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December 20, 2019

FILED IN OFFICE OF
DEC 20 2019
NM PUBLIC REGULATION COMM
RECORDS MANAGEMENT BUREAU

HAND – DELIVERED
Melanie Sandoval
Record Bureau Chief
New Mexico Public Regulations Commission
1120 Paseo de Peralta
Santa Fe, NM 87501

Case No: 18-00065-UT

Dear Ms. Sandoval:

Enclosed for filing, please find an original and five copies (plus a sixth copy for conforming for our records) of the Corona Wind Companies' ***Motion to Reopen*** and the ***Amended Joint Application for Location Site Approval of The Expansion of The Corona Wind Projects, Reconfiguration of the Proposed Corona Gen-Tie System, Extension of The Corona Gen-Tie System and Request for Right Of Way Determination.***

Please contact me at your earliest convenience with any questions or comments.

Sincerely,

VIRTUE & NAJJAR, PC

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BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	Case No. 18-00065-UT
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

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MOTION TO REOPEN DOCKET

Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Wind LLC, Tecolote Wind LLC, Gallinas Mountain Wind LLC, and Viento Loco LLC (collectively referred to as the "Corona Wind Companies" or the "Joint Applicants") respectfully move the New Mexico Public Regulation Commission ("Commission") pursuant to Rule 1.2.2.37(E) NMAC to reopen the above-captioned proceeding, as follows:

FACTUAL BACKGROUND

1. The Commission previously heard testimony and reviewed numerous pleadings and expert analyses in support of the Corona Wind Companies' Joint Application for Location Site Approval of the Corona Wind Projects, the Corona Gen-Tie System, and Request for Right of Way Determination (the "Initial Joint Application") which was filed on March 27, 2018. The Commission granted approval of the Initial Joint Application on October 3, 2018, subject to numerous conditions and Protective Measures proposed by the Joint Applicants and the Commission Staff ("Final Order").

2. Subsequent to the approval of the Initial Joint Application, the Joint Applicants have identified additional land areas for the placement of wind turbines and determined that modifications to the approved route for the Corona Gen-Tie System are necessary to minimize environmental impacts and maximize efficiency. The modifications to the Corona Gen-Tie System will require that some portions of the transmission lines and associated facilities be located outside of the corridor that was studied and identified in the Commission's consideration of the Initial Joint Application. Additionally, the Joint Applicants have determined to extend the original Corona Gen-Tie System by approximately 35 miles to enable it to interconnect with the Western Spirit Transmission line.

3. In particular, the Joint Applicants seek the Commission's approval to: (a) expand the area of the previously approved Corona Wind Projects generation area ("Corona Wind Update"); (b) modify the proposed route for the previously approved 345-kilovolt Corona Gen-Tie system ("Reconfigured Corona Gen-Tie System"); (c) extend by approximately 35 miles the transmission system and associated transmission facilities of the Corona Gen-Tie System ("Extended Corona Gen-Tie System"); and, (d) provide, to the extent necessary, approval for the continued use of the 180-foot right-of-way ("ROW") for the Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System (collectively referred to as the "Updated Corona Gen-Tie System") that was authorized in the Commission's Final Order.

4. The Joint Applicants evaluated the air and water pollution control standards in connection with the proposed Corona Wind Update and determined that the proposed Corona Wind Update will comply with these standards. Similarly, all of the statutory and regulatory requirements for siting a transmission line or associated facilities have or will be satisfied with respect to the Updated Corona Gen-Tie System. Further, because the Commission previously

approved the right-of-way width of 180 feet for the Corona Gen-Tie system transmission facilities, Joint Applicants do not believe the Commission needs to revisit this issue with respect to areas of the Updated Corona Gen-Tie System not covered by the Commission's order in NMPRC Case No. 18-00065-UT. However, to the extent that the Commission believes another review is necessary the Joint Applicants have submitted expert analysis demonstrating that the previously approved 180-foot ROW should apply uniformly throughout the Updated Corona Gen-Tie System.

LEGAL STANDARD

NMAC 1.2.2.37(E) provides:

> (1) Before the issuance of a commission order or after the issuance of a recommended decision, staff or a party to a proceeding may file a motion to reopen the proceeding.
>
> (4) The commission on its own may at any time reopen any proceeding when it has reason to believe that conditions of fact or law have so changed as to require, or that the public interest requires, the reopening of such proceeding.

See NMAC 1.2.2.37(E)(1) and (4).

ARGUMENT

5. The Commission already considered a significant amount of pleadings, testimony, and comprehensive expert analyses in NMPRC Case No. 18-00065-UT. Recently, Joint Applicants have made some changes to the previously approved Corona Wind Projects that raise new issues of fact for the Commission to consider. Namely, Joint Applicants have identified additional areas for placement of wind turbines.

6. Joint Applicants also determined that some variation in the proposed route for the Corona Gen-Tie System identified in Case No. 18-00065-UT is necessary and, in addition, that such transmission system should be extended to provide another point of interconnection for transmitting the power produced by the Corona Wind Projects.

7. Pursuant to NMAC 12.2.2.37(E), the Commission can reopen NMPRC Case No. 18-00065-UT to consider these new facts. Reopening the prior case would allow for the best use of limited resources and provide a more efficient use of time, instead of initiating a completely new docket. Given that NMPRC Case No. 18-00065-UT contained numerous studies and expert testimony that are still valid with respect to the areas of the Corona Wind Update and Updated Corona Gen-Tie System that are unchanged, requiring a new proceeding to be initiated would be inefficient and require that considerable time and effort be devoted to taking administrative notice of evidence in NMPRC Case No. 18-00065-UT.

8. Joint Applicants have agreed to apply all the conditions that were approved in NMPRC Case No. 18-00065-UT to any new areas of the Corona Wind Update and Updated Corona Gen-Tie System. Additionally, Joint Applicants have consulted with the Commission Staff to determine the most efficient and expeditious manner to proceed with the least amount of confusion. It was agreed that reopening this Docket is preferable than initiating a new proceeding that would address modifications to the project that was the subject of NMPRC Case No. 18-00065-UT.

9. Joint Applicants have requested the position on this Motion of the other parties to this proceeding and been informed as follows:

Staff does not oppose this Motion.

Claunch-Pinto Soil and Water Conservation District does not object to the Motion.

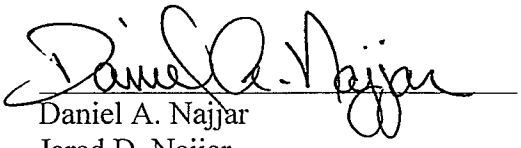
Blanchard Corona Ranch did not respond.

Wherefore, for the foregoing reasons and in the interest of efficiency, Joint Applicants respectfully request that the Commission reopen NMPRC Case No. 18-00065-UT to allow them to address the new facts highlighted above without the burden and expense associated with

initiating a new proceeding. In the absence of reopening NMPRC Case No. 18-00065-UT, Joint Applicants respectfully request that this filing be treated as initiating a new proceeding in a separate docket to enable the process of Commission review to move forward expeditiously.

Respectfully submitted,

VIRTUE & NAJJAR, P.C.

By: 

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BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	Case No. 18-00065-UT
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

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AMENDED JOINT APPLICATION FOR LOCATION SITE APPROVAL OF THE EXPANSION OF THE CORONA WIND PROJECTS, RECONFIGURATION OF THE PROPOSED CORONA GEN-TIE SYSTEM, EXTENSION OF THE CORONA GEN-TIE SYSTEM AND REQUEST FOR RIGHT OF WAY DETERMINATION

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	Case No. 18-00065-UT
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AMENDED JOINT APPLICATION FOR LOCATION SITE APPROVAL OF THE EXPANSION OF THE CORONA WIND PROJECTS, RECONFIGURATION OF THE PROPOSED CORONA GEN-TIE SYSTEM, EXTENSION OF THE CORONA GEN-TIE SYSTEM AND REQUEST FOR RIGHT OF WAY DETERMINATION

Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Wind LLC, Tecolote Wind LLC, Gallinas Mountain Wind LLC, and Viento Loco LLC, (collectively, the "Corona Wind Companies" or the "Joint Applicants") respectfully move the New Mexico Public Regulation Commission ("Commission") to reopen the above-captioned proceeding to consider this amended Joint Application and supporting testimony and exhibits for approval to: a) expand the area for the wind turbines for the previously approved Corona Wind Projects ("Corona Wind Update "); b) modify the proposed route for the previously approved 345- kilovolt ("kV") Corona Gen-Tie System ("Reconfigured Corona Gen-Tie System"); c) extend by approximately 35 miles the transmission system and associated transmission facilities of the Corona Gen-Tie System ("Extended Corona Gen-Tie System"); and, d) provide the necessary approval for the 180-foot right-of-way ("ROW") for the Reconfigured Corona Gen-Tie System and Extended Corona Gen-

Tie System (collectively referred to as the "Updated Corona Gen-Tie System"). The Updated Corona Gen-Tie System will be located within a 1-mile-wide corridor more specifically described in this Joint Application pursuant to NMSA 1978, §§62-9-3, 62-9-3.2, and Commission Rule 17.9.592 NMAC.

I. BACKGROUND.

A. THE JOINT APPLICANTS.

1. The Corona Wind Companies are limited liability companies, organized under the laws of the State of Delaware and are indirectly held subsidiaries of Pattern Energy Group 2 LP (together with Pattern Energy Group LP, referred to as "Pattern Development"). Pattern Development has developed and constructed other wind projects of significant size and scope in Imperial County, California; Shasta County, California; Benton County, Indiana; White Pine County, Nevada; Carson County, Texas; Comanche County, Texas; Kennedy County, Texas; and Curry County, New Mexico. Pattern Development has also developed and constructed additional wind projects in Puerto Rico, Chile, and Canada.

2. Pattern Development is affiliated with Pattern Energy Group Inc. ("PEGI") (collectively, "Pattern Group"). PEGI currently owns and operates over 3,000 MW and operates over 4,500 MW of wind energy spread out across 18 wind projects. The Pattern Group has offices in San Francisco, California; San Diego, California; Houston, Texas; Toronto, Canada; Mexico City, Mexico; and Tokyo, Japan.

3. The Corona Wind Companies and the Pattern Group entities are not public utilities under New Mexico law, NMSA 1978, §62-3-3(G), and none are regulated by the Commission.

B. THE CORONA WIND PROJECTS.

4. The Corona Wind Projects will consist of up to 2,300 MW of wind power facilities and will be located within approximately 347,000 acres of private and state land within Lincoln, Torrance, and Guadalupe Counties in New Mexico.

5. To produce the desired energy, it is anticipated that there will be up to 950 wind turbines with a nameplate capacity ranging from 2.3 MW to 3.0 MW. Each of the turbines will be connected by 34.5-kV collection lines to new substations ("Generation Project Substations") to be located within each project area. A final determination of the number of turbines to be used and the siting of the turbines, collection lines and Generation Project Substations will be made over time, and such information will be made available to the Commission.

6. The location of the Corona Wind Projects was approved by the Commission in its Final Order issued on October 3, 2018 in NMPRC Case No. 18-00065-UT. Since that time additional areas for placement of wind turbines have been identified and the Corona Wind Companies now seek approval for the addition of approximately 11,700 acres of property to the wind generation of the approved Corona Wind Projects. The Corona Wind Update will include areas not previously identified and evaluated in NMPRC Case No. 18-00065-UT. An updated environmental analysis has been performed and is sponsored by and submitted as an exhibit to the Testimony of Adam Cernea Clark in this filing. This comprehensive environmental analysis is applied to the entire area of the Corona Wind Update even though this level of analysis is only required for areas that will be traversed by transmission lines.

C. THE UPDATED CORONA GEN-TIE SYSTEM.

7. The Corona Gen-Tie System that was approved in NMPRC Case No. 18-00065-UT consists of an approximately 80-mile 345-kV transmission system and associated transmission

facilities, including a 180-foot ROW located within a one mile-wide corridor, referred to as the Corona Gen-Tie System Corridor.

8. The Joint Applicants stated an intent in NMPRC Case No. 18-00065-UT that the Corona Gen-Tie System will connect the Corona Wind Projects to one of the proposed SunZia Transmission LLC's two 500-kV transmission lines ("SunZia Project"). The first phase of the SunZia Project when completed will be utilized by the Corona Wind Projects. The Sun Zia Project has not obtained location approval from this Commission and may be delayed while additional studies are performed, including addressing issues of national security interest.

