010-2011)	WEST 2005c	Enk et al. 2012b	Mustang Hills, CA (2014-2015)		WEST 2016c

Appendix E2. (*continued*). Wind energy facilities in North America with comparable use and fatality data for diurnal raptors. Data from the following sources:

Study	Use Reference	Fatality Reference	Study	Use Reference	Fatality Reference
Biglow Canyon, OR (Phase III; 2010-2011)	WEST 2005c	Enk et al. 2012a	Mustang Hills, CA (2016-2017)		WEST 2018
Blue Sky Green Field, WI (2008; 2009)		Gruver et al. 2009	Nine Canyon, WA (2002-2003)	Erickson et al. 2001a	Erickson et al. 2003a
Buffalo Gap I, TX (2006)		Tierney 2007	Noble Altona, NY (2010)		Jain et al. 2011a
Buffalo Gap II, TX (2007-2008)		Tierney 2009	Noble Bliss, NY (2008)		Jain et al.2009c
Buffalo Mountain, TN (2000-2003)		Nicholson et al. 2005	Noble Bliss, NY (2009)		Jain et al. 2010c
Buffalo Mountain, TN (2005)		Fiedler et al. 2007	Noble Chateaugay, NY (2010)		Jain et al. 2011b
Buffalo Ridge, MN (Phase I; 1996)		Johnson et al. 2000a	Noble Clinton, NY (2008)		Jain et al. 2009d
Buffalo Ridge, MN (Phase I; 1997)		Johnson et al. 2000a	Noble Clinton, NY (2009)		Jain et al. 2010a
Buffalo Ridge, MN (Phase I; 1998)		Johnson et al. 2000a	Noble Ellenburg, NY (2008)		Jain et al. 2009e
Buffalo Ridge, MN (Phase I; 1999)		Johnson et al. 2000a	Noble Ellenburg, NY (2009)		Jain et al. 2010b
Buffalo Ridge, MN (Phase II; 1998)		Johnson et al. 2000a	Noble Wethersfield, NY (2010)		Jain et al. 2011c
Buffalo Ridge, MN (Phase II; 1999)		Johnson et al. 2000a	NPPD Ainsworth, NE (2006)		Derby et al. 2007
Buffalo Ridge, MN (Phase III; 1999)		Johnson et al. 2000a	Pacific Wind, CA (2015-2016)		WEST 2017a
Buffalo Ridge I, SD (2009-2010)		Derby et al. 2010e	Pebble Springs, OR (2009-2010)		Gritski and Kronner 2010b
Buffalo Ridge II, SD (2011-2012)		Derby et al. 2012a	Pinnacle, WV (2012)		Hein et al. 2013
Bull Hill, ME (2013)		Stantec Consulting (Stantec) 2014a	Pinyon Pines I & II, CA (2013-2014)		Chatfield and Russo 2014
Cameron Ridge/Section 15, CA (2014-2015)		WEST 2016b	Pinyon Pines I & II, CA (2015-2016)		Rintz and Starcevich 2016
Cameron Ridge/Section 15, CA (2015-2016)		Rintz and Thompson 2017	Pinyon Pines I & II, CA (2017-2018)		Rintz and Pham 2018
Casselman, PA (2008)		Arnett et al. 2009	Pioneer Prairie I, IA (Phase II; 2011-2012)		Chodachek et al. 2012
Casselman, PA (2009)		Arnett et al. 2010	Prairie Rose, MN (2014)		Chodachek et al. 2015
Cedar Ridge, WI (2009)		BHE Environ-mental 2010	PrairieWinds ND1 (Minot), ND (2010)		Derby et al. 2011d
Cedar Ridge, WI (2010)		BHE Environ-mental 2011	PrairieWinds ND1 (Minot), ND (2011)		Derby et al. 2012d
Cohocton/Dutch Hill, NY (2009)		Stantec 2010	PrairieWinds SD1, SD (2011-2012)		Derby et al. 2012c
Cohocton/Dutch Hills, NY (2010)		Stantec 2011a	PrairieWinds SD1, SD (2012-2013)		Derby et al. 2013a
Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2003c	Young et al. 2006	PrairieWinds SD1, SD (2013-2014)		Derby et al. 2014
Combine Hills, OR (2011)	Young et al. 2003c	Enz et al. 2012	Rail Splitter, IL (2012-2013)		Good et al. 2013a

Appendix E2. (*continued*). Wind energy facilities in North America with comparable use and fatality data for diurnal raptors. Data from the following sources:

Study	Use Reference	Fatality Reference	Study	Use Reference	Fatality Reference
Criterion, MD (2011)		Young et al. 2012b	Red Hills, OK (2012-2013)		Derby et al. 2013c
Diablo Winds, CA (2005-2007)	WEST 2006	WEST 2006, 2008	Ripley, ON (2008)		Jacques Whitford 2009
Dillon, CA (2008-2009)		Chatfield et al. 2009	Rising Tree, CA (2015-2016)		Rintz et al. 2016
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Thompson et al. 2011	Rising Tree, CA (2017-2018)		Chatfield et al. 2018
Dry Lake II, AZ (2011-2012)		Thompson and Bay 2012	Rugby, ND (2010-2011)		Derby et al. 2011c
Elkhorn, OR (2008)	WEST 2005a	Jeffrey et a. 2009a	Shiloh I, CA (2006-2009)		Kerlinger et al. 2009
Elkhorn, OR (2010)	WEST 2005a	Enk et al. 2011a	Shiloh II, CA (2009-2010)		Kerlinger et al. 2010
Elm Creek, MN (2009-2010)		Derby et al. 2010f	Shiloh II, CA (2010-2011)		Kerlinger et al. 2013a
Elm Creek II, MN (2011-2012)		Derby et al. 2012b	Shiloh II, CA (2011-2012)		Kerlinger et al. 2013a
Foote Creek Rim I, WY (1999)	Johnson et al. 2000b	Young et al. 2003a	Solano III, CA (2012-2013)		AECOM 2013
Foote Creek Rim I, WY (2000)	Johnson et al. 2000b	Young et al. 2003a	Spring Valley, NV (2012-2013)		WEST 2014
Foote Creek Rim I, WY (2001-2002)	Johnson et al. 2000b	Young et al. 2003a	Stateline, OR/WA (2001-2002)	Erickson et al. 2003b	Erickson et al. 2004
Foote Creek Rim I, WY (UV; 1999-2000)	Johnson et al. 2000b	Young et al. 2003b	Stateline, OR/WA (2003)	Erickson et al. 2003b	Erickson et al. 2004
Fowler I, IN (2009)		Johnson et al. 2010	Stateline, OR/WA (2006)	Erickson et al. 2003b	Erickson et al. 2007
Goodnoe, WA (2009-2010)		URS Corporation (URS) 2010a	Steel Winds I & II, NY (2013)		Stantec 2014c
Grand Ridge I, IL (2009-2010)	Derby et al. 2009	Derby et al. 2010a	Stetson Mountain I, ME (2009)		Stantec 2009c
Groton, NH (2013)		Stantec and WEST 2014	Stetson Mountain I, ME (2011)		Normandeau Associates 2011
Groton, NH (2014)		Stantec and WEST 2015a	Stetson Mountain I, ME (2013)		Stantec 2014d
Groton, NH (2015)		Stantec and WEST 2015b	Stetson Mountain II, ME (2010)		Normandeau Associates 2010
Harvest Wind, WA (2010-2012)		Downes and Gritski 2012a	Stetson Mountain II, ME (2012)		Stantec 2013d
Hatchet Ridge, CA (2011)		Tetra Tech 2013a	Summerview, AB (2005-2006)		Brown and Hamilton 2006
Hatchet Ridge, CA (2012-2013)		Tetra Tech 2014	Thunder Spirit, ND (2016-2017)		Baerwald 2008
Hay Canyon, OR (2009-2010)		Gritski and Kronner 2010a	Top of Iowa, IA (2003)		Jain 2005
High Sheldon, NY (2010)		Tidhar et al. 2012a	Top of Iowa, IA (2004)		Jain 2005
High Sheldon, NY (2011)		Tidhar et al. 2012b	Top of the World, WY (2010-2011)		Rintz and Bay 2012
High Winds, CA (2003-2004)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of the World, WY (2011-2012)		Rintz and Bay 2013
High Winds, CA (2004-2005)	Kerlinger et al. 2005	Kerlinger et al. 2006	Top of the World, WY (2012-2013)		Rintz and Bay 2014
Hopkins Ridge, WA (2006)	Young et al. 2003e	Young et al. 2007b	Tucannon River, WA (2015)		Hallingstad et al. 2016

Appendix E2. (*continued*). Wind energy facilities in North America with comparable use and fatality data for diurnal raptors. Data from the following sources:

Study	Use Reference	Fatality Reference	Study	Use Reference	Fatality Reference
Hopkins Ridge, WA (2008)	Young et al. 2003e	Young et al. 2009b	Tuolumne (Windy Point I), WA (2009-2010)	Johnson et al. 2006	Enz and Bay 2010
Kewaunee County, WI (1999-2001)		Howe et al. 2002	Vansycle, OR (1999)	WCIA and WEST 1997	Erickson et al. 2000
Kittitas Valley, WA (2011-2012)		Stantec Consulting Services 2012	Vantage, WA (2010-2011)		Ventus Environmental Solutions 2012
Klondike, OR (2002-2003)	Johnson et al. 2002a	Johnson et al. 2003	Wessington Springs, SD (2009)	Derby et al. 2008	Derby et al. 2010d
Klondike II, OR (2005-2006)	Johnson et al. 2002a	Northwest Wildlife Consultants (NWC) and WEST 2007	Wessington Springs, SD (2010)		Derby et al. 2011a
Klondike III (Phase I), OR (2007-2009)		Gritski et al. 2010	White Creek, WA (2007-2011)		Downes and Gritski 2012b
Klondike IIIa (Phase II), OR (2008-2010)		Gritski et al. 2011	Wild Horse, WA (2007)	Erickson et al. 2003d	Erickson et al. 2008
Lakefield Wind, MN (2012)		Minnesota Public Utilities Commission 2012	Windstar, CA (2012-2013)		Levenstein and Bay 2013b
Leaning Juniper, OR (2006-2008)	Kronner et al. 2005	Gritski et al. 2008	Windy Flats, WA (2010-2011)		Enz et al. 2011
Lempster, NH (2009)		Tidhar et al. 2010	Winnebago, IA (2009-2010)		Derby et al. 2010a
Lempster, NH (2010)		Tidhar et al. 2011			

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Alite, CA (2009-2010)	8	24	80	8	200 m x 200 m	1 year	weekly (spring, fall), bi-monthly (summer, winter)
Alta I, CA (2013-2014)	290	720	80	NA	120-m radius	1 year	monthly;twice per month
Alta I, CA (2015-2016)	290	720	80	NA	120-m radius	1 year	monthly;twice per month
Alta II-V, CA (2013-2014)	290	720	80	NA	120-m radius	1 year	monthly;twice per month
Alta II-V, CA (2015-2016)	290	720	80	NA	120-m radius	1 year	monthly;twice per month
Alta VIII, CA (2012-2013)	50	150	90	12 plots (equivalent to 15 turbines)	240 x 240 m	1 year	bi-weekly
Alta VIII, CA (2014-2015)	100	300	90	NA	240 m x 240 m	NA	twice per month
Alta VIII, CA (2016-2017)	100	300	100	NA	240 m x 240 m	1 year	twice per month
Alta X, CA (2014-2015)	48	137	100	NA	240 m x 240 m	1 year	twice per month
Alta X, CA (2015-2016)	48	137	100	NA	240 m x 240 m	1 year	twice per month
Alta Wind I, CA (2011-2012)	100	150	80	25	120-m radius circle	12.5 months	every 2 weeks
Alta Wind II-V, CA (2011-2012)	190	570	80	41	120-m radius circle	14.5 months	every 2 weeks
Barton I & II, IA (2010-2011)	80	160	100	35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	every 2 days
Beech Ridge, WV (2013)	67	100.5	80	67	40 m radius	7.5 months	every 2 days

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Big Blue, MN (2013)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (November and December)
Big Blue, MN (2014)	18	36	78 or 90 (according to Gamesa website)	18	200m diameter	NA	weekly, monthly (November and December)
Big Horn, WA (2006-2007)	133	199.5	80	133	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Big Smile, OK (2012-2013)	66	132	78	17 (plus one met tower)	100 x 100	1 year	weekly (spring, summer, fall), monthly (winter)
Biglow Canyon, OR (Phase I; 2008)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase I; 2009)	76	125.4	80	50	110 m x 110 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2009-2010)	65	150	80	50	250 m x 250 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Biglow Canyon, OR (Phase II; 2010-2011)	65	150	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Biglow Canyon, OR (Phase III; 2010-2011)	76	174.8	80	50	252 m x 252 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Bingham Wind Project, ME (2017)	56	185	94	NA	within 80 m; within 140 m	7 months	twice per week
Blue Sky Green Field, WI (2008; 2009)	88	145	80	30	160 m x 160 m	fall, spring	daily(10 turbines), weekly (20 turbines)
Buffalo Gap I, TX (2006)	67	134	78	21	215 m x 215 m	10 months	every 3 weeks
Buffalo Gap II, TX (2007-2008)	155	233	80	36	215 m x 215 m	14 months	every 21 days
Buffalo Mountain, TN (2000-2003)	3	1.98	65	3	50-m radius	3 years	bi-weekly, weekly, bi-monthly
Buffalo Mountain, TN (2005)	18	28.98	V47 = 65; V80 = 78	18	50-m radius	1 year	bi-weekly, weekly, bi-monthly, and 2- to 5-day intervals

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Buffalo Ridge, MN (Phase I; 1996)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1997)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1998)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase I; 1999)	73	25	36	21	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1998)	143	107.25	50	40	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase II; 1999)	143	107.25	50	40	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge, MN (Phase III; 1999)	138	103.5	50	30	126 m x 126 m	1 year	bi-monthly (spring, summer, and fall)
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Buffalo Ridge II, SD (2011-2012)	105	210	78	65 (60 road and pad, 5 turbine plots)	100 x 100m	1 year	weekly (spring, summer, fall), monthly (winter)
Bull Hill, ME (2013)	19	34	95	19	80 m radius	6 months	weekly (spring), daily and weekly (fall)
Cameron Ridge/Section 15, CA (2014-2015)	34	102	80	NA	62.5m radius	1 year	weekly
Cameron Ridge/Section 15, CA (2015-2016)	34	102	80	NA	125m radius	NA	weekly
Casselman, PA (2008)	23	34.5	80	10	126 m x 120 m	7 months	daily
Casselman, PA (2009)	23	34.5	80	10	126 m x 120 m	7.5 months	daily searches
Cedar Ridge, WI (2009)	41	67.6	80	20	160 m x 160 m	spring, summer, fall	daily, every 4 days; late fall searched every 3 days
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	spring, summer, fall	daily (5 turbines), weekly (12 turbines)
Cohocton/Dutch Hill, NY (2013)	50	125	80	NA	120 m x 120 m	4 months	weekly
Cohocton/Dutch Hills, NY (2010)	50	125	80	17	120 m x 120 m	spring, summer, fall	daily, weekly
Combine Hills, OR (Phase I; 2004-2005)	41	41	53	41	90-m radius	1 year	monthly
Combine Hills, OR (2011)	104	104	53	52 (plus 1 MET tower)	180 m x 180 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Criterion, MD (2011)	28	70	80	28	40- to 50-m radius	7.3 months	daily
Criterion, MD (2012)	28	70	80	14	40- to 50-m radius	7.5 months	weekly
Criterion, MD (2013)	28	70	80	14	40-to 50-m radius	7.5 months	weekly
Diablo Winds, CA (2005-2007)	31	20.46	50 and 55	31	75 m x 75 m	2 years	monthly
Dillon, CA (2008-2009)	45	45	69	15	200 m x 200 m	1 year	weekly, bi-monthly in winter
Dry Lake I, AZ (2009-2010)	30	63	78	15	160 m x 160 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Dry Lake II, AZ (2011-2012)	31	65	78	31: 5 (full plot), 26 (road & pad)	160 m x 160 m	1 year	twice weekly (spring, summer, fall), weekly (winter)
Elkhorn, OR (2008)	61	101	80	61	220 m x 220 m	1 year	monthly
Elkhorn, OR (2010)	61	101	80	31	220 m x 220 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Elm Creek, MN (2009-2010)	67	100	80	29	200 m x 200 m	1 year	weekly, monthly