9. Since the Final Order granting a location permit for the Corona Gen-Tie System was issued, the Joint Applicants have determined that some variation in the proposed route identified in that proceeding is necessary. Some reconfiguration of the initial proposed Corona Gen-Tie System was previously mentioned in NMPRC Case No. 18-00065-UT as a possibility after further site evaluations were performed. Since that proposed route for the Reconfigured Corona Gen-Tie System extends in some areas outside of the original one-mile wide study corridor within the Corona Wind Project Area, the Joint Applicants are seeking a modification of the location permit previously granted by the Commission to approve those portions of Reconfigured Corona Gen-Tie System located outside of the previously approved Corona Gen-Tie System Corridor. The environmental analysis submitted with this Joint Application includes a comprehensive analysis of the Reconfigured Corona Gen-Tie System route with a particular focus on those segments of the Reconfigured Corona Gen-Tie System that are located within a one-mile corridor that is outside of the previously approved Corona Gen-Tie System Corridor (the "Reconfigured Corona Gen-Tie System Corridor") and thereby subject to additional location approval by the Commission.

D. THE EXTENDED CORONA GEN-TIE SYSTEM

10. As a result of the delays in the Sun Zia Project proceeding, and the advancement of the Western Spirit Transmission Project ("Western Spirit"), the Joint Applicants determined that the construction of the Extended Corona Gen-Tie System will enable a subset of the Corona Wind Projects to interconnect to Western Spirit while still preserving an interconnection route to SunZia via the Reconfigured Corona Gen-Tie System. The Extended Corona Gen-Tie System will be an approximately 35-mile extension of transmission and associated infrastructure of the Corona Gen-Tie System to the Western Spirit Switchyard, as more specifically described in Exhibit 1 to this Application and the supporting testimony which is filed herewith.

11. The purpose of the Extended Corona Gen-Tie System is to allow for an additional point of interconnection to Western Spirit under development by the Renewable Energy Transmission Authority ("RETA"). RETA is the owner of the transmission line project and Western Spirit Transmission LLC ("WST") is the lessee. WST is an entity formed by Pattern Development to develop, secure land easements, design, construct and bring to commercial operation the RETA Project on behalf of and in partnership with RETA. The Commission approved the acquisition of the Western Spirit by PNM in its Final Order in NMPRC Case No. 19-00129-UT, dated October 2, 2019. The portion of the Corona Wind Projects that ultimately interconnect with Western Spirit will be responsible for payment to PNM of their pro rata share of PNM's applicable transmission tariffs. These wind projects will also be solely responsible for the costs of construction of the Extended Corona Gen-Tie System. The Extended Corona Gen-Tie System will enable some of the Corona Wind Companies the option to transmit electricity to consumers independent of the status of the SunZia Project. It is anticipated that those Corona Wind

Companies not interconnecting with the Western Spirit Transmission line will be able to connect to SunZia at a later date.

II. LOCATION CONTROL REQUIREMENTS AND RIGHT-OF-WAY.

A. LOCATION STATUTORY REQUIREMENTS, NMSA 1978, §62-9-3.

12. The purpose of NMSA 1978, §62-9-3 ("Siting Statute"), is to provide for the supervision and control by the Commission of the location within this state of new plants, facilities and transmission lines for the generation and transmission of electricity for sale to the public. NMSA 1978, §62-9-3(A).

13. The Siting Statute further provides that no application shall be approved pursuant to this section if such application violates an existing state, county or municipal land use statute or administrative regulation unless the Commission finds that the regulation is unreasonably restrictive, and compliance is not in the interest of the public convenience and necessity. NMSA 1978, §62-9-3(G). The Joint Applicants have determined that applicable state, county, and municipal land use statutes and administrative regulations are not violated and will allow for the installation of the Updated Corona Gen-Tie System.

14. Under the Siting Statute, the Commission may approve an application without a formal hearing if no protests are filed within sixty (60) days of the date the notice is given. NMSA 1978, §62-9-3(K). An application is deemed to be approved if the Commission fails to issue an order within six (6) months after filing. NMSA 1978, §62-9-3(L).

15. The Corona Wind Companies respectfully request the Commission proceed to an expedited decision without a hearing if no valid protests are filed within sixty (60) days of the date of publication notice. A proposed form of notice is attached as Exhibit 2 to this Joint Application and incorporated herein.

1. GENERATION PLANT.

16. The Siting Statute provides the Commission with specific and limited jurisdiction over the siting of power plants within the State of New Mexico with a "capacity of three hundred thousand kilowatts [300 MW] or more for the generation of electricity for the sale to the public within or without [the state of New Mexico.]" NMSA 1978, §62-9-3(B).

17. The Commission is required to approve an application for the location of the generating plant unless it finds that the operations of the facilities for which approval is sought will not comply with all applicable existing air and water pollution control standards and regulations. NMSA 1978, §62-9-3(E). However, the Commission is precluded by the Siting Statute from requiring "compliance with performance standards other than those established by the agency of this state having jurisdiction over a particular pollution source." *Id.* The New Mexico agency that has jurisdiction over air and water pollution is the New Mexico Environment Department ("NMED").

18. The Joint Applicants have evaluated the air and water pollution control standards in connection with the proposed Corona Wind Update and have determined that the Corona Wind Projects will comply with these standards. Furthermore, in NMPRC Case No. 18-00065-UT, the Joint Applicants elected to extend the protection measures addressing sensitive resources under the standard of review for location control of transmission facilities to the generation area of the Corona Wind Projects. This same commitment is here made with respect to the additional land that would be included in the Corona Wind Update. For more detailed information please refer to the Direct Testimony of Adam Cernea Clark and the environmental report performed by Burns & McDonnell Engineering Company Inc., regarding the Corona Wind Update, the Reconfigured

Corona Gen-Tie System and the Extended Corona Gen-Tie System which is an exhibit to the Direct Testimony of Adam Cernea Clark ("Corona Environmental Report").

2. TRANSMISSION LINES.

19. The Siting Statute gives the Commission jurisdiction over "transmission lines in connection with ... a [generating] plant, on a location within [New Mexico] ...." NMSA 1978, §62-9-3(B). For purposes of this statute, transmission line "means any electric transmission line and associated facilities designed for or capable of operations at a nominal voltage of two hundred thirty kilovolts or more...." *Id.*

20. The Commission is required to approve an application for the location of transmission lines unless it finds the location will unduly impair important environmental values. NMSA 1978, §62-9-3(F). Past Commission decisions have held that environmental values will not be unduly impaired if the requirements under Commission Rule 17.9.592.10 NMAC are met. *In the Matter of Sw. Pub. Serv. Company's Application Requesting: (1) Issuance of A Certificate of Pub. Convenience & Necessity Authorizing Constr. & Operation of A 345-Kv Transmission Line & Associated Facilities in Eddy & Lea Ctys., New Mexico; (2) Approval of the Location of the 345-Kv Transmission Line; (3) Determination of Right of Way Width; & (4) Authorization to Accrue an Allowance for Funds Used During Constr. for the Transmission Line & Associated Facilities Sw. Pub. Serv. Company*, Case No. 16-00126-UT, 2016 WL 6678978, at 6 (Nov. 9, 2016); *In the Matter of Sw. Pub. Serv. Co.'s Application for: (1) Issuance of A Certificate of Pub. Convenience & Necessity Authorizing Constr. & Operation of Two 230 Kv Transmission Lines & Associated Substation Facilities in Curry & Roosevelt Ctys., New Mexico; (2) Approval of the Location of the 230 Kv Transmission Lines & Associated Facilities; & (3) Authorizing Accrual of an Allowance for Funds Used During Constr. For the Transmission and Associated Facilities Sw.*

Pub. Serv. Co.'s Applicant, Case No. 12-00027-UT, 2012 WL 10937016, at 1 (June 20, 2012). See Section II(C) for more details on Commission Rule 17.9.592.10 NMAC.

21. The Commission also has the discretion to consider certain additional factors under NMSA 1978, §62-9-3(M) to determine if a proposed transmission line unduly impairs important environmental values. These additional factors are:

(1) existing plans of the state, local government, and private entities for other developments at or in the vicinity of the proposed location;

(2) fish, wildlife, and plant life;

(3) noise emission levels and interference with communication signals;

(4) the proposed availability of the location to the public for recreational purposes, consistent with safety considerations and regulations;

(5) existing scenic areas, historic, cultural or religious sites and structures or archaeological sites at or in the vicinity of the proposed location; and,

(6) additional factors that require consideration under applicable federal and state laws pertaining to the location.

22. The Joint Applicants have evaluated these factors in connection with the proposed portions of the Reconfigured Corona Gen-Tie System outside of the previously approved one-mile Corona Gen-Tie System Corridor, the Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System overall, and have determined that the statutory and regulatory requirements for siting a transmission line or associated facilities are or will be satisfied. Analysis and conclusions of the studies performed are discussed in detail in the Direct Testimony of Adam Cernea Clark and in the Corona Environmental Report.

B. ROW WIDTH STATUTORY REQUIREMENTS, NMSA 1978, §62-9-3.2.

23. NMSA 1978, §62-9-3.2 ("ROW Statute") provides that "unless otherwise agreed to by the parties, no person shall begin the construction of any transmission line requiring a width for right of way of greater than one hundred feet without first obtaining from the commission a determination of the necessary right-of-way width to construct and maintain the transmission line." NMSA 1978, §62-9-3.2(A). With exception of the Extended Corona Gen-Tie System and those portions of the Reconfigured Corona Gen-Tie System located outside of the original one-mile study corridor, the Commission has previously approved the right-of-way width of 180 feet for the Corona Gen-Tie System transmission facilities. The Joint Applicants do not believe that the Commission needs to revisit this issue with respect to areas of the Updated Corona Gen-Tie System not covered by the Commission's Order in NMPRC Case No. 18-00065-UTas the ROW width for the entire Updated Corona Gen-Tie System needs to remain constant. Nevertheless, Joint Applicants have included a request for ROW approval with this Joint Application to assure that the Joint Application is deemed complete to the extent that the Commission determines that an additional ROW width approval is necessary for the updates to the Corona Gen-Tie System identified here as the Extended Corona Gen-Tie System and the Reconfigured Corona Gen-Tie System.

24. Under the ROW Statute, "the applicant shall cause notice of the time and place of hearing on the application for the [ROW] determination to any owner of property proposed to be taken." NMSA 1978, §62-9-3.2(D). Notice shall be given by first class mail at least twenty (20) days before the time set for hearing, and the applicant shall file proof of notice on or before the hearing. *Id.*

25. The statute further provides the Commission shall act upon the application, after public hearing, within six (6) months of the date the application was filed, and failure to do so is deemed to be approval of the application. NMSA 1978, §§62-9-3.2(E) and (F).

1. REGULATORY REQUIREMENTS, COMMISSION RULE 17.9.592 NMAC.

26. The Commission's Location of Large Capacity Plants and Transmission Lines Rule 17.9.592 NMAC ("Location Rule") states the requirements for an application for location approval of a large capacity generation plant and a transmission line, pursuant to the Siting Statute, NMSA 1978, §62-9-3. The Joint Application, including the supporting testimonies and exhibits, provide all the required information for Commission review.