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Elm Creek II, MN (2011-2012)	62	148.8	80	30	200 m x 200 m (2 random migration search areas 100 m x 100 m)	1 year	20 searched every 28 days, 10 turbines every 7 days during migration)
Foote Creek Rim I, WY (1999)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim I, WY (2000)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim I, WY (2001-2002)	69	41.4	40	69	126 m x 126 m	1 year	monthly
Foote Creek Rim, WY (UV; 1999-2000)	105	67.95	Mitsubishi = 40, NEG = 50	105	120 m x 120 m	17 months	monthly
Fowler I, IN (2009)	162	301	78 (Vestas), 80 (Clipper)	25	160 m x 160 m	spring, summer, fall	weekly, bi-weekly
Goodnoe, WA (2009-2010)	47	94	80	24	180 m x 180 m	1 year	14 days during migration periods, 28 days during non-migration periods
Grand Ridge I, IL (2009-2010)	66	99	80	30	160 m x 160 m	1 year	weekly, monthly
Groton, NH (2013)	24	48	78	NA	road/pad; 60-m radius	7 months	weekly
Groton, NH (2014)	24	48	78	NA	road/pad; 60-m radius	6 months	weekly
Groton, NH (2015)	24	48	78	NA	road/pad; 60-m radius	6 months	weekly
Hancock, ME (2017)	17	51	80	NA	within 80 m; within 140 m	7 months	twice per week

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Harvest Wind, WA (2010-2012)	43	98.9	80	32	180 m x 180 m & 240 m x 240 m	2 years	twice a week, weekly and monthly
Hatchet Ridge, CA (2011)	44	101	80	NA	127 m x 127 m (bi-monthly), 190 m x 190 m (monthly)	NA	monthly;twice per month
Hatchet Ridge, CA (2012-2013)	44	NA	80	NA	127 m x 127 m	1 year	twice per month
Hatchet Ridge, CA (2012)	44	101	80	NA	127 m x 127 m (bi-monthly), 190 m x 190 m (monthly)	NA	monthly;twice per month
Hay Canyon, OR (2009-2010)	48	100.8	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Heritage Garden, MI (2012-2013)	14	28	90	NA	120 m x 120 m	2 years	twice per month;weekly
Heritage Garden, MI (2013-2014)	14	28	90	NA	120 m x 120 m	2 years	twice per month;weekly
High Sheldon, NY (2010)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
High Sheldon, NY (2011)	75	112.5	80	25	115 m x 115 m	7 months	daily (8 turbines), weekly (17 turbines)
High Winds, CA (2003-2004)	90	162	60	90	75-m radius	1 year	bi-monthly
High Winds, CA (2004-2005)	90	162	60	90	75-m radius	1 year	bi-monthly
Hopkins Ridge, WA (2006)	83	150	67	41	180 m x 180 m	1 year	monthly, weekly (subset of 22 turbines spring and fall migration)

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Hopkins Ridge, WA (2008)	87	156.6	67	41-43	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Howard, NY (2012)	27	54	78.5	NA	120 m x 120 m	7 months	daily;weekly
Howard, NY (2013)	27	54	78.5	NA	120 m x 120 m	6 months	daily;weekly
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	bi-weekly from August 15 - October 31 and March 16 - May 15; every 4 weeks from November 1 - March 15 and May 16 - August 14
Klondike, OR (2002-2003)	16	24	80	16	140 m x 140 m	1 year	monthly
Klondike II, OR (2005-2006)	50	75	80	25	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (summer, winter)
Klondike III (Phase I), OR (2007-2009)	125	223.6	GE = 80; Siemens= 80, Mitsubishi = 80	46	240 m x 240 m (1.5 MW) 252 m x 252 m (2.3 MW)	2 year	bi-monthly (spring, fall migration), monthly (summer, winter)
Klondike IIIa (Phase II), OR (2008-2010)	51	76.5	GE = 80	34	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (summer, winter)
Lakefield Wind, MN (2012)	137	205.5	80	26	100 m x 100 m	7.5 months	3 times per week
Laurel Mountain, WV (2014)	61	98	80	NA	90 m x 90 m	7 months	twice per week;weekly
Leaning Juniper, OR (2006-2008)	67	100.5	80	17	240 m x 240 m	2 years	bi-monthly (spring, fall), monthly (winter, summer)
Lempster, NH (2009)	12	24	78	4	120 m x 130 m	6 months	daily
Lempster, NH (2010)	12	24	78	12	120 m x 130 m	6 months	weekly

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Linden Ranch, WA (2010-2011)	25	50	80	25	110 m x 110 m	1 year	bi-weekly(spring, fall), monthly (summer, winter)
Locust Ridge, PA (Phase II; 2009)	51	102	80	15	120 m x 126 m	6.5 months	daily
Locust Ridge, PA (Phase II; 2010)	51	102	80	15	120 m x 126 m	6.5 months	daily
Lower West, CA (2012-2013)	7	14	110.5	NA	120-m radius	NA	twice per month
Lower West, CA (2014-2015)	7	14	110.5	NA	120-m radius	NA	twice per month
Lower West, CA (2016-2017)	7	14	110.5	NA	120-m radius	1 year	twice per week
Maple Ridge, NY (2007)	195	321.75	80	64	130 m x 120 m	7 months	weekly
Maple Ridge, NY (2007-2008)	195	321.75	80	64	130 m x 120 m	7 months	weekly
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	daily (2 random turbines), weekly (all turbines): extended plot searched once per season
Mars Hill, ME (2008)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	spring, summer, fall	weekly: extended plot searched once per season
Milford I, UT (2010-2011)	58	145	80	24	120 m x 120 m	NA	weekly
Milford I & II, UT (2011-2012)	107	160.5 (58.5 I, 102 II)	80	43	120 m x 120 m	NA	every 10.5 days

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Montezuma I, CA (2011)	16	36.8	80	16	105-m radius	1 year	weekly and bi-weekly
Montezuma I, CA (2012)	16	36.8	80	16	105-m radius	1 year	weekly and bi-weekly
Montezuma II, CA (2012-2013)	34	78.2	80	17	105-m radius	1 year	weekly
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)
Mount Storm, WV (2009)	132	264	78	44	varied	4.5 months	weekly (28 turbines), daily (16 turbines)
Mount Storm, WV (2010)	132	264	78	24	20 to 60 m from turbine	6 months	daily
Mount Storm, WV (2011)	132	264	78	24	varied	6 months	daily
Mountaineer, WV (2003)	44	66	80	44	60-m radius	7 months	weekly, monthly
Munnsville, NY (2008)	23	34.5	69.5	12	120 m x 120 m	spring, summer, fall	weekly
Mustang Hills, CA (2012-2013)	50	150	90	13 plots (equivalent to 15 turbines)	240 m x 240 m	1 year	bi-weekly
Mustang Hills, CA (2014-2015)	100	300	90	NA	240 m x 240 m	NA	twice per month
Mustang Hills, CA (2016-2017)	100	300	100	NA	240 m x 240 m	1 year	twice per month
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	bi-monthly (spring, summer, fall), monthly (winter)
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	spring, summer, fall	daily, weekly
Noble Bliss, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Bliss, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	weekly, 8 turbines searched daily from July 1 to August 15

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Noble Chateaugay, NY (2010)	71	106.5	80	24	120 m x 120 m	spring, summer, fall	weekly
Noble Clinton, NY (2008)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)
Noble Clinton, NY (2009)	67	100	80	23	120 m x 120 m	spring, summer, fall	daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15
Noble Ellenburg, NY (2008)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)
Noble Ellenburg, NY (2009)	54	80	80	18	120 m x 120 m	spring, summer, fall	daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15
Noble Wethersfield, NY (2010)	84	126	80	28	120 m x 120 m	spring, summer, fall	weekly
NPPD Ainsworth, NE (2006)	36	20.5	70	36	220 m x 220 m	spring, summer, fall	bi-monthly
Oakfield, ME (2017)	48	148	94	NA	within 80 m; within 140 m	7 months	other
Odell, MN (2016-2017)	100	200	NA	NA	120 m x 120 m	1 year	monthly;weekly
Pacific Wind, CA (2014-2015)	70	144	78.5	NA	126-m radius	NA	weekly
Pacific Wind, CA (2015-2016)	70	144	78.5	NA	63-m radius	NA	weekly
Palouse Wind, WA (2012-2013)	58	104.4	80, 90, or 105 m (according to the Vestas website)	19	120 m x 120 m	1 year	montly (winter) and weekly (spring-fall)

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Passadumkeag, ME (2016)	13	43	NA	NA	80-m radius	6 months	twice per week
Pebble Springs, OR (2009-2010)	47	98.7	79	20	180 m x 180 m	1 year	bi-monthly (spring, fall), monthly (winter, summer)
Pine Tree, CA (2009-2010, 2011)	90	135	65	40	100-m radius	1.5 year	bi-weekly, weekly
Pinnacle, WV (2012)	23	55.2	80	11	126 m x 120 m	9 months	weekly
Pinyon Pines I & II, CA (2013-2014)	100	NA	90	25 plots (aprox. 31 turbines)	240 m x 240 m	NA	bi-weekly
Pinyon Pines I & II, CA (2015-2016)	100	300	90	NA	240m x 240m	NA	twice per month
Pinyon Pines I & II, CA (2017-2018)	100	300	90	NA	240m x 240m	1 year	twice per month
Pioneer Prairie I, IA (Phase II; 2011-2012)	62	102.3	80	62 (57 road/pad) 5 full search plots	80 x 80m	1 year	weekly (spring and fall), every two weeks (summer), monthly (winter)
Pleasant Valley, MN (2016-2017)	100	200	95	NA	160 m x 160 m	NA	weekly
Prairie Rose, MN (2014)	119	200	80	NA	100 m x 100 m (spring); road/pad (fall)	1 year	weekly
PrairieWinds ND1 (Minot), ND (2010)	80	115.5	89	35	minimum of 100 m x 100 m	3 seasons	bi-monthly
PrairieWinds ND1 (Minot), ND (2011)	80	115.5	80	35	minimum 100 m x 100m	3 season	twice monthly
PrairieWinds SD1, SD (2011-2012)	108	162	80	50	200 m x 200 m	1 year	twice monthly (spring, summer, fall), monthly (winter)
PrairieWinds SD1, SD (2012-2013)	108	162	80	50	200 m x 200 m	1 year	bi-weekly
PrairieWinds SD1, SD (2013-2014)	108	162	80	45	200 m x 200 m	1 year	twice monthly (spring, summer, fall), monthly (winter)

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Prince Wind Farm, ON (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	daily, weekly
Prince Wind Farm, ON (2008)	126	189	80	126	45-m radius	6.5 months	daily, 3x/week, 2x/week
Rail Splitter, IL (2012-2013)	67	100.5	80	34	60-m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Record Hill, ME (2012)	22	50.6	80	22	126.5 m x 126.5 m	5 months	three times every two weeks
Record Hill, ME (2014)	22	50.6	80	10	varied due to steep terrain and heavily vegetated areas	4.5 months	daily for 5 days a week
Record Hill, ME (2016)	22	51	80	NA	42.5-m radius	7 months	other
Red Hills, OK (2012-2013)	82	123	80	20 (plus one met tower)	100 m x 100 m	1 year	weekly (spring, summer, fall), monthly (winter)
Ripley, ON (2008)	38	76	64	38	80 m x 80 m	spring, fall	twice weekly for odd turbines; weekly for even turbines.
Rising Tree, CA (2015-2016)	60	198	84	NA	280 m x 280 m	NA	twice per month
Rising Tree, CA (2017-2018)	60	198	84	NA	280 m x 280 m	1 year	twice per month
Rollins, ME (2012)	40	60	80	20	varied; turbine laydown area and gravel access roads out to 60 m	6 months	weekly
Rollins, ME (2014)	40	60	NA	NA	60-m radius	6 months	weekly

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Roth Rock, MD (2011)	20	50	80	NA	80 m x 80 m	3 months	daily
Rugby, ND (2010-2011)	71	149	78	32	200 m x 200 m	1 year	weekly (spring, fall; migratory turbines), monthly (non-migratory turbines)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	weekly
Shiloh II, CA (2009-2010)	75	150	80	25	100-m radius	1 year	weekly
Shiloh II, CA (2010-2011)	75	150	80	25	100-m radius	1 year	weekly
Shiloh II, CA (2011-2012)	75	150	80	25	100 m radius	1 year	weekly
Shiloh III, CA (2012-2013)	50	102.5	78.5	25	100-m radius	NA	weekly
Solano III, CA (2012-2013)	55	128	80	19	100-m radius	NA	bi-weekly
Spring Valley, NV (2012-2013)	66	152	80	NA	126 m x 126 m	1 year, 2 months	daily;twice per month
Spruce Mountain Wind Project, ME (2014)	10	20	78	NA	road/pad; 100-m radius	NA	twice per week
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	bi-weekly
Steel Winds I & II, NY (2013)	14	35	80	NA	120 m x 120 m	5 months	twice per week
Stetson II, ME (2014)	17	26	NA	NA	60-m radius	6 months	weekly

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	weekly
Stetson Mountain I, ME (2011)	38	57	80	19	79.45 m x 79.45 m	6 months	weekly
Stetson Mountain I, ME (2013)	38	57	80	19	76-m diameter	6 months	weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	74.5 m x 74.5 m	6 months	weekly (3 turbines twice a week)
Stetson Mountain II, ME (2012)	17	25.5	80	17	laydown area and road up to 60 m	6 months	weekly
Summerview, AB (2005-2006)	39	70.2	67	39	140 m x 140 m	1 year	weekly, bi-weekly (May to July, September)
Thunder Spirit, ND (2016-2017)	43	108	80	NA	160 m x 160 m; road/pad	10 months	twice per month
Top Crop I & II,IL (2012-2013)	68 Phase I, 132 Phase II	300 (102 Phase I, 198 Phase II)	65 Phase I, 80 Phase II	100	61-m radius	1 year	weekly (spring, summer, and fall) and bi-weekly (winter)
Top of Iowa, IA (2003)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Top of Iowa, IA (2004)	89	80	71.6	26	76 m x 76 m	spring, summer, fall	once every 2 to 3 days
Top of the World, WY (2010-2011)	110	200	80	NA	160 m x 160 m	1 year	twice per month;weekly
Top of the World, WY (2011-2012)	110	200	80	NA	160 m x 160 m	1 year	twice per month;weekly
Top of the World, WY (2012-2013)	110	200	80	NA	160 m x 160 m	1 year	twice per month;weekly

Appendix E3. All post-construction monitoring studies, project characteristics, and select study methodology.