2. GENERATION PLANT.

27. Location Rule 17.9.592.9 NMAC for generating facilities ("Generation Location Rule") lists the requirements for a generating plant for or capable of operation at a capacity of 300 MW or greater:

A. a description of the large capacity plant, including, but not limited to:

(1) a legal description of the property upon which the large capacity plant will be located;

(2) the size of the large capacity plant;

(3) fuel specifications including, but not limited to, the type of fuel to be used; and,

(4) a map showing the location of the large capacity plant;

B. identification of all applicable land use statutes and administrative regulations and proof of compliance or a statement of noncompliance with each;

C. identification of all applicable air and water pollution control standards and regulations and proof of compliance or a statement of noncompliance with each;

D. all written air and water quality authorizations necessary to begin construction of the large capacity plant;

E. all written air and water quality authorizations necessary to begin operation of the large capacity plant; if any such authorization cannot be obtained until after construction of the large capacity plant, proof of application for such authorization;

F. the expected date that the large capacity plant will be online;

G. proof that the application has been served on all local authorities in each county and township where the large capacity plant will be located, the New Mexico attorney general, the New Mexico environment department, and the New Mexico state engineer;

H. any other information, including photographs, which the applicant wishes to submit in support of the application.

3. TRANSMISSION LINES

28. Under Commission Rule 17.9.592.10 NMAC for approval of the location of transmission lines ("Transmission Location Rule"), an applicant must file an application supported by written testimony and exhibits that contain the following information for transmission lines for which location approval is required:

A. a description of the transmission line including, but not limited to:

(1) the location of the transmission line;

(2) identification of the ownership of the land (such as private, bureau of

land management, U.S. forest service, state trust, etc.) the transmission line will cross and the number of feet the transmission line will cross over each owner's land;

(3) the total length of each transmission line in feet;

(4) a description of interconnection facilities;

(5) a map showing the location of the transmission line; and

(6) a schematic diagram showing the transmission line and the interconnection of the transmission line to the transmission grid;

B. identification of all applicable land use statutes and administrative regulations and proof of compliance or statement of noncompliance with each;

C. if required under NEPA, an environmental assessment prepared in connection with the transmission line;

D. if required under NEPA, an environmental impact statement and record of decision or a finding of no significant impact, prepared in connection with the transmission line;

E. if preparation of a federal environmental assessment or environmental impact statement is not required under NEPA in connection with the transmission line, then a report, comparable to an environmental impact statement, in the format prescribed in 40 C.F.R. Section 1502.10;

F. all written federal, state, and local environmental authorizations necessary to begin construction of the transmission line;

G. all written federal, state, and local environmental authorizations necessary to begin operation of the transmission line; if any such authorization cannot be

obtained until after construction of the transmission line, proof of application for such authorization;

H. testimony demonstrating that the transmission line will not unduly impair important environmental values; important environmental values include, but are not limited to, preservation of air and water quality, land uses, soils, flora and fauna, and water, mineral, socioeconomic, cultural, historic, religious, visual, geologic and geographic resources;

I. the expected date that the transmission line will be online;

J. proof that the application has been served on all local authorities in each county and township where the transmission line will be located, the New Mexico attorney general, the New Mexico environment department, and the New Mexico state engineer;

K. any other information, including photographs, which the applicant wishes to submit in support of the application.

III. ALL THE REQUIREMENTS FOR THE REQUESTED APPROVAL ARE SATISFIED.

29. The Updated Corona Wind Farm Project and Updated Corona Gen-Tie System will satisfy all the requirements of NMSA 1978, §62-9-3 and Commission Rule 17.9.592 NMAC for location approval of a generation facility and a transmission line because: (1) the Corona Wind Companies will cause the Corona Wind Update and the Updated Corona Gen-Tie System to comply with all applicable requirements under the Siting Statute and Location Rule; (2) existing state, county, and municipal land use statutory and administrative regulations allow for the installation of these projects; and, (3) the approximately 180-foot ROW width is necessary for the Updated Corona Gen-Tie System. The Corona Wind Companies will cause the Corona Wind

Update and the Updated Corona Gen-Tie System to implement all the conditions, including the voluntary Protective Measures, that were agreed to in the Final Order in NMPRC Case No. 18-00065-UT.

THE CORONA WIND UPDATE.

30. As renewable energy generation facilities, the Corona Wind Update will result in environmental benefits and will not negatively impact air or water quality during the operating life of the generating facilities. The Corona Wind Update will produce zero-emission electricity using state-of-the-art wind turbine technology and may even displace electricity generated from non-renewable sources causing a reduction in greenhouse gas emission and regulated air pollutants. The Corona Wind Update will also have a *de minimis* effect on water quality during the construction of the projects and will conserve water that would otherwise be used in cooling thermal power plants during the operation of the projects.

31. Pursuant to NMSA 1978, §62-9-3, the Corona Wind Companies will cause the Corona Wind Update to comply with all applicable (1) water pollution control standards and regulations of the NMED; and (2) air pollution control standards and regulations of the NMED. The Direct Testimony of Adam Cernea Clark explains the applicable requirements and summarizes how the Corona Wind Update intend to comply with these standards.

32. The types of construction activity permits needed to construct the Corona Wind Projects are typically applied for and issued shortly before the start of construction and are anticipated to consist of air quality permits from NMED for concrete batch plants and mobile rock crushing. No other air or water pollution permits are required from NMED.

33. All air and water quality permits associated with environmental impacts due to construction activities will be acquired by the balance of plant ("BOP") contractor from the NMED prior to the initiation of construction of such project. Issuance of these permits by NMED and

compliance with their terms by the Corona Wind Companies will satisfy applicable state water and air pollution control standards and regulations. This is consistent with provisions which the Commission has already approved for the Corona Wind Projects Area in the Final Order in NMPRC Case No. 18-00065-UT.

WATER POLLUTION CONTROL STANDARDS AND REGULATIONS OF THE NMED.

34. The Corona Wind Companies will not need any water quality permits from NMED to comply with all water quality performance standards and regulations of NMED. However, they will obtain a National Pollution Discharge Elimination System ("NPDES") permit from the United States Environmental Protection Agency ("EPA").

35. The purpose of the New Mexico Water Quality Control Act ("New Mexico Water Act") is to prevent the impairment of New Mexico's groundwater quality. NMSA 1978, §§74-6-1 *et seq.* Because turbines do not require water to produce electricity, the Corona Wind Update will not impair groundwater quality. Also, the Corona Wind Companies do not propose a new diversion of surface water or groundwater resources at the site. Nor do the Corona Wind Companies intend to transfer any surface or ground water rights for project use. Since the Corona Wind Companies do not intend to adversely affect surface or groundwater at the site, they will not require a permit under the New Mexico Water Act.

36. The Corona Wind Companies will acquire the NPDES permit from the EPA under the Federal Water Pollution Control Act Amendments of 1972, as amended, more commonly referred to as the "Clean Water Act". 33 U.S.C. §1342. This permit will ensure that storm water discharge from construction activities that disturb one or more acres are managed through best management practices. However, the Corona Wind Update are also expected to qualify for a storm water Construction General Permit ("CGP").

37. The Corona Wind Companies will obtain coverage under a NPDES CGP from the EPA pursuant to 33 U.S.C. §1342. This construction phase permit requires the management of storm water discharge from the site during construction, including implementation of standard erosion control measures and best management practices. Further, project facilities will be sited to avoid and/or minimize fill in Waters of the U.S. so that any fill, if necessary, would be within the thresholds allowed under the 2017 Nationwide Permit Program under Section 404 of the Clean Water Act administered by the U.S. Army Corps of Engineers. 33 U.S.C. §1344. The Corona Wind Update facilities will be sited to minimize placement in the floodplain.

AIR POLLUTION CONTROL STANDARDS AND REGULATIONS OF THE NMED.

38. With respect to applicable air pollution standards, construction activities will be required to comply with General Construction Permits ("GCP"). The Corona Wind Companies will require air quality general construction permitting from NMED to comply with all air quality performance standards and regulations of NMED.

39. The New Mexico Air Quality Control Act applies to the Corona Wind Projects. NMSA 1978, §§74-2-1 *et seq.* The Corona Wind Companies will require the BOP to obtain a GCP before the start of construction, for concrete batch plants and a general construction permit for aggregate facilities (permits GCP-5 and GCP-2, respectively) from the Air Quality Bureau of NMED. The Joint Applicants will provide copies of these permits to the Commission upon request before construction activities associated with these permits begins.

40. The application for the general construction permit will demonstrate that the construction of the Corona Wind Update complies with applicable air pollution control standards and regulations. Once the Corona Wind Update are in operation, there will be no adverse impact

to air quality. Instead, the Corona Wind Projects will benefit the air quality by displacing sources of electricity in the Southwest which adversely impact air quality.

THE GENERATION LOCATION RULE.

41. The Joint Application and supporting testimony and exhibits provide the information required by the Generation Location Rule and the necessary information needed for the Commission's evaluation of this Joint Application to construct the Corona Wind Update.

42. The Joint Applicants will require the Corona Wind Update to comply with local land use statutes and administrative regulations.

43. The Corona Wind Companies will obtain New Mexico State Land Office ("SLO") approval for use of any state trust land, in compliance with Commission Rule 17.9.592.9(B) NMAC.

44. The necessary authorizations to begin construction and operation of the wind facilities are typically obtained immediately prior to start of construction and will be obtained prior to construction.

45. The Corona Wind Companies intend to put the wind facilities into operation by the end of 2020.

46. The Joint Application and supporting testimony and exhibits have been served on all local authorities in Lincoln, Torrance and Guadalupe Counties in New Mexico, the New Mexico attorney general, the New Mexico environment department, and the New Mexico state engineer. A copy of the Joint Application and testimony is available at the public library in the Town of Carrizozo, New Mexico, which is the county seat of Lincoln County; in Estancia, New Mexico which is the county seat of Torrance County; and in Santa Rosa, New Mexico which is the county seat of Guadalupe County. This Joint Application and supporting testimony and exhibits are also available on the Joint Applicants' website, http://www.coronawindprojects.com,

all in compliance with Commission Rule 17.9.592.9(G) NMAC, and Commission Rule 17.9.592.13 NMAC.

THE TRANSMISSION LOCATION RULE

47. The location of the Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally will not unduly impair any important environmental values. A more detailed discussion of environmental aspects of the Updated Corona Gen-Tie System is provided in the Direct Testimony of Adam Cernea Clark and the Corona Environmental Report.

48. The Reconfigured Corona Gen-Tie System, Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally will comport with existing plans of the state and local government. NMSA 1978, §62-9-3(M)(1). The Updated Corona Gen-Tie System is being constructed in connection with the Corona Wind Update in Lincoln, Torrance and Guadalupe Counties in the State of New Mexico.

49. The proposed Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally will also comport with and enhance existing land uses (farming and ranching) near and adjacent to the site and the line will have limited impacts on natural resources. NMSA 1978, §62-9-3(M)(2). This conclusion is supported by extensive studies and fieldwork of the Corona Wind Update and surrounding area and the area surrounding and inclusive of the Updated Corona Gen-Tie System. These impacts are limited to impacts on the lesser prairie chicken, which is not protected as a threatened or endangered species under the New Mexico Wildlife Conservation Act, MNSA 1978, §§17-2-37 *et seq.*, or under the Endangered Species Act, 7 U.S.C. §§1531 *et seq.*

50. The Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally will not produce significant noise emission levels or interfere with communication signals. NMSA 1978, §62-9-3(M)(3). A more detailed discussion is provided in the Direct Testimony of Adam Cernea Clark.

51. The Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally is mostly located on private land which is not open to the public. The Updated Corona Gen-Tie System will not impact public access to the small portion of the line passing through state trust land, except to the extent restricted by the State Land Office. NMSA 1978, §62-9-3(M)(4). A more detailed discussion is provided in the Direct Testimony of Adam Cernea Clark.

52. The Corona Wind Companies have conducted extensive, voluntary cultural and archaeological studies and protection measures and determined that the Reconfigured Corona Gen-Tie System and Extended Corona Gen-Tie System and the Updated Corona Gen-Tie System more generally will not unduly impair "existing scenic areas, historic, cultural or religious sites and structures or archaeological sites at or in the vicinity of the proposed location" of the Updated Corona Gen-Tie System. NMSA 1978, §62-9-3(M)(5). A more detailed discussion is provided in the prepared Direct Testimony of Adam Cernea Clark and the Corona Environmental Report.

53. The Joint Application, including supporting testimony and exhibits, provides the information required by the Transmission Location Rule and the necessary information needed for the Commission's evaluation of this Joint Application.

54. The Corona Wind Companies will cause the Updated Corona Gen-Tie System to comply with local land use statutes and administrative regulations.

55. The Corona Wind Companies will obtain SLO approval for use of any state trust land, in compliance with Commission Rule 17.9.592.10(B) NMAC.

56. The necessary authorizations to begin construction and operation of the Updated Corona Gen-Tie System are typically obtained and will be obtained by the Corona Wind Companies immediately prior to the start of construction.

57. The Corona Wind Companies intend to put the Updated Corona Gen-Tie System into operation as early as 2021 and the Updated Corona Gen-Tie System will not unduly impair important environmental values in compliance with Commission Rule 17.9.592.10(I) and (H) NMAC. See the Direct Testimony of Adam Cernea Clark for further analysis and explanation on the environmental concerns.

58. The Joint Application and supporting materials have been served on all local authorities in Lincoln and Torrance Counties in New Mexico, the New Mexico Attorney General, the New Mexico Environment Department, and the New Mexico State Engineer. A copy of the Joint Application and testimony is available at the public library in the Town of Carrizozo, New Mexico, which is the county seat of Lincoln County and in Estancia, New Mexico, which is the county seat of Torrance County. This Joint Application and supporting testimony and exhibits are also available on the Joint Applicants' website, http://www.coronawindprojects.com, all in compliance with Commission Rule 17.9.592.10(J) NMAC, and Commission Rule 17.9.592.13 NMAC.