Study	Total # of Turbines	Total MW	Tower Size (m)	Number Turbines Searched	Plot Size	Length of Study	Survey Frequency
Tucannon River, WA (2015)	116	267	80	NA	134-m radius	1 year	NA
Tuolumne (Windy Point I), WA (2009-2010)	62	136.6	80	21	180 m x 180 m	1 year	monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall
Vansycle, OR (1999)	38	24.9	50	38	126 m x 126 m	1 year	monthly
Vantage, WA (2010-2011)	60	90	80	30	240 m x 240 m	1 year	monthly, a subset of 10 searched weekly during migration
Waverly Wind, KS (2016-2017)	95	199	93	NA	160 m x 160 m; road/pad	1 year	twice per month;weekly
Wessington Springs, SD (2009)	34	51	80	20	200 m x 200 m	spring, summer, fall	bi-monthly
Wessington Springs, SD (2010)	34	51	80	20	200 m x 200 m	8 months	bi-weekly (spring, summer, fall)
White Creek, WA (2007-2011)	89	204.7	80	89	180 m x 180 m & 240 m x 240 m	4 years	twice a week, weekly and monthly
Wild Horse, WA (2007)	127	229	67	64	110 m from 2 turbines in plot	1 year	monthly, weekly (fall, spring migration at 16 turbines)
Windstar, CA (2012-2013)	53	106	107;110.5	NA	120-m radius	NA	monthly;twice per month
Windy Flats, WA (2010-2011)	114	262.2	80	36 (plus 1 MET tower)	180 m x 180 m (120 m at met tower)	1 year	monthly (spring, summer, fall, and winter), weekly (spring and fall migration)
Winnebago, IA (2009-2010)	10	20	78	10	200 m x 200 m	1 year	weekly (migratory), monthly (non-migratory)

Appendix E3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Study	Reference	Study	Reference
Alite, CA (2009-2010)	Chatfield et al. 2010a	Lower West, CA (2016-2017)	WEST 2017b
Alta I, CA (2013-2014)	Chatfield et al. 2014	Maple Ridge, NY (2007)	Jain et al. 2009a
Alta I, CA (2015-2016)	Thompson et al. 2016a	Maple Ridge, NY (2007-2008)	Jain et al. 2009b
Alta II-V, CA (2013-2014)	Chatfield et al. 2014	Marengo I, WA (2009-2010)	URS 2010b
Alta II-V, CA (2015-2016)	Thompson et al. 2016a	Marengo II, WA (2009-2010)	URS 2010c
Alta VIII, CA (2012-2013)	Chatfield and Bay 2014	Mars Hill, ME (2007)	Stantec 2008
Alta VIII, CA (2014-2015)	Western EcoSystems Technology, Inc. (WEST) 2016c	Mars Hill, ME (2008)	Stantec 2009a
Alta VIII, CA (2016-2017)	WEST 2018	Milford I, UT (2010-2011)	Stantec 2011b
Alta X, CA (2014-2015)	Chatfield et al. 2015	Milford I & II, UT (2011-2012)	Stantec 2012
Alta X, CA (2015-2016)	Thompson et al. 2016b	Montezuma I, CA (2011)	ICF International 2012
Alta Wind I, CA (2011-2012)	Chatfield et al. 2012	Montezuma I, CA (2012)	ICF International 2013
Alta Wind II-V, CA (2011-2012)	Chatfield et al. 2012	Montezuma II, CA (2012-2013)	Harvey & Associates 2013
Barton I & II, IA (2010-2011)	Derby et al. 2011b	Moraine II, MN (2009)	Derby et al. 2010g
Barton Chapel, TX (2009-2010)	WEST 2011	Mount Storm, WV (2009)	Young et al. 2009a, 2010b
Beech Ridge, WV (2012)	Tidhar et al. 2013a	Mount Storm, WV (2010)	Young et al. 2010a, 2011b
Beech Ridge, WV (2013)	Young et al. 2014a	Mount Storm, WV (2011)	Young et al. 2011a, 2012a
Big Blue, MN (2013)	Fagen Engineering 2014	Mountaineer, WV (2003)	Kerns and Kerlinger 2004
Big Blue, MN (2014)	Fagen Engineering 2015	Munnsville, NY (2008)	Stantec 2009b
Big Horn, WA (2006-2007)	Kronner et al. 2008	Mustang Hills, CA (2012-2013)	Chatfield and Bay 2014
Big Smile, OK (2012-2013)	Derby et al. 2013b	Mustang Hills, CA (2014-2015)	WEST 2016c
Biglow Canyon, OR (Phase I; 2008)	Jeffrey et al. 2009b	Mustang Hills, CA (2016-2017)	WEST 2018
Biglow Canyon, OR (Phase I; 2009)	Enk et al. 2010	Nine Canyon, WA (2002-2003)	Erickson et al. 2003a
Biglow Canyon, OR (Phase II; 2009-2010)	Enk et al. 2011b	Noble Altona, NY (2010)	Jain et al. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	Enk et al. 2012b	Noble Bliss, NY (2008)	Jain et al.2009c
Biglow Canyon, OR (Phase III; 2010-2011)	Enk et al. 2012a	Noble Bliss, NY (2009)	Jain et al. 2010c
Bingham Wind Project, ME (2017)	TRC 2017a	Noble Chateaugay, NY (2010)	Jain et al. 2011b
Blue Sky Green Field, WI (2008; 2009)	Gruver et al. 2009	Noble Clinton, NY (2008)	Jain et al. 2009d
Buffalo Gap I, TX (2006)	Tierney 2007	Noble Clinton, NY (2009)	Jain et al. 2010a

Appendix E3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Study	Reference	Study	Reference
Buffalo Gap II, TX (2007-2008)	Tierney 2009	Noble Ellenburg, NY (2008)	Jain et al. 2009e
Buffalo Mountain, TN (2000-2003)	Nicholson et al. 2005	Noble Ellenburg, NY (2009)	Jain et al. 2010b
Buffalo Mountain, TN (2005)	Fiedler et al. 2007	Noble Wethersfield, NY (2010)	Jain et al. 2011c
Buffalo Ridge, MN (Phase I; 1996)	Johnson et al. 2000a	NPPD Ainsworth, NE (2006)	Derby et al. 2007
Buffalo Ridge, MN (Phase I; 1997)	Johnson et al. 2000a	Oakfield, ME (2017)	TRC 2018
Buffalo Ridge, MN (Phase I; 1998)	Johnson et al. 2000a	Odell, MN (2016-2017)	Chodachek and Gustafson 2018
Buffalo Ridge, MN (Phase I; 1999)	Johnson et al. 2000a	Pacific Wind, CA (2014-2015)	WEST 2016a
Buffalo Ridge, MN (Phase II; 1998)	Johnson et al. 2000a	Pacific Wind, CA (2015-2016)	WEST 2017a
Buffalo Ridge, MN (Phase II; 1999)	Johnson et al. 2000a	Palouse Wind, WA (2012-2013)	Stantec 2013a
Buffalo Ridge, MN (Phase III; 1999)	Johnson et al. 2000a	Passadumkeag, ME (2016)	Ritzert et al. 2017
Buffalo Ridge I, SD (2009-2010)	Derby et al. 2010e	Pebble Springs, OR (2009-2010)	Gritski and Kronner 2010b
Buffalo Ridge II, SD (2011-2012)	Derby et al. 2012a	Pine Tree, CA (2009-2010, 2011)	BioResource Consultants 2012
Bull Hill, ME (2013)	Stantec Consulting, Inc. (Stantec) 2014a	Pinnacle, WV (2012)	Hein et al. 2013
Cameron Ridge/Section 15, CA (2014-2015)	WEST 2016b	Pinyon Pines I & II, CA (2013-2014)	Chatfield and Russo 2014
Cameron Ridge/Section 15, CA (2015-2016)	Rintz and Thompson 2017	Pinyon Pines I & II, CA (2015-2016)	Rintz and Starcevich 2016
Casselman, PA (2008)	Arnett et al. 2009	Pinyon Pines I & II, CA (2017-2018)	Rintz and Pham 2018
Casselman, PA (2009)	Arnett et al. 2010	Pioneer Prairie I, IA (Phase II; 2011-2012)	Chodachek et al. 2012
Cedar Ridge, WI (2009)	BHE Environmental 2010	Pleasant Valley, MN (2016-2017)	Tetra Tech 2017b
Cedar Ridge, WI (2010)	BHE Environmental 2011	Prairie Rose, MN (2014)	Chodachek et al. 2015
Cohocton/Dutch Hill, NY (2009)	Stantec 2010	PrairieWinds ND1 (Minot), ND (2010)	Derby et al. 2011d
Cohocton/Dutch Hill, NY (2013)	Stantec 2014b	PrairieWinds ND1 (Minot), ND (2011)	Derby et al. 2012d
Cohocton/Dutch Hills, NY (2010)	Stantec 2011a	PrairieWinds SD1, SD (2011-2012)	Derby et al. 2012c
Combine Hills, OR (Phase I; 2004-2005)	Young et al. 2006	PrairieWinds SD1, SD (2012-2013)	Derby et al. 2013a
Combine Hills, OR (2011)	Enz et al. 2012	PrairieWinds SD1, SD (2013-2014)	Derby et al. 2014
Criterion, MD (2011)	Young et al. 2012b	Prince Wind Farm, ON (2007)	NRSI 2008

Appendix E3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Study	Reference	Study	Reference
Criterion, MD (2012)	Young et al. 2013	Prince Wind Farm, ON (2008)	NRSI 2009
Criterion, MD (2013)	Young et al. 2014b	Rail Splitter, IL (2012-2013)	Good et al. 2013a
Diablo Winds, CA (2005-2007)	WEST 2006, 2008	Record Hill, ME (2012)	Stantec 2013b
Dillon, CA (2008-2009)	Chatfield et al. 2009	Record Hill, ME (2014)	Stantec 2015b
Dry Lake I, AZ (2009-2010)	Thompson et al. 2011	Record Hill, ME (2016)	Stantec 2017
Dry Lake II, AZ (2011-2012)	Thompson and Bay 2012	Red Hills, OK (2012-2013)	Derby et al. 2013c
Elkhorn, OR (2008)	Jeffrey et a. 2009a	Ripley, ON (2008)	Jacques Whitford 2009
Elkhorn, OR (2010)	Enk et al. 2011a	Rising Tree, CA (2015-2016)	Rintz et al. 2016
Elm Creek, MN (2009-2010)	Derby et al. 2010f	Rising Tree, CA (2017-2018)	Chatfield et al. 2018
Elm Creek II, MN (2011-2012)	Derby et al. 2012b	Rollins, ME (2012)	Stantec 2013c
Foote Creek Rim, WY (Phase I; 1999)	Young et al. 2003a	Rollins, ME (2014)	Stantec 2015c
Foote Creek Rim, WY (Phase I; 2000)	Young et al. 2003a	Roth Rock, MD (2011)	Atwell, LLC 2012
Foote Creek Rim, WY (Phase I; 2001-2002)	Young et al. 2003a	Rugby, ND (2010-2011)	Derby et al. 2011c
Foote Creek Rim, WY (UV study; 1999-2000)	Young et al. 2003b	Shiloh I, CA (2006-2009)	Kerlinger et al. 2009
Fowler I, IN (2009)	Johnson et al. 2010	Shiloh II, CA (2009-2010)	Kerlinger et al. 2010
Goodnoe, WA (2009-2010)	URS Corporation (URS) 2010a	Shiloh II, CA (2010-2011)	Kerlinger et al. 2013a
Grand Ridge I, IL (2009-2010)	Derby et al. 2010a	Shiloh II, CA (2011-2012)	Kerlinger et al. 2013a
Groton, NH (2013)	Stantec and WEST 2014	Shiloh III, CA (2012-2013)	Kerlinger et al. 2013b
Groton, NH (2014)	Stantec and WEST 2015a	Solano III, CA (2012-2013)	AECOM 2013
Groton, NH (2015)	Stantec and WEST 2015b	Spring Valley, NV (2012-2013)	WEST 2014
Hancock, ME (2017)	TRC 2017b	Spruce Mountain Wind Project, ME (2014)	Tetra Tech 2015
Harvest Wind, WA (2010-2012)	Downes and Gritski 2012a	Stateline, OR/WA (2001-2002)	Erickson et al. 2004
Hatchet Ridge, CA (2011)	Tetra Tech 2013a	Stateline, OR/WA (2003)	Erickson et al. 2004
Hatchet Ridge, CA (2012)	Tetra Tech 2013a	Stateline, OR/WA (2006)	Erickson et al. 2007
Hatchet Ridge, CA (2012-2013)	Tetra Tech 2014	Steel Winds I & II, NY (2013)	Stantec 2014c
Hay Canyon, OR (2009-2010)	Gritski and Kronner 2010a	Stetson II, ME (2014)	Stantec 2015d
Heritage Garden, MI (2012-2013)	Kerlinger et al. 2014	Stetson Mountain I, ME (2009)	Stantec 2009c
Heritage Garden, MI (2013-2014)	Kerlinger et al. 2014	Stetson Mountain I, ME (2011)	Normandeau Associates 2011
High Sheldon, NY (2010)	Tidhar et al. 2012a	Stetson Mountain I, ME (2013)	Stantec 2014d
High Sheldon, NY (2011)	Tidhar et al. 2012b	Stetson Mountain II, ME (2010)	Normandeau Associates 2010

Appendix E3 (*continued*). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:

Study	Reference	Study	Reference
High Winds, CA (2003-2004)	Kerlinger et al. 2006	Stetson Mountain II, ME (2012)	Stantec 2013d
High Winds, CA (2004-2005)	Kerlinger et al. 2006	Summerview, AB (2005-2006)	Brown and Hamilton 2006
Hopkins Ridge, WA (2006)	Young et al. 2007b	Thunder Spirit, ND (2016-2017)	Derby et al. 2018
Hopkins Ridge, WA (2008)	Young et al. 2009b	Top Crop I & II, IL(2012-2013)	Good et al. 2013b
Howard, NY (2012)	Tidhar et al. 2013b	Top of Iowa, IA (2003)	Jain 2005
Howard, NY (2013)	Lukins et al. 2014	Top of Iowa, IA (2004)	Jain 2005
Kewaunee County, WI (1999-2001)	Howe et al. 2002	Top of the World, WY (2010-2011)	Rintz and Bay 2012
Kittitas Valley, WA (2011-2012)	Stantec Consulting Services 2012	Top of the World, WY (2011-2012)	Rintz and Bay 2013
Klondike, OR (2002-2003)	Johnson et al. 2003	Top of the World, WY (2012-2013)	Rintz and Bay 2014
Klondike II, OR (2005-2006)	Northwest Wildlife Consultants (NWC) and WEST 2007	Tucannon River, WA (2015)	Hallingstad et al. 2016
Klondike III (Phase I), OR (2007-2009)	Gritski et al. 2010	Tuolumne (Windy Point I), WA (2009-2010)	Enz and Bay 2010
Klondike IIIa (Phase II), OR (2008-2010)	Gritski et al. 2011	Vansycle, OR (1999)	Erickson et al. 2000
Lakefield Wind, MN (2012)	Minnesota Public Utilities Commission 2012	Vantage, WA (2010-2011)	Ventus Environmental Solutions 2012
Laurel Mountain, WV (2014)	Stantec 2015a	Waverly Wind, KS (2016-2017)	Tetra Tech 2017a
Leaning Juniper, OR (2006-2008)	Gritski et al. 2008	Wessington Springs, SD (2009)	Derby et al. 2010d
Lempster, NH (2009)	Tidhar et al. 2010	Wessington Springs, SD (2010)	Derby et al. 2011a
Lempster, NH (2010)	Tidhar et al. 2011	White Creek, WA (2007-2011)	Downes and Gritski 2012b
Linden Ranch, WA (2010-2011)	Enz and Bay 2011	Wild Horse, WA (2007)	Erickson et al. 2008
Locust Ridge, PA (Phase II; 2009)	Arnett et al. 2011	Windstar, CA (2012-2013)	Levenstein and Bay 2013b
Locust Ridge, PA (Phase II; 2010)	Arnett et al. 2011	Windy Flats, WA (2010-2011)	Enz et al. 2011
Lower West, CA (2012-2013)	Levenstein and Bay 2013a	Winnebago, IA (2009-2010)	Derby et al. 2010a
Lower West, CA (2014-2015)	Levenstein and DiDonato 2015		

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Alite, CA (2009-2010)	0.55	0.12	Shrub/scrub and grassland	Chatfield et al. 2010a
Alta I, CA (2013-2014)	12.05	0.15	Grassland; shrub steppe	Chatfield et al. 2014
Alta I, CA (2015-2016)	2.57	0.15	Grassland; shrub steppe	Thompson et al. 2016a
Alta II-V, CA (2013-2014)	2.79	0	Grassland; shrub steppe	Chatfield et al. 2014
Alta II-V, CA (2015-2016)	0.51	0	Grassland; shrub steppe	Thompson et al. 2016a
Alta VIII, CA (2012-2013)	0.66	0.02	Grassland and riparian	Chatfield and Bay 2014
Alta VIII, CA (2014-2015)	0.38	0.04	Desert creosote; grassland; Joshua tree	Western EcoSystems Technology, Inc. (WEST) 2016c
Alta VIII, CA (2016-2017)	0.25	NA	Joshua tree; shrub steppe	WEST 2018
Alta X, CA (2014-2015)	4.88	0.04	Forest/woodlot; shrub steppe	Chatfield et al. 2015
Alta X, CA (2015-2016)	2.17	0	Shrub steppe	Thompson et al. 2016b
Alta Wind I, CA (2011-2012)	7.07	0.27	Woodland, grassland, shrubland	Chatfield et al. 2012
Alta Wind II-V, CA (2011-2012)	1.66	0.05	Desert scrub	Chatfield et al. 2012
Barton I & II, IA (2010-2011)	5.5	0	Agriculture	Derby et al. 2011b
Barton Chapel, TX (2009-2010)	1.15	0.25	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	1.19	0.01	Forest	Tidhar et al. 2013a
Beech Ridge, WV (2013)	1.48	0.01	Forest	Young et al. 2014a
Big Blue, MN (2013)	0.6	0	Agriculture	Fagen Engineering 2014
Big Blue, MN (2014)	0.37	0	Agriculture	Fagen Engineering 2015
Big Horn, WA (2006-2007)	2.54	0.11	Agriculture/grassland	Kronner et al. 2008
Big Smile, OK (2012-2013)	0.09	0	Grassland, agriculture	Derby et al. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.76	0.03	Agriculture/grassland	Jeffrey et al. 2009b
Biglow Canyon, OR (Phase I; 2009)	2.47	0	Agriculture/grassland	Enk et al. 2010
Biglow Canyon, OR (Phase II; 2009-2010)	5.53	0.14	Agriculture	Enk et al. 2011b
Biglow Canyon, OR (Phase II; 2010-2011)	2.68	0.03	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	2.28	0.05	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
Bingham Wind Project, ME (2017)	3.46	NA	Bermuda grass/mixed grasses; clover; road and pad	TRC 2017a
Blue Sky Green Field, WI (2008; 2009)	7.17	0	Agriculture	Gruver et al. 2009
Buffalo Gap I, TX (2006)	1.32	0.1	Grassland	Tierney 2007
Buffalo Gap II, TX (2007-2008)	0.15	0	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	11.02	0	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	1.1	0	Forest	Fiedler et al. 2007