59. The existing state, county, and municipal land use statutory and administrative regulations allow for the installation of the Updated Corona Gen-Tie System. These projects are also supported by local landowners, business leaders, and officials.

60. There are no zoning regulations in Guadalupe County. Lincoln County does have a wind energy ordinance, and the Corona Wind Projects have received approval from Lincoln County under this ordinance. Torrance County does have a zoning ordinance that regulates the zoning of wind projects. The Corona Wind Projects have received special zoning approval. The Corona Wind Companies will comply with all zoning requirements of Lincoln and Torrance Counties.

61. The great majority of the Updated Corona Gen-Tie System will be located on privately-owned land. As discussed in the Direct Testimony of Crystal Coffman, landowners, local businesses and political figures support the Updated Corona Gen-Tie System and its location approval.

62. The Corona Wind Companies will cause the Updated Corona Gen-Tie System to comply with the conditions for use of state trust lands. The Corona Wind Companies have submitted applications for lease agreements for 39,388 acres of state trust lands. State trust land use is further discussed in the Direct Testimony of Crystal Coffman.

THE 180-FOOT ROW WIDTH IS NECESSARY FOR THE UPDATED CORONA GEN-TIE SYSTEM

63. The 180-foot ROW width is necessary for the Updated Corona Gen-Tie System to connect the Corona Wind Update to the electric transmission grid in a safe and reliable manner. The 180-foot ROW width which has previously been approved for the Corona Gen-Tie System after integrating the modifications characterized by the Extended Corona Gen-Tie System and those portions of the Reconfigured Corona Gen-Tie System located outside of the previously approved Corona Gen-Tie System Corridor (i.e. within the Reconfigured Corona Gen-Tie System Corridor) to provide sufficient space for variation in design while addressing electrical safety code requirements and construction and operation considerations according to prudent and standard

industry practice. It would be unwarranted and unjustifiable to have different ROW widths for different segments of the overall transmission system. Further detail about the ROW width is provided in the direct testimony of Greg Parent. Accordingly, the Corona Wind Companies do not believe that a new Commission approval, as opposed to a finding of sufficiency of the previous approval, is needed under the ROW Statute in the situation presented here and request such a determination.

64. The Updated Corona Gen-Tie System will be located primarily on private land for which the Corona Wind Companies have obtained or will obtain land rights. All underlying landowners will agree to the ROW and no land will be "taken" as the location, construction and operation of the Updated Corona Gen-Tie System will be dependent upon landowner agreements. Accordingly, the Corona Wind Companies do not believe that Commission approval is needed under the ROW Statute in the situation as presented here and request such determination.

65. To the extent that the Commission finds the requested ROW width approval is necessary, the Corona Companies request such approval pursuant to NMSA 1978, §62-9-3.2.

IV. THE CORONA WIND UPDATE AND UPDATED CORONA GEN-TIE SYSTEM HAVE THE SUPPORT OF LOCAL LANDOWNERS, COMMUNITIES, BUSINESSES, AND POLITICAL FIGURES.

66. The Corona Wind Update and Updated Corona Gen-Tie System have received letters of support from landowners, local community officials, and leading figures of the New Mexico business community.

67. The Corona Wind Companies have also engaged in outreach to economic development organizations, potential construction partners, and vendors that may participate in the construction of the Corona Wind Update and Updated Corona Gen-Tie System. There is strong interest in the opportunity these projects afford.

V. NOTICE AND PROCEDURAL MATTERS.

68. Attached to this Joint Application is a proposed form of Notice of Application that the Corona Wind Companies propose, upon order of the Commission, to publish in a newspaper of general circulation in Lincoln and Torrance Counties.

VI. TESTIMONIES.

69. In support of its Joint Application, the Corona Wind Companies accompany their Joint Application with the following testimonies:

Witness	Subjects
Crystal Coffman	Project overview
Greg Parent	Right-of-Way Issues
Adam Cernea Clark	Pattern's environmental values, regulatory compliance, and environmental report

VII. CONCLUSION.

70. The Corona Wind Companies have demonstrated that the Corona Wind Update, the Extended Corona Gen-Tie System, and the Reconfigured Corona Gen-Tie System meet or exceed all applicable requirements of NMSA 1978, §§62-9-3, 62-9-3.2 and Commission Rule 17.9.592 NMAC. Specifically, (1) the location of the Corona Wind Update and Updated Corona Gen-Tie System will comply with applicable statutes and environmental regulations under NMSA 1978, §62-9-3 and Commission Rule 17.9.592 NMAC; (2) the existing state, county, and municipal land use statutory and administrative regulations allow for the installation of the Updated Corona Gen-Tie System, NMSA 1978, §62-9-3(G); and, (3) the approximately 180-foot ROW width is necessary for the Extended Corona Gen-Tie System.

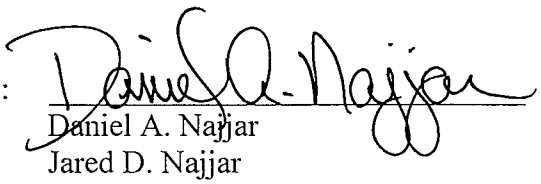
71. The Corona Wind Update and the Updated Corona Gen-Tie System will comply with all the conditions and Protective Measures set forth in the Final Order in NMPRC Case No. 18-00065-UT.

72. The Corona Wind Companies have complied with all the applicable requirements of NMSA 1978, §§62-9-3, 62-9-3.2 and Commission Rule 17.9.592 NMAC, and respectfully request the Commission issue a Final Order as expeditiously as possible approving the Corona Wind Companies' Joint Application for the location of the Corona Wind Update, Updated Corona Gen-Tie System in Lincoln, Torrance and Guadalupe Counties and the associated 180-foot ROW and provide such other relief as the Commission deems necessary and appropriate.

WHEREFORE, for the foregoing reasons the Corona Wind Companies request that the Commission grant this Joint Application to the extent required by law and for such other relief as may be deemed necessary and appropriate.

Respectfully submitted,

VIRTUE & NAJJAR, P.C.

By: 

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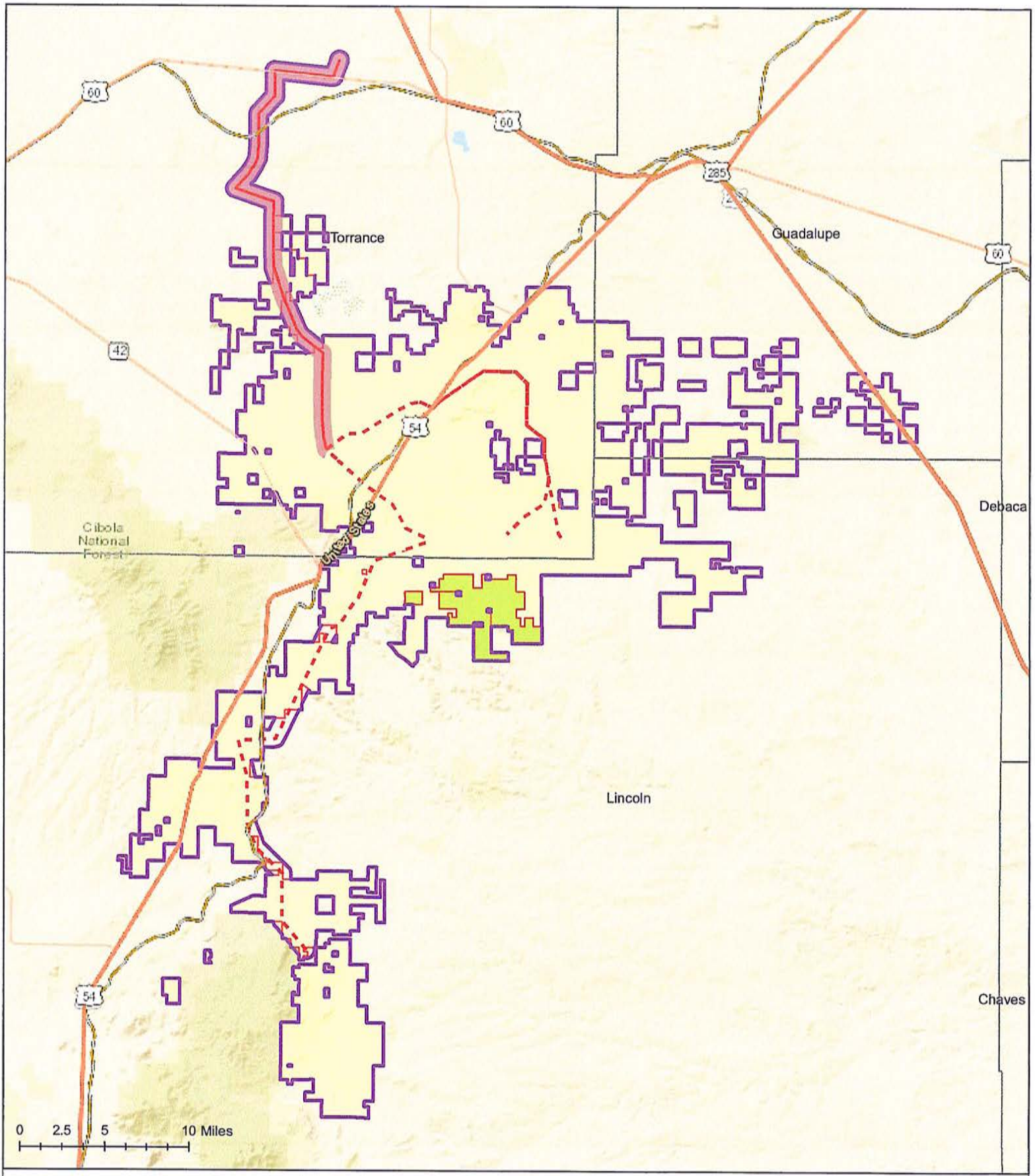
BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

FILED IN OFFICE OF
DEC 20 2019
NM PUBLIC REGULATION COMM
RECORDS MANAGEMENT BUREAU

AMENDED JOINT APPLICATION

Exhibit 1



Extended Corona Gen-Tie System
Reconfigured Corona Gen-Tie System
Updated Corona Wind Project Area
Extended Corona Gen-Tie System Corridor
Corona Wind Project Area
Corona Wind Update

CORONA WIND PROJECT UPDATE EXTENDED CORONA GEN-TIE SYSTEM

Pattern Development

12/12/2019

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BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

FILED IN OFFICE OF
DEC 20 2019
NM PUBLIC REGULATION COMM
RECORDS MANAGEMENT BUREAU

AMENDED JOINT APPLICATION

Exhibit 2

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

NOTICE

NOTICE is hereby given by the New Mexico Public Regulation Commission ("Commission" or "NMPRC") of the following:

1. Pursuant to NMSA 1978, §§62-9-3, 62-9-3.2 and Commission Rule 17.9.592 NMAC, on December ___, 2019 , Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Wind LLC, Tecolote Wind LLC, Viento Loco LLC. and, Gallinas Mountain Wind LLC (collectively the "Corona Wind Companies" or the "Joint Applicants") filed a Motion to Reopen NMPRC Case No. 18-00065-UT with the New Mexico Public Regulation Commission ("Commission") and a Joint Application and supporting direct testimony and exhibits ("Joint Application") requesting the Commission enter a Final Order that grants a new location approval for a modification to the wind projects and associated transmission line and facilities previously approved in NMPRC Case No. 18-00065-UT. Specifically, NMPRC Case No. 18-00065-UT granted approval to locate up to 2,200 megawatts ("MW") of wind generation from the Joint Applicants' wind energy facilities (collectively the "Corona Wind Projects") in Lincoln, Torrance

and Guadalupe Counties in New Mexico. In that proceeding the Commission also approved a location permit for the transmission line and associated facilities to interconnect the Corona Wind Projects with the proposed SunZia transmission line ("Corona Gen-Tie System").

2. The Joint Applicants are now seeking approval to expand the area of the Corona Wind Projects ("Corona Wind Update"), reconfigure parts of the previously approved location for the Corona Gen-Tie System ("Reconfigured Corona Gen-Tie System") and extend the Corona Gen-Tie System to also enable interconnection with the proposed Western Spirit Transmission Line ("Extended Corona Gen-Tie System"). The Joint Applicants also request approval, to the extent required by law, to utilize a 180-foot right-of-way ("ROW") for the Reconfigured Corona Gen-Tie System and the Extended Corona Gen-Tie System to be located within a one-mile-wide corridor within the same three counties. This ROW approval would be consistent with the approval granted in NMPRC Case No. 18-00065-UT.