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Buffalo Ridge, MN (Phase I; 1996)	4.14	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1997)	2.51	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1998)	3.14	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase I; 1999)	1.43	0.47	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1998)	2.47	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase II; 1999)	3.57	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge, MN (Phase III; 1999)	5.93	0	Agriculture	Johnson et al. 2000a
Buffalo Ridge I, SD (2009-2010)	5.06	0.2	Agriculture/grassland	Derby et al. 2010e
Buffalo Ridge II, SD (2011-2012)	1.99	0	Agriculture, grassland	Derby et al. 2012a
Bull Hill, ME (2013)	8.65	0	Forest	Stantec Consulting, Inc. (Stantec) 2014a
Cameron Ridge/Section 15, CA (2014-2015)	0.45	0.04	Shrub steppe	WEST 2016b
Cameron Ridge/Section 15, CA (2015-2016)	0.57	0	Shrub steppe	Rintz and Thompson 2017
Casselman, PA (2008)	1.51	0	Forest	Arnett et al. 2009
Casselman, PA (2009)	2.88	0	Forest, pasture, grassland	Arnett et al. 2010
Cedar Ridge, WI (2009)	6.55	0.18	Agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	3.72	0.13	Agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	1.39	0	Agriculture/forest	Stantec 2010
Cohocton/Dutch Hill, NY (2013)	1.58	NA	Agriculture; forest/woodlot	Stantec 2014b
Cohocton/Dutch Hills, NY (2010)	1.32	0.08	Agriculture/forest	Stantec 2011a
Combine Hills, OR (Phase I; 2004-2005)	2.56	0	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	2.33	0.05	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Criterion, MD (2011)	6.4	0.02	Forest, agriculture	Young et al. 2012b
Criterion, MD (2012)	2.14	NA	Forest, agriculture	Young et al. 2013
Criterion, MD (2013)	3.49	NA	Forest, agriculture	Young et al. 2014b
Diablo Winds, CA (2005-2007)	4.29	0.4	NA	WEST 2006, 2008
Dillon, CA (2008-2009)	4.71	0	Desert	Chatfield et al. 2009
Dry Lake I, AZ (2009-2010)	2.02	0	Desert grassland/forested	Thompson et al. 2011
Dry Lake II, AZ (2011-2012)	1.57	0	Desert grassland/forested	Thompson and Bay 2012
Elkhorn, OR (2008)	0.64	0.06	Shrub/scrub & agriculture	Jeffrey et a. 2009a
Elkhorn, OR (2010)	1.95	0.08	Shrub/scrub & agriculture	Enk et al. 2011a
Elm Creek, MN (2009-2010)	1.55	0	Agriculture	Derby et al. 2010f
Elm Creek II, MN (2011-2012)	3.64	0	Agriculture, grassland	Derby et al. 2012b

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Foote Creek Rim I, WY (1999)	3.4	0.08	Grassland	Young et al. 2003a
Foote Creek Rim I, WY (2000)	2.42	0.05	Grassland	Young et al. 2003a
Foote Creek Rim I, WY (2001-2002)	1.93	0	Grassland	Young et al. 2003a
Foote Creek Rim, WY (UV; 1999-2000)	2.3	0.06	Grassland	Young et al. 2003b
Fowler I, IN (2009)	2.83	0	Agriculture	Johnson et al. 2010
Goodnoe, WA (2009-2010)	1.4	0.17	Grassland and shrub-steppe	URS Corporation (URS) 2010a
Grand Ridge I, IL (2009-2010)	0.48	0	Agriculture	Derby et al. 2010a
Groton, NH (2013)	2.45	0.06	Forest/woodlot	Stantec and WEST 2014
Groton, NH (2014)	1.5	0	Forest/woodlot	Stantec and WEST 2015a
Groton, NH (2015)	0.98	0.22	Forest/woodlot	Stantec and WEST 2015b
Hancock, ME (2017)	1.52	NA	Clover; gravel; road and pad	TRC 2017b
Harvest Wind, WA (2010-2012)	2.94	0.23	Grassland/shrub-steppe	Downes and Gritski 2012a
Hatchet Ridge, CA (2011)	2.5	0.03	Forest/woodlot	Tetra Tech 2013a
Hatchet Ridge, CA (2012)	0.83	NA	Forest/woodlot	Tetra Tech 2013a
Hatchet Ridge, CA (2012-2013)	1.22	0	NA	Tetra Tech 2014
Hay Canyon, OR (2009-2010)	2.21	0	Agriculture	Gritski and Kronner 2010a
Heritage Garden, MI (2012-2013)	1.3	NA	Agriculture	Kerlinger et al. 2014
Heritage Garden, MI (2013-2014)	2.4	NA	Agriculture	Kerlinger et al. 2014
High Sheldon, NY (2010)	1.76	0.06	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.57	0	Agriculture	Tidhar et al. 2012b
High Winds, CA (2003-2004)	1.62	0.5	Agriculture/grassland	Kerlinger et al. 2006
High Winds, CA (2004-2005)	1.1	0.28	Agriculture/grassland	Kerlinger et al. 2006
Hopkins Ridge, WA (2006)	1.23	0.14	Agriculture/grassland	Young et al. 2007b
Hopkins Ridge, WA (2008)	2.99	0.07	Agriculture/grassland	Young et al. 2009b
Howard, NY (2012)	1.29	NA	Agriculture; forest/woodlot; pasture	Tidhar et al. 2013b
Howard, NY (2013)	0.37	NA	Agriculture; forest/woodlot; pasture	Lukins et al. 2014
Kewaunee County, WI (1999-2001)	1.95	0	Agriculture	Howe et al. 2002
Kittitas Valley, WA (2011-2012)	1.06	0.09	Sagebrush-steppe, grassland	Stantec Consulting Services 2012
Klondike, OR (2002-2003)	0.95	0	Agriculture/grassland	Johnson et al. 2003
Klondike II, OR (2005-2006)	3.14	0.06	Agriculture/grassland	Northwest Wildlife Consultants (NWC) and WEST 2007
Klondike III (Phase I), OR (2007-2009)	3.02	0.15	Agriculture/grassland	Gritski et al. 2010

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Klondike IIIa (Phase II), OR (2008-2010)	2.61	0.06	Grassland/shrub-steppe and agriculture	Gritski et al. 2011
Lakefield Wind, MN (2012)	2.75	0	Agriculture	Minnesota Public Utilities Commission 2012
Laurel Mountain, WV (2014)	3.1	NA	Forest/woodlot	Stantec 2015a
Leaning Juniper, OR (2006-2008)	6.66	0.16	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.38	0	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	2.64	0	Grasslands/forest/rocky embankments	Tidhar et al. 2011
Linden Ranch, WA (2010-2011)	6.65	0.27	Grassland/shrub-steppe, agriculture	Enz and Bay 2011
Locust Ridge, PA (Phase II; 2009)	0.84	0	Grassland	Arnett et al. 2011
Locust Ridge, PA (Phase II; 2010)	0.76	0	Grassland	Arnett et al. 2011
Lower West, CA (2012-2013)	3.5	0	Joshua tree; shrub steppe	Levenstein and Bay 2013a
Lower West, CA (2014-2015)	0.9	0	Joshua tree; shrub steppe	Levenstein and DiDonato 2015
Lower West, CA (2016-2017)	0.73	0	Joshua tree; shrub steppe	WEST 2017b
Maple Ridge, NY (2007)	2.34	NA	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	2.07	0.03	Agriculture/forested	Jain et al. 2009b
Marengo I, WA (2009-2010)	0.27	0	Agriculture	URS 2010b
Marengo II, WA (2009-2010)	0.16	0.05	Agriculture	URS 2010c
Mars Hill, ME (2007)	1.67	0	Forest	Stantec 2008
Mars Hill, ME (2008)	1.76	0	Forest	Stantec 2009a
Milford I, UT (2010-2011)	0.56	NA	Desert shrub	Stantec 2011b
Milford I & II, UT (2011-2012)	0.73	0.04	Desert shrub	Stantec 2012
Montezuma I, CA (2011)	5.19	1.06	Agriculture and grasslands	ICF International 2012
Montezuma I, CA (2012)	8.91	0.79	Agriculture and grasslands	ICF International 2013
Montezuma II, CA (2012-2013)	1.08	0.46	Agriculture	Harvey & Associates 2013
Moraine II, MN (2009)	5.59	0.37	Agriculture/grassland	Derby et al. 2010g
Mount Storm, WV (2009)	3.85	0	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	2.6	0.1	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	4.24	0.03	Forest	Young et al. 2011a, 2012a
Mountaineer, WV (2003)	2.69	0.07	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.48	0.59	Agriculture/forest	Stantec 2009b
Mustang Hills, CA (2012-2013)	1.66	0.08	Grasslands and Riparian	Chatfield and Bay 2014
Mustang Hills, CA (2014-2015)	0.97	0.03	Desert creosote; grassland; Joshua tree	WEST 2016c

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Mustang Hills, CA (2016-2017)	0.54	0.15	Joshua tree; shrub steppe	WEST 2018
Nine Canyon, WA (2002-2003)	2.76	0.03	Agriculture/grassland	Erickson et al. 2003a
Noble Altona, NY (2010)	1.84	0	Forest	Jain et al. 2011a
Noble Bliss, NY (2008)	1.3	0.1	Agriculture/forest	Jain et al. 2009c
Noble Bliss, NY (2009)	2.28	0.12	Agriculture/forest	Jain et al. 2010c
Noble Chateaugay, NY (2010)	1.66	0.08	Agriculture	Jain et al. 2011b
Noble Clinton, NY (2008)	1.59	0.1	Agriculture/forest	Jain et al. 2009d
Noble Clinton, NY (2009)	1.11	0.16	Agriculture/forest	Jain et al. 2010a
Noble Ellenburg, NY (2008)	0.83	0.11	Agriculture/forest	Jain et al. 2009e
Noble Ellenburg, NY (2009)	2.66	0.25	Agriculture/forest	Jain et al. 2010b
Noble Wethersfield, NY (2010)	1.7	0.13	Agriculture	Jain et al. 2011c
NPPD Ainsworth, NE (2006)	1.63	0.06	Agriculture/grassland	Derby et al. 2007
Oakfield, ME (2017)	4.23	NA	Bermuda grass/mixed grasses; clover; gravel	TRC 2018
Odell, MN (2016-2017)	4.69	NA	Agriculture	Chodachek and Gustafson 2018
Pacific Wind, CA (2014-2015)	0.17	NA	Desert creosote; Joshua tree; pinyon pine/ juniper	WEST 2016a
Pacific Wind, CA (2015-2016)	0.77	0.07	Desert creosote; Joshua tree; pinyon pine/ juniper	WEST 2017a
Palouse Wind, WA (2012-2013)	0.72	NA	Agriculture and grasslands	Stantec 2013a
Passadumkeag, ME (2016)	1.91	NA	Mixed forest	Ritzert et al. 2017
Pebble Springs, OR (2009-2010)	1.93	0.04	Grassland	Gritski and Kronner 2010b
Pine Tree, CA (2009-2010, 2011)	17.44	NA	Grassland	Bio Resource Consultants 2012
Pinnacle, WV (2012)	3.99	0	Forest	Hein et al. 2013
Pinyon Pines I & II, CA (2013-2014)	1.18	0	NA	Chatfield and Russo 2014
Pinyon Pines I & II, CA (2015-2016)	0.5	0.02	Desert creosote; Joshua tree	Rintz and Starcevich 2016
Pinyon Pines I & II, CA (2017-2018)	0.56	0.01	Joshua tree; shrub steppe	Rintz and Pham 2018
Pioneer Prairie I, IA (Phase II; 2011-2012)	0.27	0	Agriculture, grassland	Chodachek et al. 2012
Pleasant Valley, MN (2016-2017)	0.68	NA	Agriculture; grassland; wetlands	Tetra Tech 2017b
Prairie Rose, MN (2014)	0.44	0.08	Agriculture; grassland	Chodachek et al. 2015
PrairieWinds ND1 (Minot), ND (2010)	1.48	0.05	Agriculture	Derby et al. 2011d
PrairieWinds ND1 (Minot), ND (2011)	1.56	0.05	Agriculture, grassland	Derby et al. 2012d
PrairieWinds SD1, SD (2011-2012)	1.41	0	Grassland	Derby et al. 2012c
PrairieWinds SD1, SD (2012-2013)	2.01	0.03	Grassland	Derby et al. 2013a
PrairieWinds SD1, SD (2013-2014)	1.66	0.17	Grassland	Derby et al. 2014
Prince Wind Farm, ON (2007)	0.26	NA	Forest	NRSI 2008

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Prince Wind Farm, ON (2008)	0.89	NA	Forest	NRSI 2009
Rail Splitter, IL (2012-2013)	0.84	0	Agriculture	Good et al. 2013a
Record Hill, ME (2012)	3.7	NA	Forest	Stantec 2013b
Record Hill, ME (2014)	1.84	NA	Forest	Stantec 2015b
Record Hill, ME (2016)	2.85	NA	Forest/woodlot; rocky outcrop	Stantec 2017
Red Hills, OK (2012-2013)	0.08	0.04	Grassland	Derby et al. 2013c
Ripley, ON (2008)	3.09	0.1	Agriculture	Jacques Whitford 2009
Rising Tree, CA (2015-2016)	3.13	0.06	Joshua tree; shrub steppe	Rintz et al. 2016
Rising Tree, CA (2017-2018)	1.63	0.14	Desert creosote; Joshua tree; shrub steppe	Chatfield et al. 2018
Rollins, ME (2012)	2.9	NA	Forest	Stantec 2013c
Rollins, ME (2014)	3.43	NA	Forest/woodlot; gravel	Stantec 2015c
Roth Rock, MD (2011)	3.12	NA	Forest/woodlot; rocky outcrop	Atwell, LLC 2012
Rugby, ND (2010-2011)	3.82	0.06	Agriculture	Derby et al. 2011c
Shiloh I, CA (2006-2009)	6.96	0.42	Agriculture/grassland	Kerlinger et al. 2009
Shiloh II, CA (2009-2010)	1.9	0.11	Agriculture	Kerlinger et al. 2010
Shiloh II, CA (2010-2011)	2.8	0.44	Agriculture	Kerlinger et al. 2013a
Shiloh II, CA (2011-2012)	2.8	0.97	Agriculture	Kerlinger et al. 2013a
Shiloh III, CA (2012-2013)	3.3	NA	NA	Kerlinger et al. 2013b
Solano III, CA (2012-2013)	1.6	0.95	NA	AECOM 2013
Spring Valley, NV (2012-2013)	0.26	0.05	Grassland; shrub steppe	WEST 2014
Spruce Mountain Wind Project, ME (2014)	5.03	NA	Forest/woodlot; gravel; rocky outcrop	Tetra Tech 2015
Stateline, OR/WA (2001-2002)	3.17	0.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2003)	2.68	0.09	Agriculture/grassland	Erickson et al. 2004
Stateline, OR/WA (2006)	1.23	0.11	Agriculture/grassland	Erickson et al. 2007
Steel Winds I & II, NY (2013)	6.2	0.83	Deciduous shrub; grassland; gravel; other	Stantec 2014c
Stetson II, ME (2014)	3.25	NA	Bermuda grass/mixed grasses; forest/woodlot	Stantec 2015d
Stetson Mountain I, ME (2009)	2.68	0	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	1.18	0	Forest	Normandeau Associates 2011
Stetson Mountain I, ME (2013)	6.95	0	Forest	Stantec 2014d
Stetson Mountain II, ME (2010)	1.42	0	Forest	Normandeau Associates 2010
Stetson Mountain II, ME (2012)	3.37	0	Forest	Stantec 2013d
Summerview, AB (2005-2006)	1.06	0.11	Agriculture	Brown and Hamilton 2006
Thunder Spirit, ND (2016-2017)	1.49	0.18	Agriculture; grassland	Derby et al. 2018

Appendix E4. Fatality estimates for North American wind-energy facilities.

Study	Bird Fatalities (birds/MW/year)	Raptor Fatalities (raptors/MW/year)	Predominant Habitat Type	Reference
Top Crop I & II, IL (2012-2013)	1.35	NA	Agriculture	Good et al. 2013b
Top of Iowa, IA (2003)	0.42	0	Agriculture	Jain 2005
Top of Iowa, IA (2004)	0.81	0.17	Agriculture	Jain 2005
Top of the World, WY (2010-2011)	0.69	0.04	Grassland; other	Rintz and Bay 2012
Top of the World, WY (2011-2012)	0.77	0.04	Grassland; other	Rintz and Bay 2013
Top of the World, WY (2012-2013)	0.3	0.05	Grassland; other	Rintz and Bay 2014
Tucannon River, WA (2015)	1.5	0.16	Cropland; developed; grassland; shrub steppe; winter wheat	Hallingstad et al. 2016
Tuolumne (Windy Point I), WA (2009-2010)	3.2	0.29	Grassland/shrub-steppe, agriculture and forest	Enz and Bay 2010
Vansycle, OR (1999)	0.95	0	Agriculture/grassland	Erickson et al. 2000
Vantage, WA (2010-2011)	1.27	0.29	Shrub-steppe, grassland	Ventus Environmental Solutions 2012
Waverly Wind, KS (2016-2017)	5.95	NA	Agriculture; grassland	Tetra Tech 2017a
Wessington Springs, SD (2009)	8.25	0.06	Grassland	Derby et al. 2010d
Wessington Springs, SD (2010)	0.89	0.07	Grassland	Derby et al. 2011a
White Creek, WA (2007-2011)	4.05	0.47	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
Wild Horse, WA (2007)	1.55	0.09	Grassland	Erickson et al. 2008
Windstar, CA (2012-2013)	6.65	0.18	Grassland; pinyon pine/ juniper	Levenstein and Bay 2013b
Windy Flats, WA (2010-2011)	8.45	0.04	Grassland/shrub-steppe, agriculture	Enz et al. 2011
Winnebago, IA (2009-2010)	3.88	0.27	Agriculture/grassland	Derby et al. 2010a

DATE: 23 May 2017

TO: James Lynch, K&L Gates; John Wycherly, Leeward Energy

FROM: Victoria Poulton, WEST, Inc.

RE: DRAFT - Confidential Business Informational/Pre-Decisional
Survey results, aerial raptor nest surveys at the Cedar Creek Project, 2017

Western EcoSystems Technology, Inc. (WEST) conducted two aerial survey rounds for raptor nests at the Cedar Creek Wind Project (the Project) on 25-26 February and 2-3 May 2017. The aerial surveys were designed to detect raptor nests within one mile of the Project boundary, and any eagle nests within 10 miles of the Project boundary. Surveys were conducted from a helicopter with two observers in addition to the pilot. During the surveys, potential nesting habitat such as trees, power poles, rocky outcrops, and cliff faces were examined for stick nest structures and the presence of raptors.

During the February survey, two great horned owl nests, one golden eagle nest, one prairie falcon aerie, one great blue heron rookery, and 135 inactive nests were detected (Table 1, Figure 1). Of the 135 inactive nests, 28 were large stick nests on cliffs that could be used by golden eagles. Many of the raptor nests recorded were more than one mile from the Project boundary; only the prairie falcon nest and 42 inactive nests were within the one-mile buffer. The active golden eagle nest was in a previously unrecorded location about 8.8 miles (mi; 14.1 kilometers [km]) northwest of the Project. Other golden eagle nest locations known from surveys during previous years were not occupied during the February 2017 survey.

During the May survey, there was increased nesting activity (Table 1, Figure 2). Fourteen active ferruginous hawk nests, 13 active red-tailed hawk nests, five great-horned owl nests, four active golden eagle nests, three active nests of unknown species, one active prairie falcon aerie, and 98 inactive nests were detected (Table 1, Figure 2). Of the inactive nests, 23 were large stick nests that could be used by golden eagles. In addition, two Canada goose nests were seen in trees, and the great blue heron rookery was recorded again. Four of the ferruginous hawk nests, three of the red-tail nests, one of the great-horned owls, one golden eagle nest, and 35 of the inactive nests were within the Project boundary or the one-mile buffer. The golden eagle nest that was detected in February was still active during the May survey, with an adult observed on the nest. Two golden eagle nests in known locations from pervious years that were inactive in February were active with adults observed at the nests in May. One nest was about 0.7 mi (1.1 km) south of Project turbine P15, and one was 7.0 mi (11.2 km) to the east. A fourth active golden eagle nest was in a previously unrecorded location 1.7 mi (2.7 km) southwest of Project turbine A10.

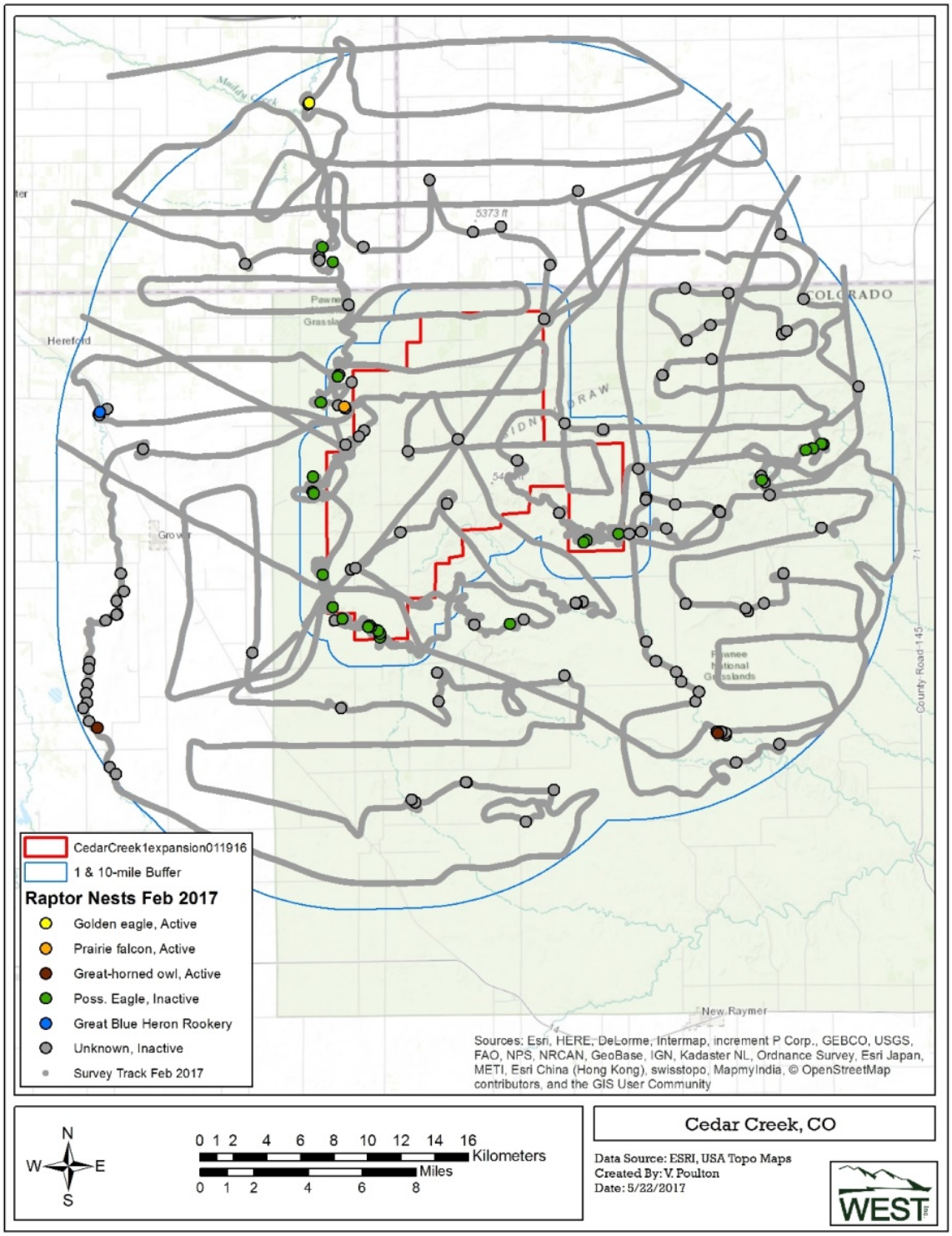


Figure 1. Raptor nests detected during aerial raptor nest surveys at the Cedar Creek Wind Project, 25-26 February 2017.

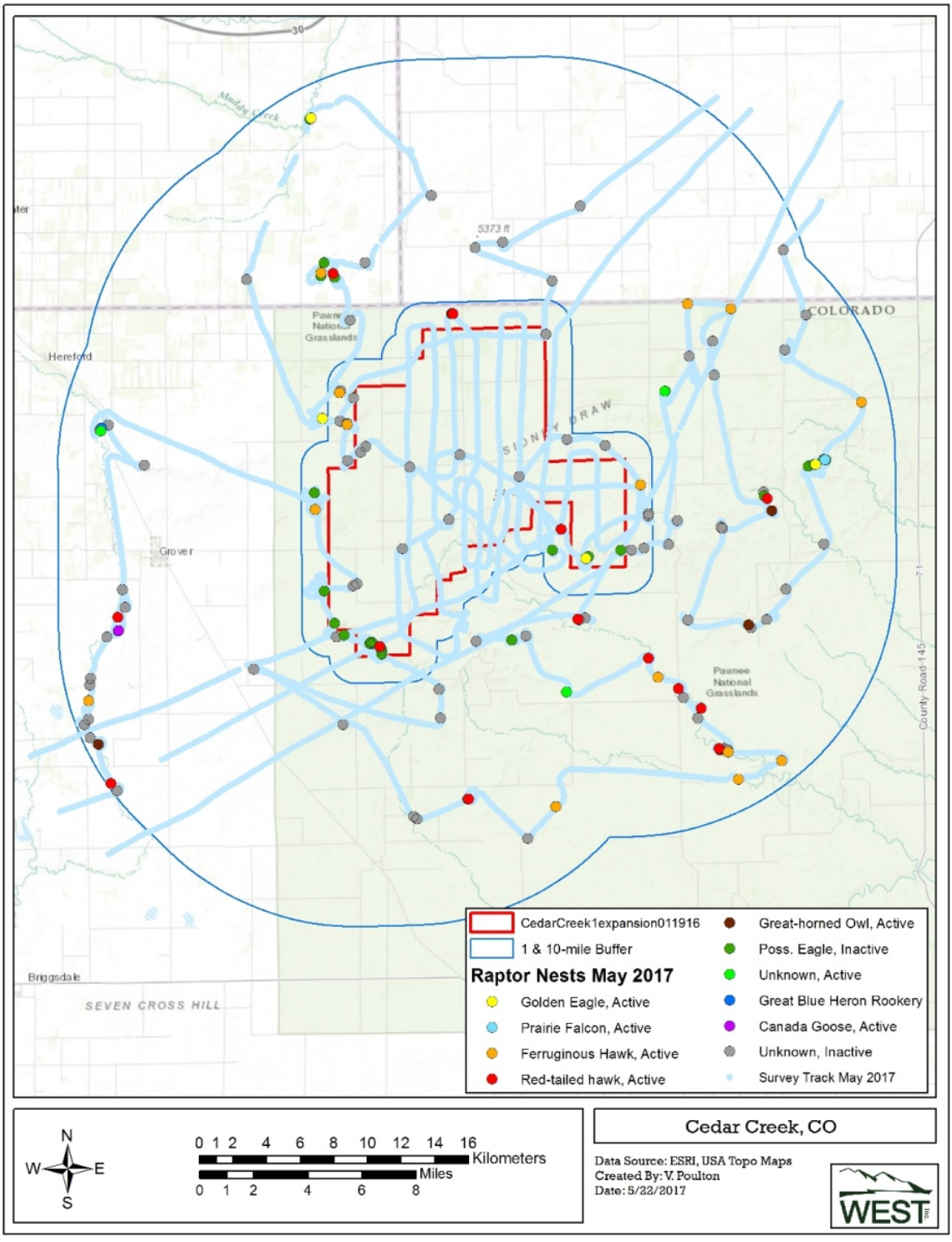


Figure 2. Raptor nests detected during aerial raptor nest surveys at the Cedar Creek Wind Project, 2-3 May 2017.

Table 1. List of all observations during aerial raptor nest surveys at the Cedar Creek Wind Project on 25-26 February and 2-3 May 2017. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Location	Date 1	Species 1	Status 1	Date 2	Species 2	Status 2
357	574267	4550528		2/25/2017	Golden eagle	Active	5/3/2017	Golden Eagle	Active
358	574212	4550447		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
359	590278	4545275		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
360	577478	4541929		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
361	581426	4545911		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
362	584018	4542804		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
363	585670	4543140		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
364	588611	4540845		2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
365	588247	4537643	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
366	602356	4542671		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
367	603706	4538815		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
368	607017	4533601		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
369	604880	4530170		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
370	604769	4530191		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
371	604221	4529903		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
372	604270	4529904		2/25/2017	Other	Inactive	5/2/2017	Golden Eagle	Active
373	603849	4529788		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
374	602271	4512265		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
375	599695	4511166		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
376	597289	4514797		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
377	597479	4515388		2/25/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
378	596414	4516008		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
379	596122	4516563		2/25/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
380	594913	4517229		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
381	594354	4518368		2/25/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
382	594350	4526974	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
383	594329	4526842	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
384	593864	4528690	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Ferruginous Hawk	Active
385	599241	4539159		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
386	596660	4539459		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
387	596760	4536339		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
388	598168	4537245		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive

Table 1. List of all observations during aerial raptor nest surveys at the Cedar Creek Wind Project on 25-26 February and 2-3 May 2017. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Location	Date 1	Species 1	Status 1	Date 2	Species 2	Status 2
389	602451	4536733		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
390	602708	4536914		2/25/2017	Other	Inactive	5/2/2017	Not Detected	
391	598246	4535219		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
392	595336	4534276		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
393	595319	4534265		2/25/2017	Other	Inactive	5/2/2017	Other	Active
394	591777	4531040	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
395	589486	4531391	In 1-mi Buffer	2/25/2017	Other	Inactive	5/3/2017	Other	Inactive
396	601692	4527141		2/25/2017	Other	Inactive	5/2/2017	Great-horned Owl	Active
397	601416	4527870		2/25/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
398	601224	4528025		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
399	601191	4528269		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
400	596054	4526564		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
401	598651	4526190		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
402	598748	4526094		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
403	604782	4525160		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
404	596699	4520644		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
405	600430	4520183		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
406	600295	4520362		2/25/2017	Other	Inactive	5/2/2017	Great-horned Owl	Active
407	601374	4520678		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
408	602526	4522470		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
409	599085	4512798		2/25/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
410	599071	4512919		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
411	598839	4513002		2/25/2017	Other	Inactive	5/2/2017	Other	Inactive
412	598612	4512904		2/25/2017	Great-horned owl	Active	5/2/2017	Great-horned Owl	Active
413	598538	4512986		2/25/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
414	570432	4540908		2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
415	575046	4541905		2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
416	574863	4541306		2/26/2017	Other	Inactive	5/3/2017	Ferruginous Hawk	Active
417	574849	4541135		2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
418	575666	4541029		2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
419	576601	4538479		2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
420	562207	4532249		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
421	561793	4532072		2/26/2017	Great Blue Heron	Active	5/2/2017	Great Blue Heron	Active

Table 1. List of all observations during aerial raptor nest surveys at the Cedar Creek Wind Project on 25-26 February and 2-3 May 2017. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Location	Date 1	Species 1	Status 1	Date 2	Species 2	Status 2
422	561723	4531938		2/26/2017	Other	Inactive	5/2/2017	Canada Goose	Active
423	561756	4531903		2/26/2017	Other	Inactive	5/2/2017	Other	Active
424	576383	4532337	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
425	576415	4532272	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Ferruginous Hawk	Active
426	576341	4532405	In 1-mi Buffer	2/26/2017	Prairie falcon	Tending	5/3/2017	Not Detected	
427	575992	4532472	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
428	574944	4532648		2/26/2017	Other	Inactive	5/3/2017	Golden Eagle	Active
429	576803	4533862	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
430	575954	4534179	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Ferruginous Hawk	Active
431	576028	4534284	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
432	577516	4530974	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
433	577237	4530618	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
434	576426	4530137	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
435	564354	4529860		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
436	563035	4522447		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
437	563194	4521383		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
438	562777	4520804		2/26/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
439	562830	4520025		2/26/2017	Other	Inactive	5/2/2017	Canada Goose	Active
440	562786	4519988		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
441	562115	4519643		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
442	561147	4517178		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
443	561112	4516759		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
444	561046	4515841		2/26/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
445	560946	4515292		2/26/2017	Other	Inactive	5/2/2017	Not Detected	
446	561024	4514731		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
447	560794	4514423		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
448	561123	4513625		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
449	561619	4513242		2/26/2017	Great-horned owl	Active	5/2/2017	Great-horned Owl	Active
450	562379	4510906		2/26/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
451	562720	4510495		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
452	587170	4507639		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
453	588836	4509542		2/26/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
454	583631	4509981		2/26/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active