3. The Corona Wind Update will consist of up to 2,300 MW of wind power facilities located in Lincoln, Torrance and Guadalupe Counties in New Mexico and will encompass approximately 347,000 acres of private and state land within the three counties ("Updated Corona Wind Project Area").

4. The Reconfigured Corona Gen Tie System and the Extended Corona Gen-Tie System (collectively referred to as the "Updated Corona Gen-Tie System") will connect the electricity generated by the Corona Wind Projects to one of the proposed SunZia Transmission LLC's two 500-kV transmission lines and related facilities located in Lincoln, Socorro, Sierra, Luna, Grant, Torrance, and Hidalgo Counties in New Mexico ("SunZia Project") and to the Western Spirit Transmission Line.

5. The Corona Wind Update and the Updated Corona Gen Tie System will be owned by the Joint Applicants.

6. The Joint Applicants request for a ROW width determination of 180-foot within a one-mile-wide corridor in the areas of the Updated Corona Gen-Tie System that were not previously approved in NMPRC Case No. 18-00065-UT pursuant to NMSA 1978, §62-9-3.2 is also necessary to provide sufficient space for variation in design while addressing electrical safety code requirements and construction and operation considerations for the Updated Corona Gen Tie System to connect the Corona Wind Projects to the SunZia Project and the Western Spirit Transmission Line in a safe and reliable manner.

7. The Commission has assigned Case No. 18-00065-UT to this Joint Application, and all correspondence, pleadings, comments, and other communications shall refer to that case number.

8. The procedural schedule established in this case is as follows:

A. The Joint Applicants shall, at their sole expense, publish notice in a newspaper of general circulation in Lincoln, Torrance and Guadalupe Counties on or before;

B. The Commission's Utility Division Staff ("Staff") shall file a response to the Joint Application by advising the Commission on Staff's position as to the merits of the Joint Application and the need for a public hearing on the location application;

C. Any interested person may intervene in this case by filing a motion for leave to intervene pursuant to Commission Rule 1.2.2.23(A) NMAC and 1.2.2.23(B) NMAC on or before June 25, 2018;

D. Staff shall, and Interveners may, file direct testimony by;

E. Any rebuttal testimony shall be filed on or before, and;

F. A public hearing will be held on, starting at 9:00 a.m. at the Commission's offices in the P.E.R.A. Building, 1120 Paseo de Peralta, Santa Fe, New Mexico, 87504, to hear and receive evidence, arguments, and any other appropriate matters pertaining to the case.

9. In accordance with NMSA 1978, §62-9-3(K), the Commission may approve the Joint Applicants' request for location approval without formal hearing if no protest is filed within sixty (60) days after notice has been given that the Joint Application has been filed.

10. The Joint Application may be examined by an interested person at the Commission's website (http://www.nmprc.state.nm.us/), the Joint Applicants website (http://www.coronawindprojects.com) or at the offices of the Joint Applicants and the Commission at the following addresses:

The Corona Wind Companies
Pier 1, Bay 3
San Francisco, CA 94111

New Mexico Public Regulation Commission
P.E.R.A. Building
1120 Paseo de Peralta
Santa Fe, NM 87504

11. Pursuant to Commission Rule 17.9.592.13 NMAC, the Joint Application may also be examined by any interested person at:

Town of Carrizozo Public Library,
c/o Head Librarian
406 Central Avenue (Hwy 54)
Carrizozo, NM 88301

Town of Estancia, Public Library
c/o Angela Creamer - Head Librarian
601 South Tenth Street
PO Box 166 Estancia, NM 87016

Moise Memorial Library
c/o Mary Martinez - Library Director
208 S. 5th St.
Santa Rosa, NM 88435

12. Any interested person may appear at the time and place of hearing and make a written or oral comment, pursuant to Commission Rule 1.2.2.23(F) NMAC without becoming an intervenor. Such comments will not be considered as evidence in this case.

13. The procedural dates and requirements provided herein are as provided in the Procedural Order issued in this case and are subject to further order of the Commission or Hearing Examiner. Any interested person should contact the Commission for confirmation of the hearing date, time and place since hearings are occasionally rescheduled.

14. Anyone filing pleadings, documents or testimony shall serve copies thereof on all parties of record and Staff and the Hearing Examiner by (1) first class mail or hand-delivery and (2) by email as provided by the Procedural Order. Copies served on the Hearing Examiner shall include an electronic version of the filing in word format. All filings shall be e-mailed on the date they are filed with the Commission. Any person whose testimony has been pre-filed will attend the hearing and submit to examination under oath.

15. The Commission's Rules of Procedure, 1.2.2 NMAC, shall apply to this case except as modified by order of the Commission or Hearing Examiner. A copy of the rules may be obtained from the offices of the Commission or at www.nmprc.state.nm.us/nmcc/.

16. All documents mailed to the Commission and its personnel shall be mailed to New Mexico Public Regulation Commission, P.E.R.A. Building, P.O. Box 1269, Santa Fe, New Mexico 87504-1269. The following physical address of the Commission shall be used only for special or hand-deliveries: 1120 Paseo de Peralta, Santa Fe, New Mexico 87504.

17. ANY PERSON WITH A DISABILITY REQUIRING SPECIAL ASSISTANCE IN ORDER TO PARTICIPATE IN THIS CASE SHOULD CONTACT THE COMMISSION AT LEAST 24 HOURS PRIOR TO THE COMMENCEMENT OF THE HEARING.

ISSUED at Santa Fe, New Mexico, this ____ day of _____, 2019.

NEW MEXICO PUBLIC REGULATION COMMISSION

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

DIRECT TESTIMONY OF

CRYSTAL COFFMAN

ON BEHALF OF THE CORONA WIND COMPANIES

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	Case No. 18-00065-UT
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JOINT APPLICANTS.	)	

DIRECT TESTIMONY OF

CRYSTAL COFFMAN

ON BEHALF OF THE CORONA WIND COMPANIES

DECEMBER 20, 2019

INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Crystal Coffman. My business address is 1201 Louisiana St. Suite 3200 Houston, Texas.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am employed by Pattern Energy Group LP (together, with Pattern Energy Group 2 LP, "Pattern Development") as a Business Development Director.

Q. PLEASE DESCRIBE YOUR EDUCATION BACKGROUND AND EXPERIENCE.

A. I have a Bachelor of Science degree in both Architecture and Civil Engineering from Texas Tech University and a Master of Business Administration degree from Rice University. I have worked in the renewables industry for Pattern Development or its predecessor, Babcock & Brown, for over 12 years and have experience in both Project Finance and Development. I played a direct role in the financing and development of over 1,700 megawatts ("MW") of wind farms in operation to date.

Q. PLEASE DESCRIBE THE DUTIES AND RESPONSIBILITIES FOR YOUR CURRENT POSITION.

A. As a Director in Business Development my duties include the following:

- Coordinating activities and communicating project objectives among the Permitting, Land, Power Marketing, Transmission, Meteorology, Engineering and Construction, Legal, Finance and Accounting teams.
- Ensuring timely decisions are made in collaboration with other stakeholders of the development.
- Regularly reviewing the risks, schedule and budget progress of a project.

- Actively negotiating with permitting agencies, landowners, local and state governmental agencies with assistance and guidance of my colleagues to facilitate the development of renewable energy projects.
- Delivering high-quality, low-risk, construction-ready projects.

Q. ON WHOSE BEHALF ARE YOU APPEARING IN THIS PROCEEDING?

A. I am testifying on behalf of the joint applicants, Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Wind LLC, Tecolote Wind LLC, Gallinas Mountain Wind LLC, and Viento Loco LLC, (collectively, the "Corona Wind Companies" or the "Joint Applicants") in support of this Joint Application for location control approval before the New Mexico Public Regulation Commission ("Commission") pursuant to NMSA 1978, §§62-9-3, 62-9-3 and Commission Rule 17.9.592 NMAC ("Joint Application").

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I am submitting testimony in support of this Joint Application for location approval of a modification to the area of the Corona Wind Projects ("Corona Wind Update"), a variation of the route of the Corona Gen-Tie System that was approved by the Commission in NMPRC Case No. 18-00065-UT ("Reconfigured Corona Gen-Tie System"), and an extension of the Corona Gen-Tie System ("Extended Corona Gen-Tie System"). For purposes of clarity, I refer to the Reconfigured Corona Gen-Tie System and the Extended Corona Gen-Tie System collectively as the "Updated Corona Gen-Tie System."

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. First, I will provide an overview of Pattern Development and the Joint Applicants. Then, I will review the originally proposed 2,200 MW of wind generation of the Joint Applicants' wind energy facilities ("Corona Wind Projects") and their relationship with the 345-

kilovolt ("kV") transmission system and associated transmission facilities, including a 180-foot right-of-way ("ROW"). The Corona Wind Projects, the associated Corona Gen-Tie System and the request for a right-of-way width of 180-feet were all initially approved in NMPRC Case No. 18-00065-UT (Case 18-00065"). I discuss the reason for this filing to make changes in the previously approved location of the Corona Wind Projects and the Gen-Tie System. In my testimony I discuss the reason for the approximate 35-mile extension to the Updated Corona Gen-Tie System for which the Joint Applicants are now seeking a location permit from the Commission in this proceeding. I also discuss the additions to the area of the Corona Wind Update and the Reconfigured Corona Gen-Tie System. Finally, I will summarize Pattern Development's public outreach, and our coordination with local, state, and federal agencies.

Q. WHAT SUBJECTS WILL OTHER WITNESSES ADDRESS?

A. The Joint Application will have the supporting testimony of the following witnesses:

- Adam Cernea Clark of Pattern Development will provide more detailed testimony about the environmental values which are incorporated into the planning, design, construction, and operation of our projects. He will also describe the Corona Wind Update and the Updated Corona Gen-Tie System and the Joint Applicants' commitment to comply with federal, state, and local law. Finally, he provides detailed testimony regarding the environmental report for the Extended Corona Gen-Tie System prepared by Burns & McDonnell Engineering Company, Inc. ("Burns & McDonnell"), hereafter referred to as the "Environmental Report." His testimony will address the environmental, biological, cultural, and archeological studies performed at the location of the Updated Corona Gen-Tie System.

- Greg Parent of Ulteig Engineers, Inc. will describe the technical design of the Updated Gen-Tie System including design conditions, ROW determination, structure spans and footprints, and transmission structure design.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE ANY REGULATORY AUTHORITIES?

A. Yes, I provided testimony before the Commission in NMPRC Case No. 18-00065-UT.

II. OVERVIEW OF PATTERN DEVELOPMENT, PATTERN ENERGY GROUP, INC., AND THE JOINT APPLICANTS

Q. PLEASE PROVIDE SOME BACKGROUND OF PATTERN DEVELOPMENT.

A. Pattern Development is a leading developer of renewable energy and transmission assets throughout the world. With a global footprint spanning all over the United States, Canada, Mexico, Chile and Japan, the highly experienced Pattern Development team has brought more than 5,000 MW of renewable power projects to market. Pattern Development's headquarters are in San Francisco, California.

Pattern Development's affiliate, Pattern Energy Group Inc., ("PEGI"), is an independent power company listed on the NASDAQ Global Select Market and Toronto Stock Exchange that owns and operates wind power facilities.

PEGI has a portfolio of renewable energy facilities in the United States, Puerto Rico, Canada, and Chile that use proven, best-in-class technology. PEGI's headquarters are co-located with Pattern Development in San Francisco, California.

Pattern Development may be thought of as the company that brings projects to the point of operation while PEGI may be thought of as the company that operates projects once they are built.

Q. PLEASE DESCRIBE THE RECENT ANNOUNCEMENT REGARDING THE FUTURE OWNERSHIP OF PATTERN ENERGY GROUP INC. AND ITS AFFILIATES.

A. On November 4, 2019, Pattern Energy Group Inc. (Pattern Energy) and Canada Pension Plan Investment Board (CPPIB) announced that they entered into a definitive agreement, pursuant to which CPPIB will acquire Pattern Energy. Concurrently, CPPIB and Riverstone entered into an agreement pursuant to which CPPIB and Riverstone will combine Pattern Energy and Pattern Energy Group Holdings 2 LP (Pattern Development) under common ownership. This brings together the operating renewable energy assets of Pattern Energy with the world class development projects and capabilities of Pattern Development under one company.