Table 1. List of all observations during aerial raptor nest surveys at the Cedar Creek Wind Project on 25-26 February and 2-3 May 2017. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Location	Date 1	Species 1	Status 1	Date 2	Species 2	Status 2
455	583599	4509998		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
456	580567	4508802		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
457	580366	4508950		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
458	589467	4516358		2/26/2017	Other	Inactive	5/2/2017	Other	Active
459	581874	4516511		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
460	581966	4514797		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
461	576162	4514417		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
462	592699	4524805	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
463	593327	4524812	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
464	594063	4524920	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
465	595533	4525133		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
466	590772	4524413	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
467	590608	4524305	Within Project	2/26/2017	Other	Inactive	5/3/2017	Golden Eagle	Active
468	589146	4526044	In 1-mi Buffer	2/26/2017	Other	Inactive	5/3/2017	Red-tailed Hawk	Active
469	586640	4529178	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
470	583122	4530462	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
471	580135	4529742	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
472	590575	4520772		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
473	590217	4520649		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
474	590148	4520694		2/26/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
475	582460	4526622	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
476	579700	4524900	Within Project	2/26/2017	Other	Inactive	5/3/2017	Other	Inactive
477	576765	4522680	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
478	577004	4522783	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
479	587056	4519709		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
480	586209	4519440		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
481	584098	4519392		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
482	578475	4518616	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
483	578468	4518866	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
484	578366	4519060	Within Project	2/26/2017	Other	Inactive	5/2/2017	Red-tailed Hawk	Active
485	578388	4519034	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
486	577933	4519245	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
487	577868	4519339	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive

Table 1. List of all observations during aerial raptor nest surveys at the Cedar Creek Wind Project on 25-26 February and 2-3 May 2017. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Location	Date 1	Species 1	Status 1	Date 2	Species 2	Status 2
488	577773	4519242	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
489	576239	4519743	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
490	575774	4519643	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
491	575662	4520434	Within Project	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
492	570852	4517719		2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
493	575053	4522375	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
494	574456	4527325	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Not Detected	
495	574512	4527224	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Ferruginous Hawk	Active
496	574474	4528212	In 1-mi Buffer	2/26/2017	Other	Inactive	5/2/2017	Other	Inactive
873	604851	4530185					5/2/2017	Prairie Falcon	Active
874	588628	4524808	In 1-mi Buffer				5/3/2017	Other	Inactive
875	575581	4541262					5/3/2017	Red-tailed Hawk	Active
876	582718	4538871	In 1-mi Buffer				5/3/2017	Red-tailed Hawk	Active
877	582627	4538876	In 1-mi Buffer				5/3/2017	Great-horned Owl	Active

DATE: 22 May 2018

TO: James Lynch, K&L Gates; John Wycherly, Leeward Energy

FROM: Victoria Poulton, WEST, Inc.

RE: DRAFT - Confidential Business Informational/Pre-Decisional
Survey results, aerial raptor nest surveys at the Mountain Breeze Project, 2018

Western EcoSystems Technology, Inc. (WEST) conducted two aerial survey rounds for raptor nests at the Mountain Breeze Wind Project (the Project) on 10-12 March and 8 May 2018. The aerial surveys were designed to detect raptor nests within one mile of the Project boundary, and any eagle nests within 10 miles of the Project boundary. Surveys were conducted from a helicopter with two observers in addition to the pilot. During the first survey, potential nesting habitat such as trees, power poles, rocky outcrops, and cliff faces were examined for stick nest structures and the presence of raptors, and previously detected golden eagle nest locations were visited. Potential prey sources for golden eagles such as prairie dog colonies and waterfowl concentrations also were recorded during the first survey round. The second survey round targeted previously identified nest locations.

During the first survey round in March, three active golden eagle nests and 51 inactive nests were detected (Table 1). Of the 135 inactive nests, 46 were large stick nests on cliffs that could be used by golden eagles, though many were in poor condition. Most of the raptor nests recorded were more than one mile from the Project boundary; only eight inactive nests were within the one-mile buffer (Table 1). The three active golden eagle nests were in previously recorded locations to the south and east of the Project. The nearest golden eagle nest was about 4.0 miles (mi; 6.4 kilometers [km]) south-southwest of the Project boundary. Other golden eagle nest locations known from surveys during previous years were not occupied during the March 2018 survey.

During the May survey, there was increased nesting activity (Table 1, Figure 1). Six ferruginous hawk nests, four great horned owl nests, four golden eagle nests, three red-tailed hawk nests, one two Swainson's hawk nests, and one active prairie falcon aerie were recorded as active, and 54 inactive nests were detected (Table 1, Figure 2). Of the inactive nests, 39 were large stick nests that could be used by golden eagles. One golden eagle nest that was active in March was not occupied during the May survey. One of the active red-tailed hawk nests and 11 of the inactive nests were within the Project boundary or the one-mile buffer (Table 1). All four active golden eagle nests were observed to have an adult on the nest, and chicks were seen in one of the nests. The nearest active golden eagle nest to the Project was 2.6 mi (4.2 km) west of the Project. Other active nests were between 4.7 mi (7.5 km) and 7.4 mi (11.8 km) from the Project boundary.

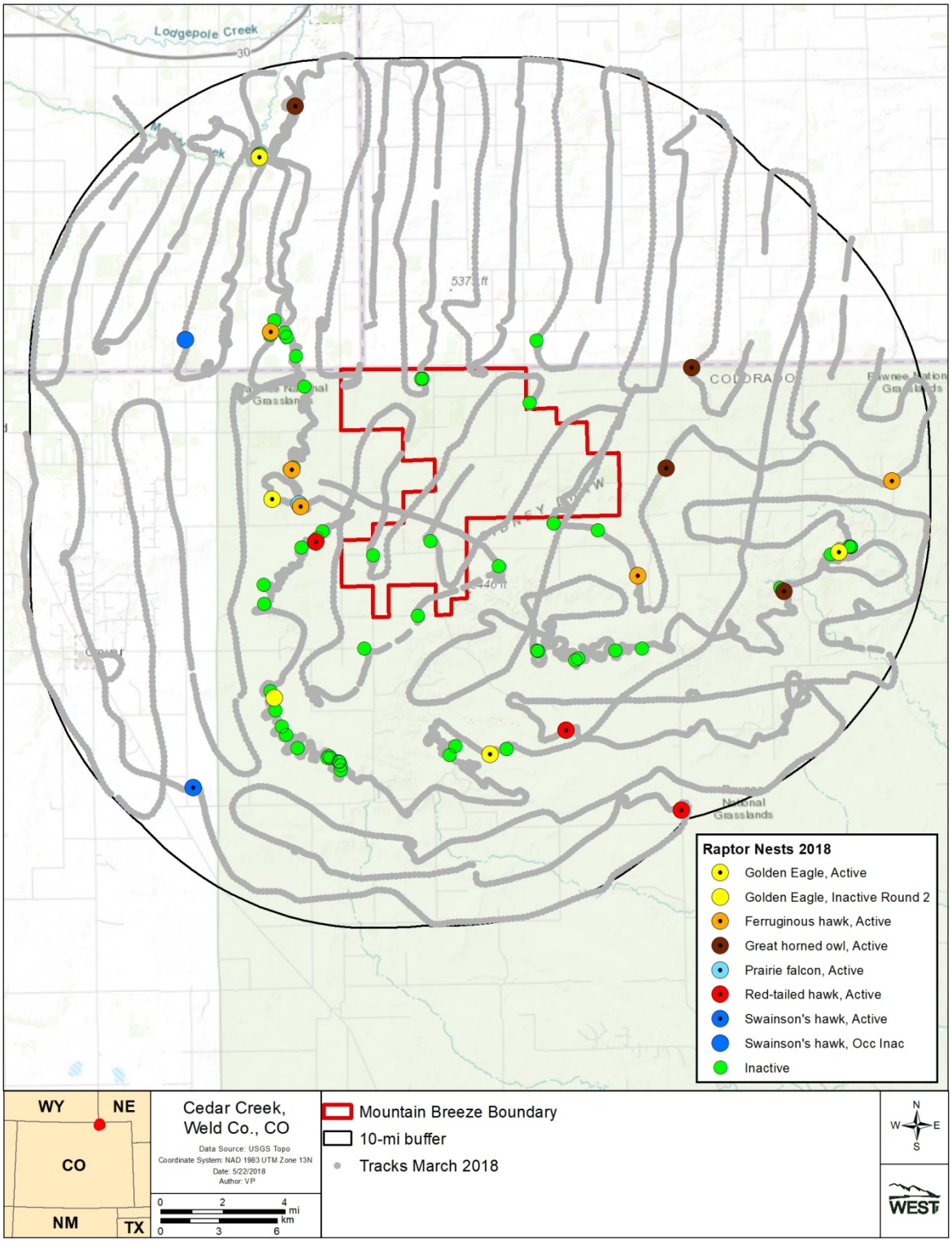


Figure 1. Raptor nests detected during aerial raptor nest surveys at the Mountain Breeze Wind Project, March 10-12 and May 8, 2018.

Table 1. List of all nests detected during aerial raptor nest surveys at the Mountain Breeze Wind Project, March 10-12 and May 8, 2018. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Date 1	Status 1	Date 2	Status 2	Species	Location
357	574267	4550528	3/10/2018	Inactive	5/8/2018	Inactive	Other	
358	574212	4550447	3/10/2018	Inactive	5/8/2018	Inactive	Other	
364	588611	4540845	3/10/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
365	588247	4537643	3/10/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
368	607017	4533601			5/8/2018	Active	Ferruginous hawk	
369	604880	4530170	3/12/2018	Inactive	5/8/2018	Inactive	Other	
370	604769	4530191	3/12/2018	Inactive	5/8/2018	Inactive	Other	
371	604221	4529903	3/12/2018	Inactive	5/8/2018	Inactive	Other	
372	604270	4529904	3/12/2018	Active	5/8/2018	Active	Golden Eagle	
373	603849	4529788	3/12/2018	Inactive	5/8/2018	Inactive	Other	
379	596122	4516563			5/8/2018	Active	Red-tailed hawk	
384	593864	4528690			5/8/2018	Active	Ferruginous hawk	
386	596660	4539459			5/8/2018	Active	Great horned owl	
393	595319	4534265			5/8/2018	Active	Great horned owl	
394	591777	4531040	3/10/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
395	589486	4531391	3/10/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
397	601416	4527870			5/8/2018	Active	Great horned owl	
398	601224	4528025	3/12/2018	Inactive	5/8/2018	Inactive	Other	
414	570432	4540908			5/8/2018	Occ Inac	Swainson's hawk	
415	575046	4541905	3/10/2018	Inactive	5/8/2018	Inactive	Other	
416	574863	4541306	3/10/2018	Inactive	5/8/2018	Active	Ferruginous hawk	
417	574849	4541135	3/10/2018	Inactive	5/8/2018	Inactive	Other	
418	575666	4541029	3/10/2018	Inactive	5/8/2018	Inactive	Other	
419	576601	4538479			5/8/2018	Inactive	Other	
424	576383	4532337	3/12/2018	Inactive	5/8/2018	Inactive	Other	

Table 1. List of all nests detected during aerial raptor nest surveys at the Mountain Breeze Wind Project, March 10-12 and May 8, 2018. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Date 1	Status 1	Date 2	Status 2	Species	Location
425	576415	4532272	3/12/2018	Inactive	5/8/2018	Active	Ferruginous hawk	
426	576341	4532405			5/8/2018	Active	Prairie falcon	
428	574944	4532648	3/12/2018	Inactive	5/8/2018	Active	Golden Eagle	
430	575954	4534179	3/12/2018	Inactive	5/8/2018	Active	Ferruginous hawk	
431	576028	4534284			5/8/2018	Inactive	Other	
432	577516	4530974	3/12/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
433	577237	4530618	3/12/2018		5/8/2018	Inactive	Other	In 1-mi Buffer
434	576426	4530137			5/8/2018	Inactive	Other	
462	592699	4524805	3/12/2018	Inactive	5/8/2018	Inactive	Other	
464	594063	4524920	3/12/2018	Inactive	5/8/2018	Inactive	Other	
466	590772	4524413	3/12/2018	Inactive	5/8/2018	Inactive	Other	
467	590608	4524305	3/12/2018	Inactive	5/8/2018	Inactive	Other	
469	586640	4529178			5/8/2018	Inactive	Other	
470	583122	4530462	3/10/2018		5/8/2018	Inactive	Other	In Project
471	580135	4529742	3/10/2018		5/8/2018	Inactive	Other	In Project
474	590148	4520694			5/8/2018	Active	Red-tailed hawk	
475	582460	4526622	3/10/2018	Inactive	5/8/2018	Inactive	Other	In 1-mi Buffer
476	579700	4524900			5/8/2018	Inactive	Other	
479	587056	4519709	3/12/2018	Inactive	5/8/2018	Inactive	Other	
480	586209	4519440	3/12/2018	Active	5/8/2018		Golden Eagle	
481	584098	4519392	3/12/2018	Inactive	5/8/2018	Inactive	Other	
482	578475	4518616	3/12/2018	Inactive	5/8/2018	Inactive	Other	
483	578468	4518866	3/12/2018	Inactive	5/8/2018	Inactive	Other	
484	578366	4519060	3/12/2018	Inactive	5/8/2018	Inactive	Other	
485	578388	4519034	3/12/2018	Inactive	5/8/2018	Inactive	Other	
486	577933	4519245	3/12/2018	Inactive	5/8/2018	Inactive	Other	
487	577868	4519339	3/12/2018	Inactive	5/8/2018	Inactive	Other	

Table 1. List of all nests detected during aerial raptor nest surveys at the Mountain Breeze Wind Project, March 10-12 and May 8, 2018. UTM coordinates are NAD 83 zone 13.

Nest ID	Easting	Northing	Date 1	Status 1	Date 2	Status 2	Species	Location
488	577773	4519242	3/12/2018	Inactive	5/8/2018	Inactive	Other	
489	576239	4519743	3/12/2018	Inactive	5/8/2018	Inactive	Other	
491	575662	4520434	3/12/2018	Inactive	5/8/2018	Inactive	Other	
492	570852	4517719			5/8/2018	Active	Swainson's hawk	
493	575053	4522375	3/12/2018	Active	5/8/2018	Inactive	Golden Eagle	
494	574456	4527325	3/12/2018		5/8/2018			
495	574512	4527224	3/12/2018	Inactive	5/8/2018	Inactive	Other	
496	574474	4528212	3/12/2018	Inactive	5/8/2018	Inactive	Other	
873	604851	4530185	3/12/2018	Inactive	5/8/2018	Inactive	Other	
874	588628	4524808	3/12/2018	Inactive	5/8/2018	Inactive	Other	
875	575581	4541262	3/10/2018	Inactive	5/8/2018	Inactive	Other	
876	582718	4538871	3/10/2018	Inactive	5/8/2018	Inactive	Other	In Project
877	582627	4538876	3/10/2018		5/8/2018	Inactive	Other	In Project
1029	574276	4550363	3/10/2018	Inactive	5/8/2018	Active	Golden Eagle	
1030	576124	4552987	3/10/2018	Inactive	5/8/2018	Active	Great horned owl	
1031	576149	4540047	3/10/2018	Inactive	5/8/2018	Inactive	Other	
1032	588670	4524794	3/12/2018	Inactive	5/8/2018	Inactive	Other	
1033	584410	4519868	3/12/2018	Inactive	5/8/2018	Inactive	Other	
1034	575413	4520881	3/12/2018	Inactive	5/8/2018	Inactive	Other	
1035	575099	4521700	3/12/2018	Inactive	5/8/2018	Inactive	Other	
1036	574846	4522696	3/12/2018	Inactive	5/8/2018	Inactive	Other	
1037	577195	4530437	3/12/2018	Inactive	5/8/2018	Active	Red-tailed hawk	In 1-mi Buffer

DATE: 24 May 2018

TO: James Lynch, K&L Gates; John Wycherly, Leeward Energy

FROM: Victoria Poulton, WEST, Inc.