Canada Pension Plan Investment Board is a professional investment management organization that invests funds of the Canadian Pension Plan in the best interests of 20 million contributors and beneficiaries. At June 30, 2019, the Canadian Pension Plan Fund totaled C$400.6 billion. Riverstone is an energy and-power focused private investment firm, which has committed approximately $40 billion to more than 180 investments around the globe.

The transaction is expected to close in the second quarter of 2020. Following the closing of the transaction, the new Pattern company will be led by the same management team and maintain the same mission and focus of developing, constructing and operating renewable energy projects. Pattern's core focus on renewable energy in New Mexico will only be strengthened under this new structure.

Q. PLEASE PROVIDE AN OVERVIEW OF THE JOINT APPLICANTS.

A. The Corona Wind Companies are limited liability companies, organized under the laws of the State of Delaware, registered in the State of New Mexico, and are wholly owned subsidiaries of Pattern Development. Each of the Corona Wind Companies will obtain the land rights and permits needed for the development and construction of the Corona Wind Projects and the Corona Gen-Tie System.

Q. WILL PATTERN DEVELOPMENT IMPLEMENT COMPANY ENVIRONMENTAL POLICIES OR PRACTICES REGARDING THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM?

A. Yes. As discussed more in the testimony of Adam Cernea Clark, Pattern Development actively participates in wind industry efforts to understand, study, and minimize the environmental impacts of wind energy and to advance the development of technology and best practices. Pattern Development also routinely implements voluntary best management practices and mitigation strategies that further its environmental values. As evidence of our commitment to implementing environmental best practices with all of our projects, when Pattern Development acquired the Mesa Canyons Wind Project in 2018, a wind farm in Lincoln County, New Mexico, which was previously approved by the Commission in its Final Order issued February 28,2018 in NMPRC Case No. 17-00221-UT, we voluntarily elected to implement the same conditions and Protective Measures that we proposed and which were accepted by the Commission for the Corona Wind Projects in Case 18-00065. These additional Protective Measures were not a requirement of the Commission's Final Order in NMPRC Case 17-00221-UT.

Q. WHO WILL CONSTRUCT THE EXTENDED CORONA GEN-TIE SYSTEM?

A. Construction will be managed by Pattern Development's in-house construction group, which has successfully completed over 5,000 MW of wind projects including the Broadview wind farms in Curry County, New Mexico. Construction of the Corona Wind Extended Corona Gen-Tie System will be performed under one or more balance of plant agreements by one or more qualified third-party contractors. This is likely to be the same group of third-party contractors used for the Updated Corona Wind Farm Project and Updated Corona Gen-Tie System.

Q. WHAT COMMISSION APPROVALS ARE THE JOINT APPLICANTS REQUESTING?

A. The Corona Wind Companies request that the Commission approve the location of the Updated Corona Wind Farm Project, the Extended Corona Gen-Tie System in Torrance and Guadalupe Counties in New Mexico and the Reconfigured Corona Gen-Tie System pursuant to NMSA 1978, §§62-9-3, 62-9-3.2 and Commission Rule 17.9.592 NMAC. Joint Applicants are also requesting approval by the Commission of the 180-foot right-of-way for the entire Updated Corona Gen-Tie System.

Q. ARE THE CORONA WIND COMPANIES REQUESTING THE COMMISSION ISSUE A PUBLIC CERTIFICATE OF CONVENIENCE AND NECESSITY?

A. No. Neither the Joint Applicants, Pattern Development, nor PEGI entities are or will be public utilities if the proposed location permits are granted and the Corona Wind Projects and Extended Corona Gen-Tie System constructed.

III. THE CORONA WIND UPDATE

Q. PLEASE DESCRIBE THE CORONA WIND UPDATE.

A. The Corona Wind Update will consist of approximately 2,300 MW of wind power facilities. The Corona Wind Projects will still be located in Lincoln, Torrance and Guadalupe Counties in New Mexico and will encompass approximately 347,000 acres of private and state land within the three counties ("Updated Corona Wind Project Area"). The intention remains to interconnect the Corona Wind Update to one of SunZia Transmission LLC's two 500-kV transmission lines ("SunZia Project") via the Updated Corona Gen-Tie System. However, we also intend to interconnect the Corona Wind Update to the Western Spirit Transmission line. This is the reason for the Extended Corona Gen-Tie System.

To produce the desired energy, it is anticipated that there will be up to 950 wind turbines with a nameplate capacity ranging from 2.3 MW to 3.0 MW. Each of the turbines in the Corona Wind Update will be connected by 34.5-kV collection lines to new substations ("Generation Project Substations") to be located within the Updated Corona Wind Project Area. I have provided detailed maps as Exhibit CC-1 to my testimony showing the location of the Corona Wind Update and identifying areas that have been added to the generation facilities since our filing in NMPRC Case No. 18-00065-UT.

Q. IS THE PROPOSED LOCATION WELL-SUITED FOR WIND ENERGY GENERATION?

A. Yes. In this regard there is no change to the suitability of the site from the initial information filed in NMPRC Case No. 18-00065-UT. Exhibit CC-2 shows the average wind speed across New Mexico at 80 meters above ground level (the approximate height of an average wind turbine). The Corona Wind Update are at the intersection of Lincoln, Torrance, and Guadalupe Counties where some of the highest wind speeds are shown. Pattern

Development expects to pair industry leading wind turbine equipment with the strong wind resource in the Updated Corona Wind Project Area to maximize energy generation at the Corona Wind Update.

Q. HOW WAS THE UPDATED CORONA WIND PROJECT AREA CHOSEN FOR THE CORONA WIND PROJECTS?

A. As discussed previously, the Corona Wind Update is in an area with a wind resource superior to much of the rest of the State of New Mexico. After starting development for its Broadview and Grady projects in Curry County, New Mexico, Pattern Development began looking for more opportunities to leverage its experience elsewhere in the state. Once Pattern Development recognized the favorable resource at the location for the Corona Wind Update, it also recognized that this site has relatively low numbers of sensitive species and natural resources, support from private landowners for wind development, large areas of buildable terrain, and close proximity to the eastern terminus of the proposed SunZia Project.

Q. WHAT IS THE TIMEFRAME FOR CONSTRUCTION OF THE CORONA WIND PROJECTS?

A. Construction of a portion of the Corona Wind Update is expected to begin once all the necessary permits to begin construction are in hand. The Corona Wind Update are expected to be in service by the end of 2021 and the remaining wind power associated with the Corona Wind Update and Mesa Canyons Projects are expected to be in service between 2022 and 2024.

Q. WHAT IS THE REASON FOR THE CHANGE IN THE IN-SERVICE DATE?

A. The delay of the in-service date is a result of ongoing development work and economic optimization by the project. Pattern Development remains committed to the successful buildout of all of its assets in central New Mexico.

Q. HAS THE TIMEFRAME FOR CONSTRUCTION OF THE CORONA WIND UPDATE BEEN DELAYED BECAUSE OF THE CHANGES DESCRIBED IN THIS FILING?

A. No. The changes in this filing are the product of ongoing diligence and development by Pattern Development. Transmission route changes and project land additions are common in any wind farm development process.

Q. WILL THE CORONA WIND UPDATE HAVE AN INCREASED NAMEPLATE THAN WAS PREVIOUSLY ESTIMATED IN NMPRC CASE NO. 18-00065-UT?

A. The addition of private lands to the Corona Wind Update will offer increased flexibility for siting wind turbines and potentially for additional MW. This has not been finalized yet.

Q. WILL THERE BE ADDITIONAL TURBINES THAN ESTIMATED IN NMPRC CASE NO. 18-00065-UT?

A. Although the overall nameplate of the farm may increase, the number of turbines is still expected to be approximately 950. This is possible because the nameplate of each turbine is expected to be closer to 3.0 MW, which is the upper limit in the 2.3 – 3.0 MW range stated in my previous testimony in NMPRC Case No. 18-00065-UT.

IV. <u>THE UPDATED CORONA GEN-TIE SYSTEM</u>

Q. PLEASE DESCRIBE THE UPDATED CORONA GEN-TIE SYSTEM.

A. The Updated Corona Gen-Tie System is a 345-kV transmission system and associated transmission facilities, including a 180-foot ROW located within a one-mile-wide corridor. The Updated Corona Gen-Tie System will be located within the Updated Corona Wind

Project Area. Approximately 94 miles of the 345-kV transmission lines will connect each of the Corona Wind Projects' substation to either the Western Spirit Switchyard or SunZia East. The electricity generated by the Corona Wind Projects that will be transmitted through the SunZia Project will be sold to out-of-state purchasers located in Arizona, California, and/or Utah under Power Purchase Agreements. The electricity generated by the Corona Wind Update that will be transmitted through the Western Spirit Switchyard will be sold to either out-of-state purchasers or local customers in New Mexico. Attached to the testimony of Adam Cernea Clark as Exhibit ACC-3 are detailed maps showing the proposed route for the Updated Corona Gen-Tie System. These maps reflect the areas of the previously approved Corona Gen-Tie System which have been reconfigured and also the area with the extension of the Corona Gen-Tie System.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM BE LOCATED ON PRIVATE LANDS OR STATE LANDS OR SOME COMBINATION?

A. As mentioned above, the Updated Corona Gen-Tie System will be located on private and state land within the Updated Corona Wind Project Area. The estimated breakout between private and state lands is provided on my Exhibit CC-3 which is attached to this testimony.

Q. HAVE THE CORONA WIND COMPANIES SECURED LAND RIGHTS FOR THE EXTENDED GEN-TIE SYSTEM FROM THE PRIVATE LANDOWNERS AND THE STATE OF NEW MEXICO?

A. All land for the Extended Corona Gen-Tie System either has or will be secured prior to any construction commencing for the Extended Gen-Tie System.

Q. WHAT LAND USE STATUTES AND ADMINISTRATIVE REGULATIONS APPLY TO THE UPDATED CORONA GEN-TIE SYSTEM?

A. The Updated Corona Gen-Tie System is subject to the zoning ordinances of Lincoln County and Torrance County for a Wind Energy Conversion System approval and a Wind Energy Special Use District, respectively. The Corona Wind Projects will comply with both county ordinances.

Q. PLEASE DESCRIBE THE EXTENDED CORONA GEN-TIE SYSTEM IN MORE DETAIL, SPECIFYING THE PURPOSE AND THE CAPACITY TO MOVE WIND POWER?

A. The Extended Corona Gen-Tie System is an approximately 35-mile, 345-kilovolt ("kV") transmission system and associated transmission facilities, including a 180-foot right-of-way ("ROW") that will enable a portion the Corona Wind Update to connect to the Western Sprit Transmission Line. By connecting to the Updated Corona Gen-Tie System, the Extended Corona Gen-Tie System will be able to transmit a significant amount of Wind Power to locations in New Mexico and to other western markets.

Q. PLEASE EXPLAIN IN DETAIL THE RELATIONSHIP OF THE EXTENDED CORONA GEN-TIE SYSTEM TO THE RECENTLY APPROVED CLINES CORNERS WIND FARM AND ASSOCIATED GEN-TIE SYSTEM.

A. The Clines Corners Wind Farm and its associated Gen-Tie system are electrically separate and distinct from the Updated Corona Gen-Tie system. Any generator and associated facilities that connect to the Western Spirit Transmission Project will be required to comply with PNM design requirements. In addition, it is typical for multiple connections to a utility system to interconnect in such a way that other generators or systems will not impact each other or the grid in the event of an outage. A sample interconnection scheme showing the potential interconnection of the Corona Extended Gen-Tie and the Clines Corners Gen-

Tie to the Western Spirit Transmission Project is shown in Exhibit CC-4 In this schematic, the Clines Corners Gen-Tie and the Corona Extended Gen-Tie are electrically separate connections into the Western Spirt Switchyard.

Q. PLEASE PROVIDE MORE DETAIL WITH RESPECT TO THE RECONFIGURED CORONA GEN-TIE SYSTEM.

A. As discussed previously, the Reconfigured Corona Gen-Tie System is a variation of the Corona Gen-Tie System route that was approved by the Commission in NMPRC Case No. 18-00065-UT. Since the original approval, the Corona Gen-Tie System design has been further optimized to minimize environmental impacts, to optimize transmission routes based on private land leases, and to accommodate an additional interconnection option via Western Spirit. These optimizations result in a net increase of 9,088 feet of proposed Gen-Tie line and associated ROW. This increase is comprised of the removal of 14,016 feet and the addition of 23,104 feet of proposed Gen-Tie line. While some of the Gen-Tie additions are within the already studied one-mile corridor, other modifications fall outside of the corridor and require Commission review. Exhibit CC-5 shows these increases in table format. The testimony of Adam Cernea Clark will further detail the Reconfigured Corona Gen-Tie System layout and associated environmental impacts.