RE: DRAFT - Confidential Business Informational/Pre-Decisional
Survey results, prairie dog colony mapping at the Mountain Breeze Project, 2018

Western EcoSystems Technology, Inc. (WEST) mapped black-tailed prairie dog (BTPD; *Cynomys ludovicianus*) colonies in and around the proposed Mountain Breeze Wind Project (Project). BTPD colonies in the area may be an attractive prey source for golden eagles (*Aquila chrysaetos*). To understand where potential prey sources for golden eagles occur, prairie dog colonies in the Project were mapped during May 2018.

Available prairie dog colony data mapped by Colorado Parks and Wildlife (CPW) in 2015 and from colonies recorded during raptor nest surveys conducted in March 2018 for the Project were used to target ground surveys. Then a biologist drove on public roads in an attempt to get a view of mapped BTPD colonies. If the colony was visible, the biologist noted if the colony appeared to be active (had prairie dogs present) or not, if the mapped area appeared to be accurate or not along with any changes in the active colony location, and if any sensitive species, including eagles or burrowing owls, were seen in the area.

Twenty-two potential BTPD colonies were mapped by CPW within 10 mi of the Project, and an additional 11 point locations for potential colonies were recorded by WEST during aerial surveys in March 2018. Of these 33 total locations, 20 were visible from public roads. Five colonies were confirmed active, eight were confirmed inactive, and the remaining colony status remained unknown due to lack of visibility or sufficient visual evidence (Figure 1). Burrowing owls (*Athene cunicularia*), a state-listed threatened species, were observed at three active colonies and one unknown status colony. No BTPD colonies were observed within the Project boundary. The nearest colony was located approximately 0.6 mi outside of the Project boundary to the south (Figure 1).

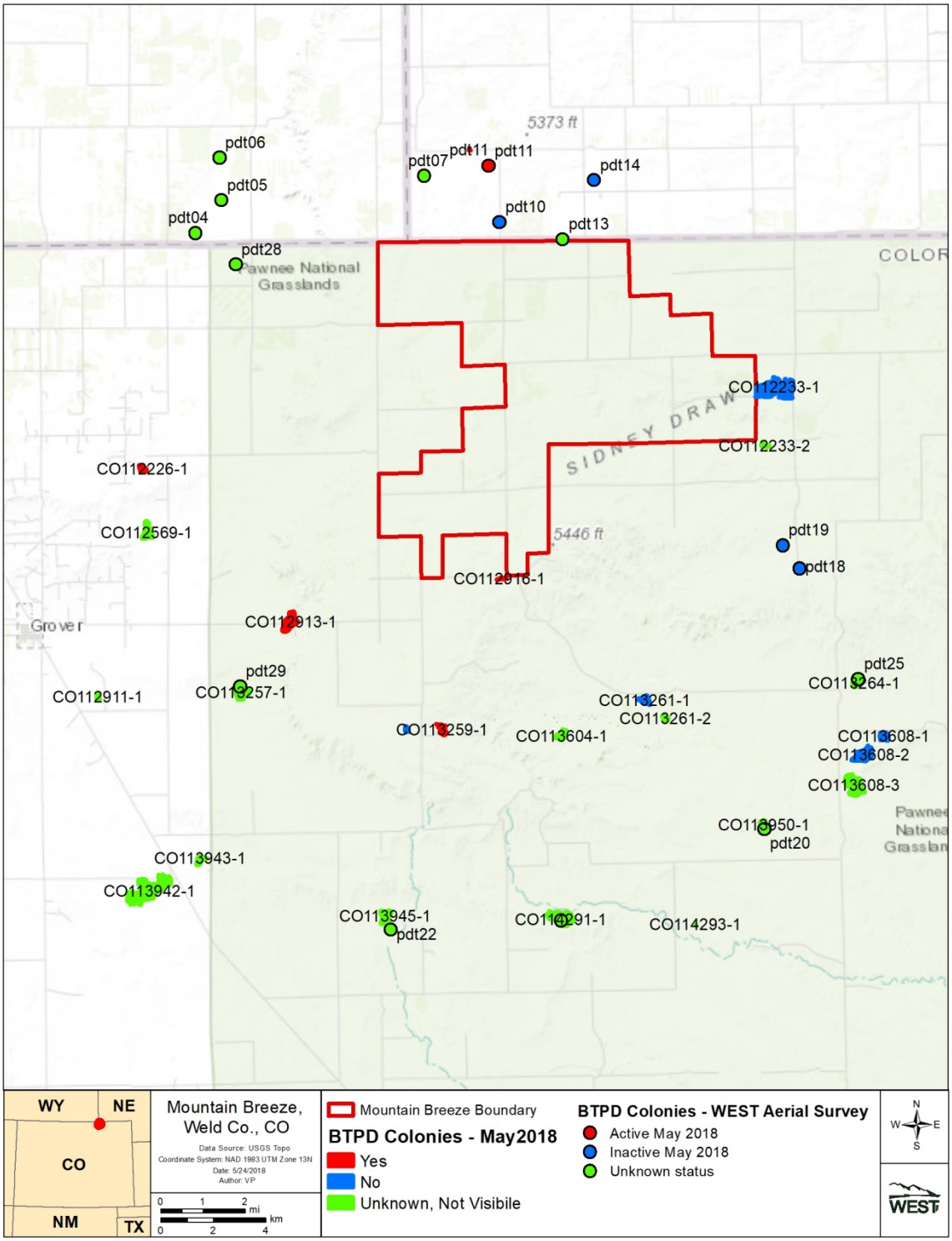


Figure 1. Black-tailed prairie dog colonies surveyed in the vicinity of the proposed Mountain Breeze Project during May 2018.

DATE: 22 May 2018

TO: James Lynch, K & L Gates

FROM: Victoria Poulton, WEST, Inc.

RE: DRAFT - Confidential Business Informational/Pre-Decisional
Survey results, lek surveys for plains sharp-tailed grouse at Mountain Breeze and Cedar Creek

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At the request of K&L Gates, Western EcoSystems Technology, Inc. (WEST) conducted ground-based lek surveys for plains sharp-tailed grouse (PSTG; *Tympanuchus phasianellus jamesi*) at the proposed Mountain Breeze Wind Project (MBWP) and the neighboring Cedar Creek Wind Project (CCWP) in Weld County, Colorado, during spring of 2018. PSTG are Colorado state-listed as endangered, but they have no special regulatory protections at the federal level. Lek surveys were designed with input from Colorado Parks and Wildlife (CPW).

Two survey rounds were conducted in spring 2018. The first survey round occurred April 10-12, and the second round was April 22 – 28. Survey points were spaced 0.5 mile apart, to the extent possible, along public roads, turbine access roads, and private access roads in grassland (grazed and ungrazed) in the MBWP and CCWP. There were a total of 68 survey points in the MBWP and 106 survey points in the CCWP (Figure 1). Surveys were conducted from 30 minutes before sunrise to two hours post-sunrise (2.5 hours total per morning). At each survey point, the surveyor shut off the vehicle, moved away from the vehicle, and listened and conducted visual scans for PSTG. Surveys were not conducted if there was heavy precipitation or if sustained wind speeds were higher than approximately 15 miles/hour (24 kilometers/hour). CPW recommendations are for lower wind speeds, but weather conditions during April were windy on most days, and there were few mornings available to survey when winds were below 15 mph.

GPS units were used to navigate to survey points, and all PSTG detections were recorded as waypoints or were mapped on detailed topographic or aerial maps. The number of birds observed in each lek were recorded if the lek was visible without disturbing the birds. For leks detected by sound only, approximate location was recorded on a map, or the surveyor took two different compass bearings to allow for triangulation of the lek location. All incidental observations of PSTG also were recorded with information about location and number of individuals present. Following guidance provided by CPW, observations of PSTG were considered leks if three or more birds were present; however, lekking activity also was observed or heard in some groups of fewer than three birds.

During the first round of surveys, six PSTG leks were detected and seven non-lek observations were recorded (Table 1, Figure 2). During the second survey round, one additional lek was detected

(on two separate days), a lek from the first round was re-detected, and eight non-lek observations were recorded (Table 1, Figure 2).

Table 1. Plains sharp-tailed grouse leks and observations recorded during ground-based lek surveys at the proposed Mountain Breeze Wind Project and existing Cedar Creek Wind Project, April 2018. Location coordinates are UTM NAD 83 zone 13.

Date	Survey Round	Observation Identification	Easting	Northing	Number of Birds	Notes
4/10/2018	1	obs			2	flying to E on E side of road
4/10/2018	1	KN2	582762	4530198	4	
4/10/2018	1	obs			3	fly by and landed to W; female on road betw pt 8 & 61
4/10/2018	1	obs				possible vocalization N of road
4/10/2018	1	KN4	580404	4529985	3	heard more than 2
4/10/2018	1	KN3	582032	4529616	3	also heard vocalization on N side of road
4/10/2018	1	KN1	583182	4528175	12	
4/11/2018	1	obs				3 grouse by side of road at Pt 59, but survey not done at this pt this day
4/11/2018	1	obs				vocalization to W of pt
4/11/2018	1	KN5	579738	4533359	13	some displaying, flying
4/11/2018	1	obs				one grouse took off from W side of point, to W
4/11/2018	1	obs				1 flew to N, occasional vocalization to N
4/12/2018	1	DK1	579064	4524993	2	male displaying, dancing; not at an obs pt
4/22/2018	2	obs				vocalization to SW, 1 grouse fly
4/22/2018	2	GN1	588345	4537784	18	north and east of trees and windmill
4/22/2018	2	obs				1 female ~500 m to SSE
4/22/2018	2	KN1	583201	4528131	14	vocalization and display flights, labeled as KN21 on datasheet
4/22/2018	2	obs	588571	4536808	4	4 PSTG on fence, flew SW across road
4/22/2018	2	obs	585817	4536895	1	single PSTG west of fence
4/23/2018	2	obs				vocalizations SSW
4/23/2018	2	obs				1 grouse fly by
4/23/2018	2	GN1	588524	4537655	14	vocalization and display, labelled as KN22 on datasheet
4/27/2018	2	obs	575896	4528306	1	one PSTG flew by
4/27/2018	2	obs	578041	4527994	1	one PSTG flew along fence to the S

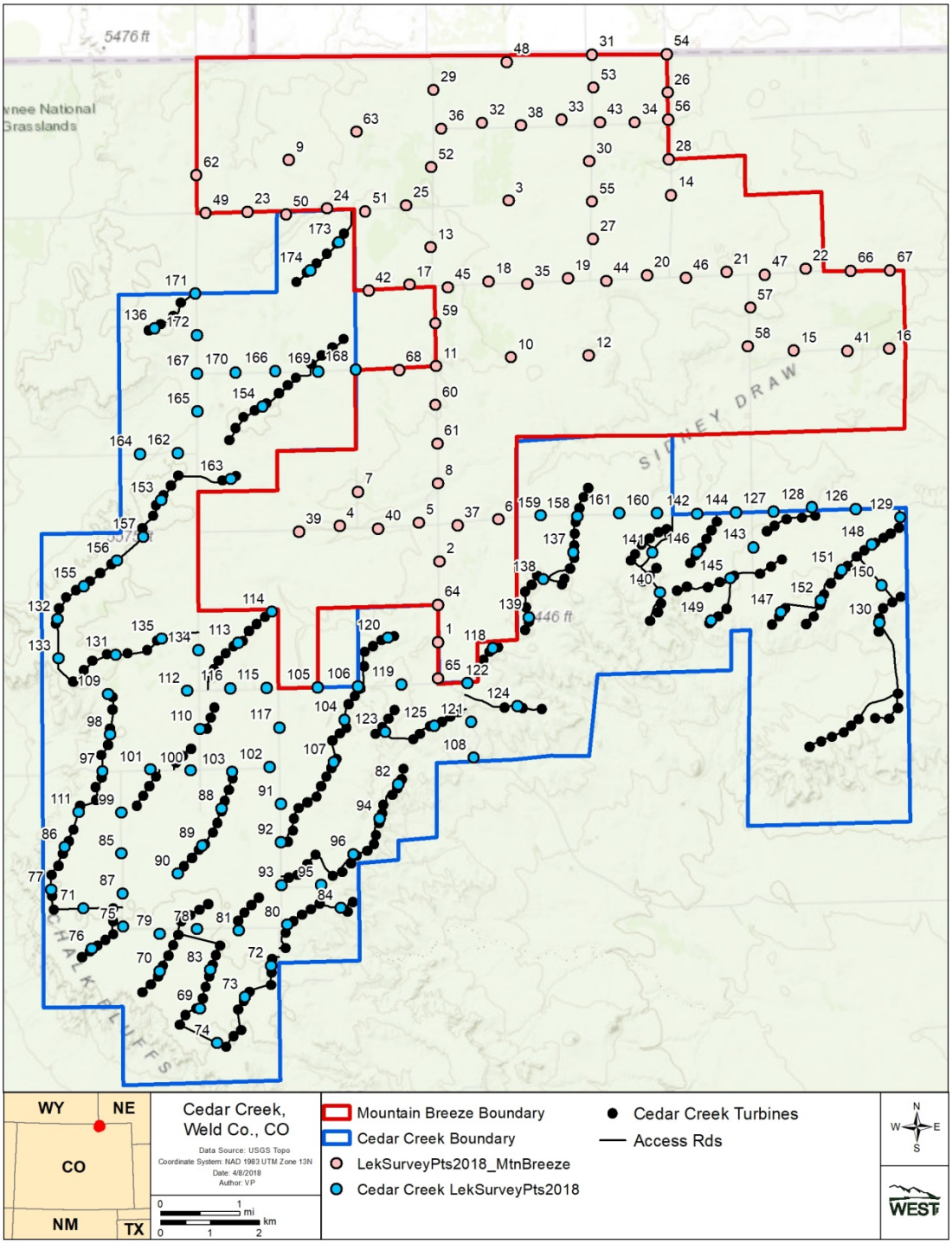


Figure 1. Lek survey points for ground-based lek surveys at the proposed Mountain Breeze Wind Project and existing Cedar Creek Wind Project, April 2018.

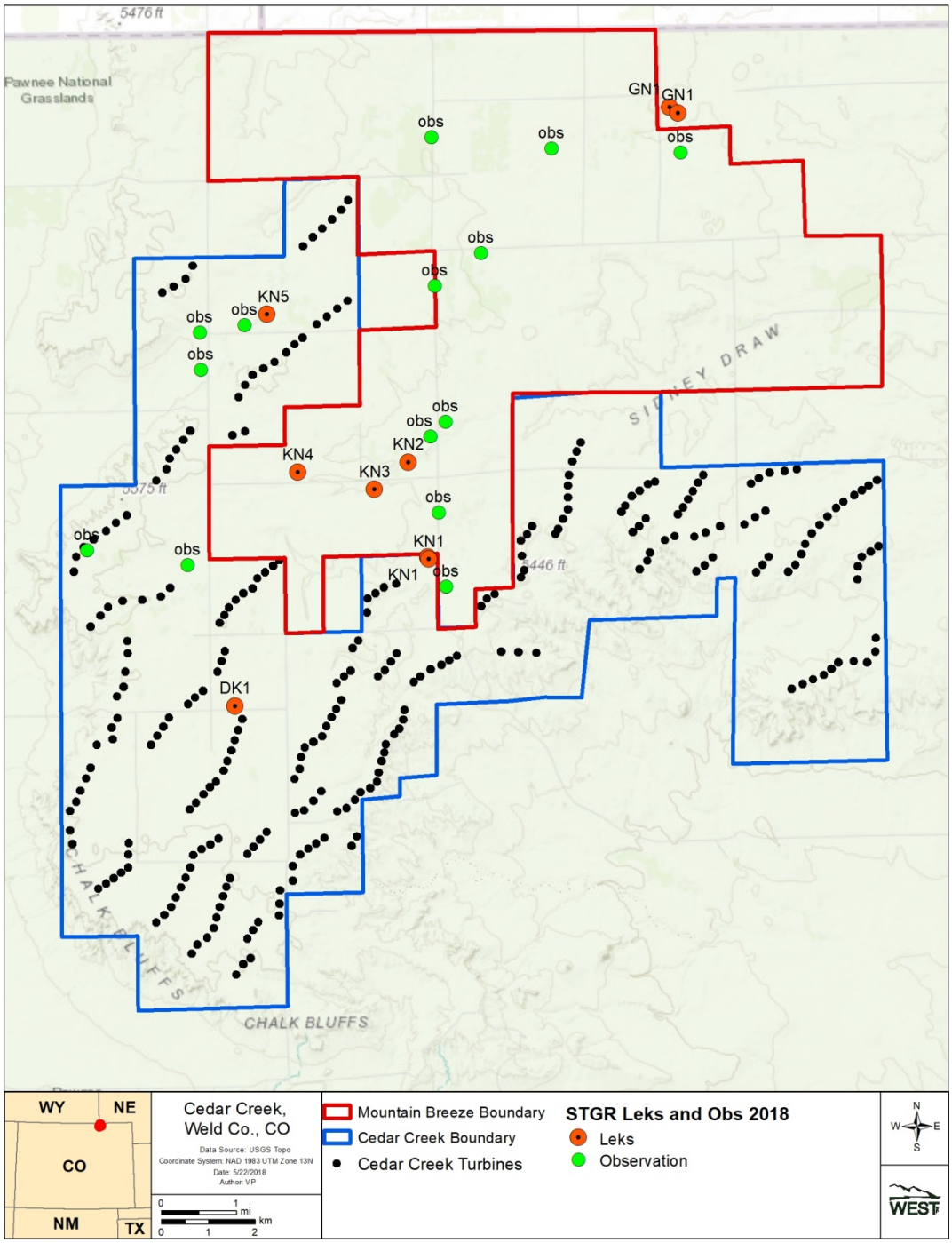


Figure 2. Lek locations and prairie chicken observations during ground-based lek surveys at the proposed Mountain Breeze Wind Project and existing Cedar Creek Wind Project, April 2018.

DATE: 29 May 2019

TO: John Wycherly; Leeward Energy; James Lynch, Ankur Tohan; K & L Gates

FROM: Victoria Poulton; WEST, Inc.

RE: DRAFT - Confidential Business Informational/Pre-Decisional
2019 Survey results, lek surveys for plains sharp-tailed grouse at the Mountain Breeze and Panorama Wind Project

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At the request of K&L Gates and Leeward Energy, Western EcoSystems Technology, Inc. (WEST) conducted ground-based lek surveys for plains sharp-tailed grouse (PSTG; *Tympanuchus phasianellus jamesi*) at the proposed Mountain Breeze and Panorama Wind Project (the Project) in Weld County, Colorado, during spring of 2019. PSTG are Colorado state-listed as endangered, but they have no special regulatory protections at the federal level. As a result of conversations with Colorado Parks and Wildlife (CPW), PSTG lek surveys in 2019 were designed to cover northwestern and northeastern portions of the Project that were added to the Project after PSTG lek surveys were conducted in 2018.

Two survey rounds were conducted in spring 2019. The first survey round occurred April 4-25, and the second round was April 23 – May 3. Survey points were spaced 0.5 mile apart, to the extent possible, along public roads and on private lands in grassland (grazed and ungrazed) in the Project. Fifty-two survey points were placed to cover areas not covered during 2018 PSTG lek surveys (Figure 1). Surveys were conducted from 30 minutes before sunrise to two hours post-sunrise (2.5 hours total per morning). At each survey point, the surveyor shut off the vehicle, moved away from the vehicle, and listened and conducted visual scans for PSTG. Surveys were not conducted if there was heavy precipitation or if sustained wind speeds were higher than approximately 15 miles/hour (24 kilometers/hour). CPW recommendations are for lower wind speeds, but weather conditions during April were inclement on many days, leaving few mornings available to survey when winds were below 15 mph.

GPS units were used to navigate to survey points, and all PSTG detections were recorded as waypoints or were mapped on topographic or aerial maps. The number of birds observed in each lek was recorded if the lek was visible without disturbing the birds. For leks detected by sound only, approximate location was recorded on a map, or the surveyor took compass bearings and recorded approximate direction to the lek location (triangulation was not always possible due to limited access). All incidental observations of PSTG also were recorded, with information about location and number of individuals present. Following guidance provided by CPW, observations of PSTG were considered leks if three or more birds were present; however, lekking activity also was observed or heard in some groups of fewer than three birds.

During the surveys, six PSTG leks were detected and mapped. There were 17 observations of PSTG that were not considered leks, either because only one or two birds were present, or larger groups were observed that were not engaged in lekking activity (Table 1, Figure 2). Of the non-lek observations, 14 were observed during surveys, and three were recorded incidentally while traveling around the Project. Sixteen additional observations were recorded where potential PSTG lek activity was detected by sound only, but the calls were heard at a distance, and a location could not be determined due to lack of access or ability to triangulate, as well as potential that these were previously detected leks or satellite leks. These 16 non-mapped observations were recorded from survey points 1, 5, 6, 7, 9, 16, 23, 25, 41, 46, 47, and 49.

Leks labeled as CL1, CL2, CL3, JC2, and MN1 were heard from multiple survey points and/or on multiple days. Lek CL23 was detected only once, but consisted of visual detection of five birds (Table 1).

Table 1. Plains sharp-tailed grouse leks and observations recorded during ground-based lek surveys conducted between April 9 and May 3, 2019, at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado. Location coordinates are UTM NAD 83 zone 13.

Date	Survey Round	Observation Identification	Easting	Northing	Number of Birds	Notes
4/2/2019	1	observation	597517	4534565	4	flew from obs pt over hill (not a lek)
4/2/2019	1	auditory only				auditory only
4/2/2019	1	observation	599254	4535143	2	
4/2/2019	1	observation	600705	4535105	1	
4/3/2019	1	incidental	593187	4539184	unk	auditory only
4/3/2019	1	observation	591905	4540205	3	flying
4/3/2019	1	incidental	588128	4532628	1	
4/3/2019	1	JC2	596226	4536950	2	perched, poss lek
4/3/2019	1	observation	596779	4536653	1	perched, flying
4/3/2019	1	incidental	584791	4534407	10	flying
4/4/2019	1	observation	590765	4535704	1	
4/4/2019	1	JC2	596226	4536950	3	in same spot as observed from pt 47 yesterday
4/9/2019	1	observation	598782	4535033	1	poss. Lek
4/9/2019	1	observation	600792	4535295	1	
4/25/2019	1	CL1	592755	4538602	11	also heard from pt 19, pt 21; detected 4/23 from several pts
4/25/2019	1	observation	591295	4539267	2	right at point 22
4/25/2019	1	incidental	590970	4538245	1	flushed on way from pt 22to pt 23
4/25/2019	1	CL2	591403	4538933	unk	audible from Pt 21, Pt23 to NW; detected 4/23 from several pts
4/23/2019	2	CL1	592755	4538602	unk	auditory only, to south faint
4/23/2019	2	CL2	591403	4538933	unk	auditory only, to east, also heard from pts10,11,12
4/23/2019	2	CL3	590471	4538447	5	auditory only, also heard from pts 11, 10
4/23/2019	2	auditory only			unk	auditory only,to SE, also heard from pts 17, 18
4/23/2019	2	auditory only			unk	auditory only, to E
4/23/2019	2	auditory only			unk	auditory only, to SW, also heard from pt 26
4/23/2019	2	auditory only			unk	auditory only, to S
4/23/2019	2	auditory only			unk	auditory only, to W, also heard from pt 48

Table 1. Plains sharp-tailed grouse leks and observations recorded during ground-based lek surveys conducted between April 9 and May 3, 2019, at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado. Location coordinates are UTM NAD 83 zone 13.

Date	Survey Round	Observation Identification	Easting	Northing	Number of Birds	Notes
4/23/2019	2	observation	595986	4536840	2	flushed to SE
4/23/2019	2	observation	596763	4536549	2	1 perched on ground, one flew
4/23/2019	2	auditory only			unk	auditory only, to S
4/24/2019	2	auditory only			unk	audible very faint to south
4/24/2019	2	observation	579123	4539473	1	
4/24/2019	2	MN1	599404	4535526	4	audio only, also heard from Pts 43,45
4/24/2019	2	observation	598412	4535170	2	flew across road
4/24/2019	2	auditory only			unk	auditory only, about 100m north
4/24/2019	2	auditory only			unk	auditory only, about 800m SW, also heard from pt9
4/24/2019	2	auditory only			unk	auditory only, N by wind mill
4/24/2019	2	CL23	590984	4536160	5	5 grouse by fence
4/24/2019	2	auditory only			unk	audible faint to NE
4/24/2019	2	auditory only			unk	audible faint to W
5/1/2019	2	CL1	592755	4538602	11	auditory and visual, also seen and heard from pt 21, heard from pt 19
5/1/2019	2	CL2	591403	4538933	unk	auditory only, also heard from pt 21
5/1/2019	2	observation	591295	4538267	1	bird obs at point
5/1/2019	2	auditory only			unk	auditory only, to W, also heard from pt 48
5/1/2019	2	CL3	590471	4538447	1	auditory and visual, also heard from pt24
5/1/2019	2	auditory only			unk	auditory only, about 100m north
5/1/2019	2	auditory only			unk	auditory only , to N
4/2/2019	1	observation	597517	4534565	4	flew from obs pt over hill (not a lek)

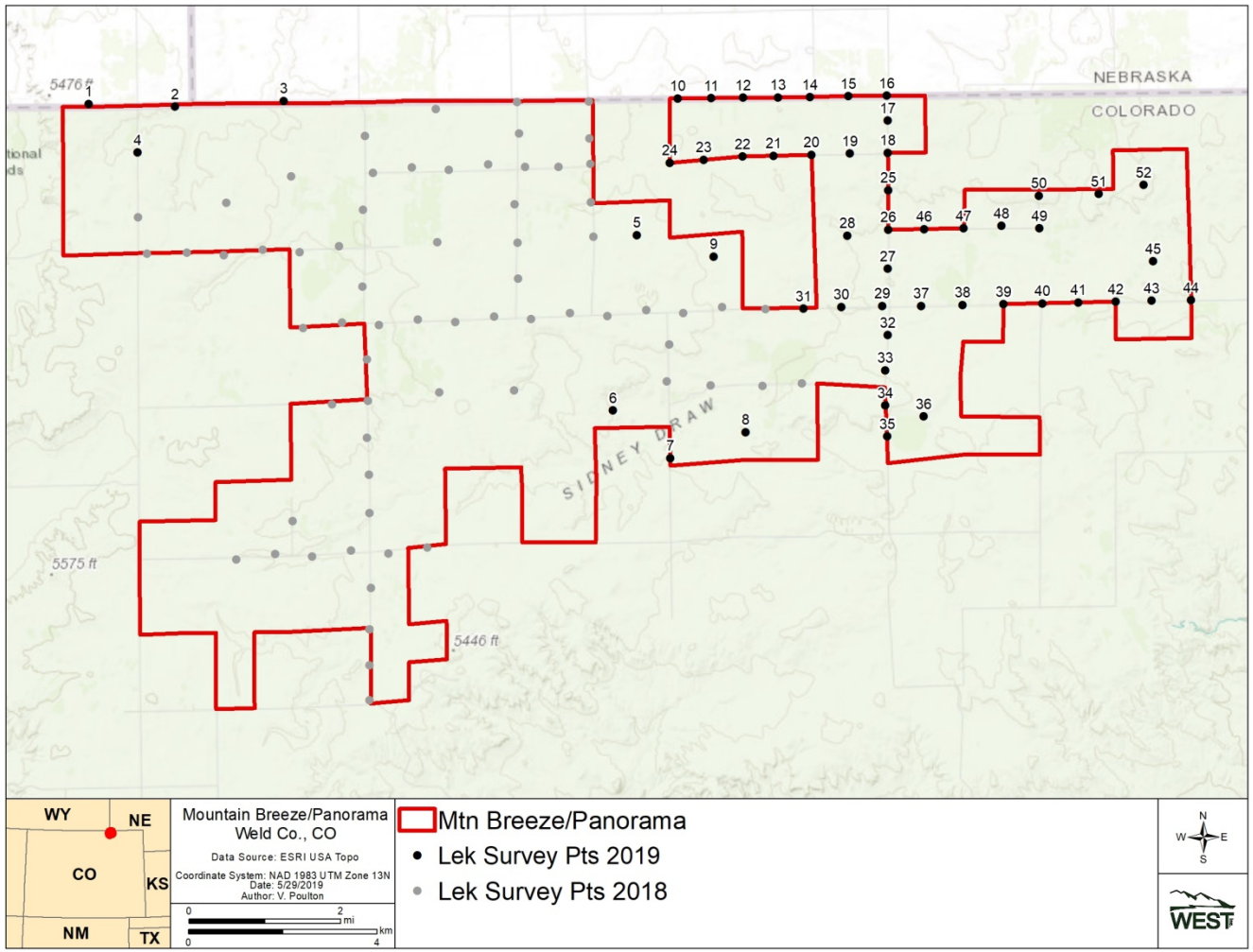


Figure 1. Lek survey points for ground-based lek surveys conducted between April 9 and May 3, 2019, at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado.

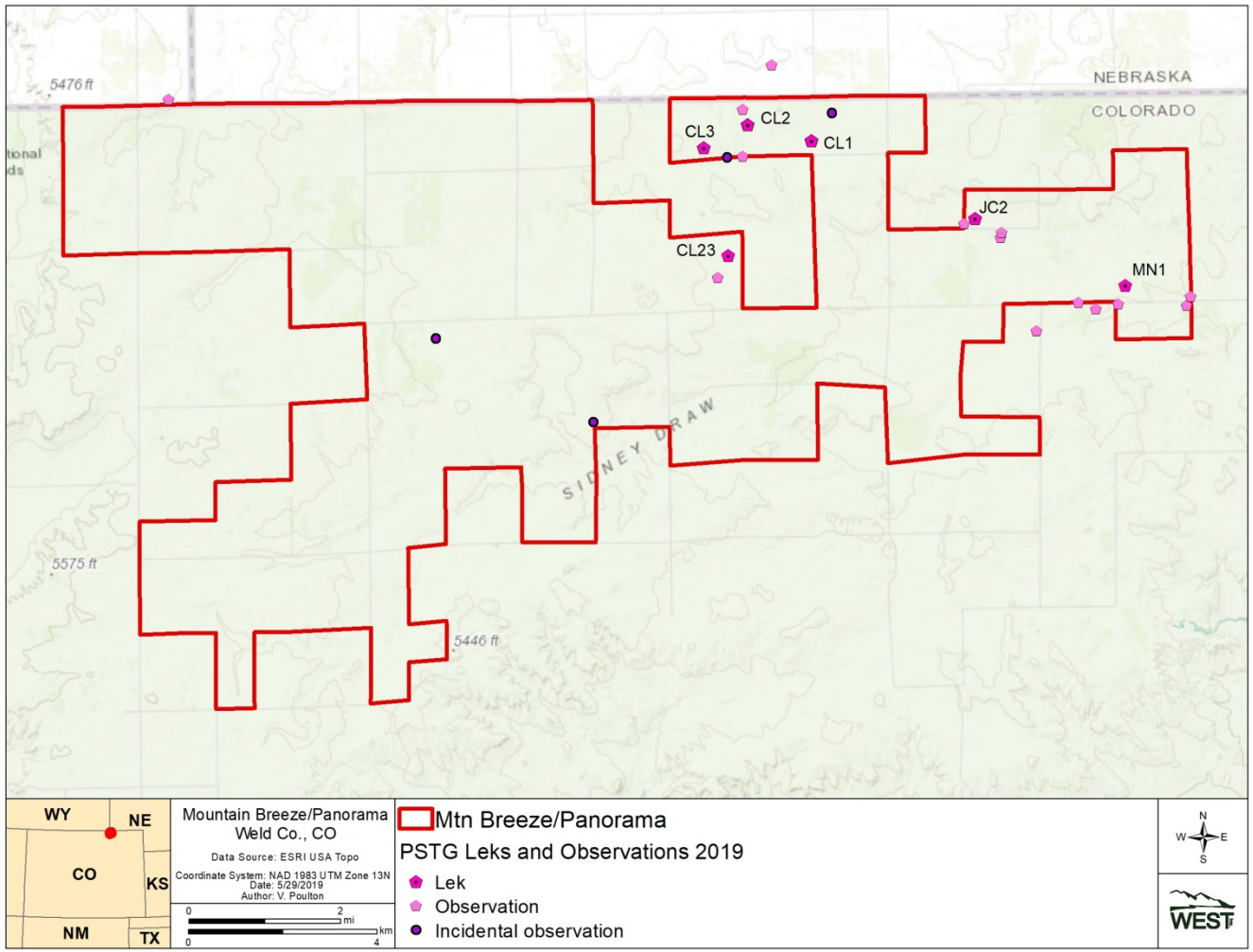


Figure 2. Locations of lek and non-lek observations during ground-based lek surveys conducted between April 9 and May 3, 2019, at the proposed Mountain Breeze/Panorama Wind Project in Weld County, Colorado.