I note that the precise final route, including the length in miles and linear feet for the Updated Corona Gen-Tie System, is dependent upon the successful execution of a lease agreement currently under negotiation with a private landowner that is reflected in the Corona Wind Update. If the lease agreement is executed, the length of the Updated Corona Gen-Tie System in miles and linear feet is reflected under Option A on Exhibit CC-6. If this lease agreement is not successfully executed the length will be modified to that

reflected under Option B on Exhibit CC-6. In both instances the final route for the Updated Corona Gen-Tie System will be within the one-mile corridor that is the subject of the environmental analysis submitted in this Joint Application.

Q. WHAT IS THE TIMEFRAME FOR CONSTRUCTION OF THE UPDATED CORONA GEN-TIE SYSTEM?

A. At least a portion of the Updated Corona Gen-Tie System is expected to be in service by the end of 2021 with the entirety to be in-service by the end of 2024.

Q. HOW WILL THE ADDITION OF THE EXTENDED CORONA GEN-TIE SYSTEM FACILITATE THE DEVELOPMENT OF THE CORONA WIND UPDATE?

A. The addition of the Extended Corona Gen-Tie System provides an additional interconnection opportunity for the Corona Wind Update. Given the large wind resource in the Corona area, Pattern Development feels it will be able to inject wind energy into both the Western Spirit Transmission line and the SunZia Transmission line from the Corona Wind Update.

V. PUBLIC OUTREACH AND SUPPORT AND GOVERNMENT COORDINATION

Q. WERE LOCAL COMMUNITIES AND PUBLIC OFFICIALS INFORMED ABOUT THE EXTENDED CORONA GEN-TIE SYSTEM?

A. Yes, Pattern Development representatives and representatives of the Corona Wind Companies have held several informational meetings with landowners discussing the Corona Wind Update timelines. In addition, the private landowners along the Extended Corona Gen-Tie system have executed ROW Agreements for its construction. Additionally, Pattern Development will submit ROW applications with the New Mexico

State Land Office for the portions of the Extended Corona Gen-Tie system on State Land in January of 2020. No portion of the Extended Corona Gen-Tie System is located on Federal lands. Finally, Pattern Development has been in communications with Torrance County officials regarding any permits or permit updates needed for the Extended Corona Gen-Tie.

Q. HAVE THE CORONA WIND COMPANIES INFORMED THE PUBLIC ABOUT THE UPDATED CORONA GEN-TIE SYSTEM?

A. Yes. In addition to several public meetings, Pattern Development representatives have met individually with many local landowners about the Updated Corona Gen-Tie System.

Q. DO THE CORONA WIND COMPANIES HAVE THE SUPPORT OF THE WIND PROJECTS SITES' LANDOWNERS AND THE STATE OF NEW MEXICO?

A. Yes, over 299,000 acres of private land have been leased from private landowners and over 31,000 acres are in the process of being leased from the State of New Mexico. These leases have been negotiated and signed by the landowners or the State of New Mexico at their discretion.

Q. ARE YOU FAMILIAR WITH THE CONDITIONS PLACED UPON THE JOINT APPLICANTS AS PART OF THE COMMISSION'S FINAL ORDER IN NMPRC CASE NO. 18-00065-UT?

A. Yes. I was intimately involved in that proceeding and agreed to those conditions at that time.

Q. ARE YOU AUTHORIZED TO AGREE TO THE SAME CONDITIONS AS PART OF THIS JOINT APPLICATION AS WERE IMPOSED UPON JOINT APPLICANTS IN CASE NO. 18-00065-UT?

A. Yes, I am. I do agree to the numerous conditions and environmental protections that were included as conditions of the Final Order in NMPRC Case No. 18-00065-UT.

VI. ECONOMIC IMPACT OF THE CORONA WIND UPDATE

Q. WILL THERE BE ANY CHANGE IN THE ECONOMIC IMPACTS ANTICIPATED FROM THE CORONA WIND PROJECTS AS A RESULT OF THE CHANGES WHICH ARE THE SUBJECT OF THIS PROCEEDING?

A. The Corona Wind Update and the Updated Corona Gen-Tie System will not reduce the beneficial impacts identified in the results of the Corona Economic Report. In fact, additional acreage leased by the project represents an increase in both direct and indirect benefits by the Corona Wind Update. Out of conservatism, Pattern Development has elected to not update the report for this update.

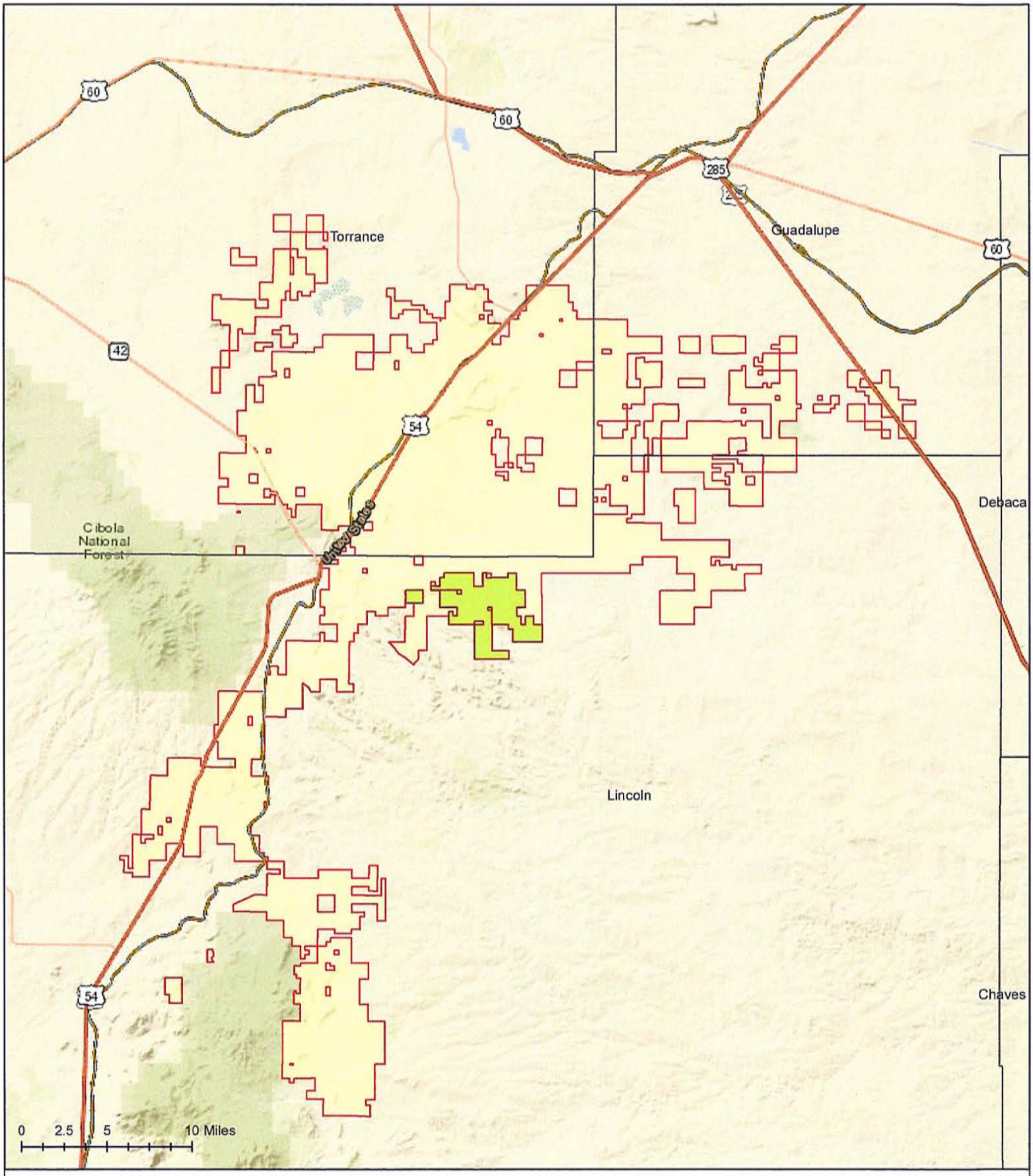
Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit CC-1



Corona Wind Project Area
Corona Wind Update

CORONA WIND PROJECT UPDATE

Pattern Development

12/12/2019

G:\Projects\New Mexico\Corona\Corona Overall Project\Map Documents\20191211_PRC_Maps_Updated_WIND.mxd

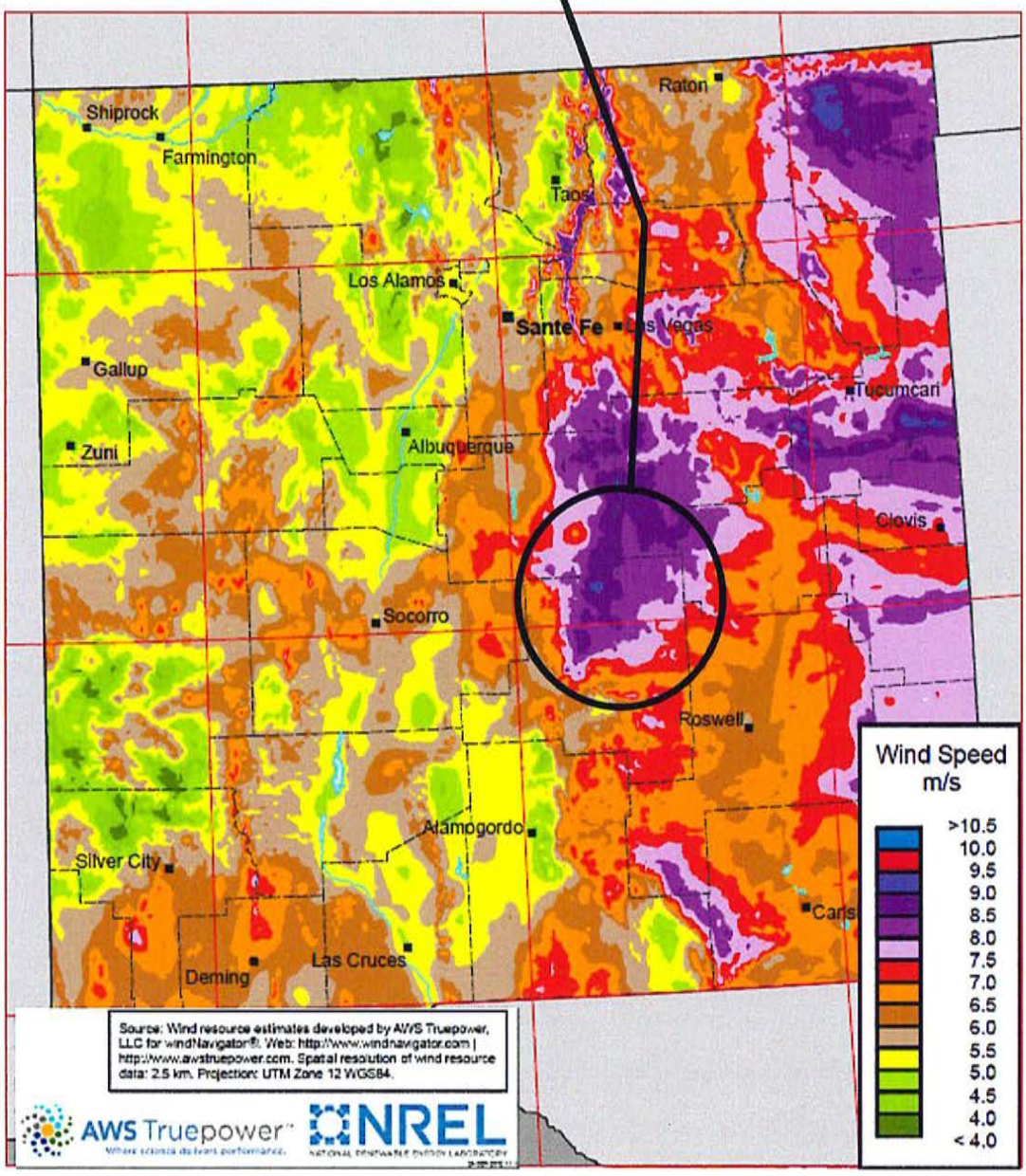
BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit CC-2

New Mexico – Annual Average Wind Speed at 80 m

The Corona Wind Projects are located in an area with some of the highest wind resource in the state.



BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

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JOINT APPLICANTS.	)	

Exhibit CC-3

Previously Approved Corona Wind Project Area

Status	Private - Previously Approved	State - Previously Approved	Total
Under option / applied	292,139	21,200	313,339
Negotiating / to apply	15,784	13,880	29,664
Total	307,923	35,080	343,003

Updated Corona Wind Project Area

Status	Private Updated	State Updated	Total
Under option / applied	299,131	33,006	332,137
Negotiating / to apply	3,560	0	3,560
Corona Wind Update	11,700	0	11,700
Total	314,391	33,006	347,397

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

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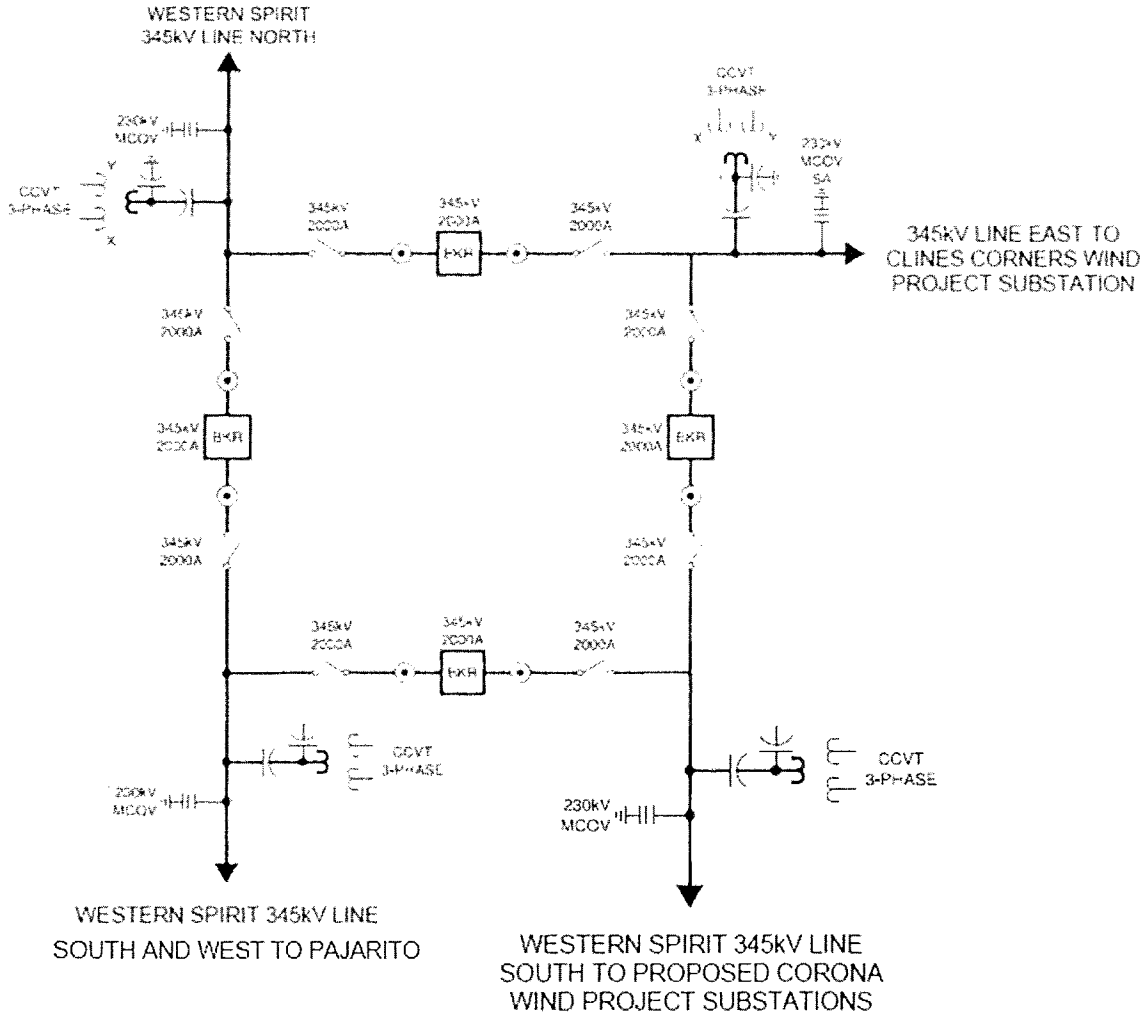
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit CC-4


WESTERN SPIRIT
345kV LINE NORTH
CCVT
3-PHASE
230kV
MCOV
345kV
2000A
EKR
345kV LINE EAST TO
CLINES CORNERS WIND
PROJECT SUBSTATION
WESTERN SPIRIT 345kV LINE
SOUTH AND WEST TO PAJARITO
WESTERN SPIRIT 345kV LINE
SOUTH TO PROPOSED CORONA
WIND PROJECT SUBSTATIONS

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
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JOINT APPLICANTS.	)	

Exhibit CC-5

Corona Gen-Tie System	Previously approved GenTie	Reconfigured Corona Gen-Tie			Extended GenTie	Updated Corona Gen-Tie System
		Miles/Acres removed	Miles/Acres remaining	Miles/Acres added		
Miles of Transmission	80	21.9	58	3	33.5	94.2
Acres of Corridor	51,200	14,016	37,184	1,664	21,440	60,288
Corridor Width	1 mile corridor	1 mile corridor	1 mile corridor	1 mile corridor	1 mile corridor	1 mile corridor
ROW Width	180 feet	180 feet	180 feet	180 feet	180 feet	180 feet

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit CC-6

Updated Corona GenTie System

	Option A	
Landowner	Length in Miles	Length in Linear feet
Private	82.3	434,280
State Land	11.9	62,832
Sum	94.2	497,112

	Option B	
Landowner	Length in Miles	Length in Linear feet
Private	81.6	430,848
State Land	11.9	62,832
Sum	93.5	493,680

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
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JOINT APPLICANTS.	)	

AFFIDAVIT OF CRYSTAL COFFMAN

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3 **ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,** **JOINT APPLICANTS.**	**Case No. 18-00065-UT**

AFFIDAVIT OF CRYSTAL COFFMAN

STATE OF TEXAS)
) ss.
COUNTY OF HARRIS)

I have read the foregoing Direct Testimony, and it is true and accurate based on my own knowledge and belief.

Crystal Coffman

SUBSCRIBED and sworn to before me this 19 day of December 2019.

SYDNEY BERROTERAN
Notary Public, State of Texas
Comm. Expires 10-01-2023
Notary ID 130390673

NOTARY PUBLIC

10/01/2023
My Commission Expires

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

DIRECT TESTIMONY OF

ADAM CERNEA CLARK

ON BEHALF OF THE CORONA WIND COMPANIES

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

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I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Adam Cernea Clark. My business address is 1088 Sansome St., San Francisco, CA 94111.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Pattern Energy Group LP (together with Pattern Energy Group 2 LP, "Pattern Development"). I hold the position of Manager of Environmental and Natural Resources. I am the project lead on environmental and permitting issues for the approximately 2,300 megawatt ("MW") of wind generation projects ("Corona Wind Projects") and the development and permitting of the 345-kilovolt ("kV") transmission system and associated transmission facilities, including a 180-foot right-of-way ("ROW") located within a one-mile-wide corridor (collectively, "Corona Gen-Tie System" or "Gen-Tie System"). The Corona Gen-Tie System and Corona Wind Projects are the subject matter of this application for location control approval before the New Mexico Public Regulation Commission ("Commission") pursuant to NMSA 1978, §§62-9-3, 62-9-3.2 and Commission Rule 17.9.592 NMAC ("Joint Application").

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND WORK BACKGROUND.

A. I am a 2005 graduate of Kenyon College with a B.A. in English and an Integrated Program in Humane Studies concentration. I am also a 2014 graduate of both Northeastern University School of Law and Vermont Law School, where I earned a Juris Doctor and Masters Degree in Environmental Law and Policy, respectively. In 2015, I was admitted as an attorney to the New York State Bar. I have been working in the wind industry since 2015, when I joined Pattern Development as an associate of environmental and natural

resources. My previous work experience includes fellowships at an international development organization and a local legal aid services, as well as corporate transactional work at a law firm in Europe.

In the course of my employment with Pattern Development, I am responsible for environmental, permitting, and non-permitting development issues related to the development of wind, solar, and transmission projects, as well as non-project-specific regulatory and policy matters. In my capacity as a representative of renewable projects such as the Corona Wind Projects, I am in charge of assessing and mitigating environmental impacts of Pattern Development's projects and securing all requisite permits prior to project construction and financing. In this capacity, I work closely with federal regulatory and environmental agencies, such as the National Park Service, the U.S. Army Corps of Engineers ("USACE"), and the U.S. Fish and Wildlife Service ("USFWS"), as well as state and local officials in communities where Pattern Development builds its projects.

I also engage with federal agencies, other renewable companies, and non-profit organizations as a representative of Pattern Development more generally to advance progress in environmental policy and research.

Q. ON WHOSE BEHALF ARE YOU APPEARING IN THIS PROCEEDING?

A. I am appearing on behalf of Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Wind LLC, Tecolote Wind LLC, Viento Loco LLC, Gallinas Mountain Wind LLC (Collectively referred to as the "Joint Applicants") in support of this Application for approval of changes to the Corona Wind Projects consisting of the following approvals: a) location approval of an expansion of the wind generation lands of the Corona Wind

Projects to encompass property (the "Corona Wind Update") not previously included in the original filing in NMPRC Case No. 18-00065-UT; b) location approval of a modification to the previously approved route for the Corona Gen-Tie System route to locate part of the route outside of the one-mile corridor presented in NMPRC Case No. 18-00065-UT ("Reconfigured Corona Gen-Tie System"); c) location approval for an extension of approximately 35 miles of the Corona Gen-Tie System within a one-mile corridor ("Extended Corona Gen-Tie System"); and, d) approval of a 180-foot right-of-way ("ROW") for the Reconfigured Corona Gen-Tie System and the Extended Corona Gen-Tie System (hereafter collectively referred to as the "Updated Corona Gen-Tie System"). I believe that approval of the ROW may not be necessary since this approval was granted in Commission's Order in NMPRC Case No. 18-00065-UT and the changes described in the Updated Corona Gen-Tie System do not alter the need for a 180 foot right of way, but am supporting this request in any event.

Q. ARE YOU SPONSORING ANY EXHIBITS WITH YOUR TESTIMONY?

A. Yes. I am sponsoring several exhibits in my testimony. However, the primary exhibit is Exhibit ACC-1, which is the Updated Corona Environmental Report ("Environmental Report") prepared by Burns & McDonnell for this Application. It was prepared under my direct supervision. I was the primary contact for the Burns & McDonnell team and have reviewed and am familiar with all of the work performed and the conclusions reached. The remaining exhibits are discussed later in my testimony in more detail.

Q. PLEASE PROVIDE A SUMMARY OF YOUR TESTIMONY.

A. I am submitting testimony explaining that the Corona Wind Projects have been modified by adding an area, the Corona Wind Update, that was not previously included in the

description in NMPRC Case No. 18-00065-UT. I describe the area where additional wind turbines might be located and explain that this area and the location of these generation facilities therein is in compliance with all applicable laws and regulations in New Mexico, as well as the environmental protections agreed upon by the Joint Applicants and Commission Staff in NMPRC Case No. 18-00065-UT..

I further describe the need to modify the route of the Corona Gen-Tie System, the Reconfigured Corona Gen-Tie System, from that which was approved in NMPRC Case No. 18-00065-UT. I describe the Reconfigured Corona Gen-Tie System primarily within the Reconfigured Corona Gen-Tie System Corridor, where it is located outside of the previously approved Corona Gen-Tie System Corridor that we discussed in NMPRC Case No. 18-00065-UT. I discuss how these new areas that were not previously studied in that prior proceeding will also comply with all of the Commission requirements for location permit approval for a transmission system. Next, I describe the additional approximately 35-mile extension of the Corona Gen-Tie System, the Extended Corona Gen-Tie System, and the fact that our environmental analysis confirms that this extension merits location permit approval as well. I also discuss how these new areas will implement the environmental protections agreed upon by the Joint Applicants and Commission staff in NMPRC Case No. 18-00065-UT.

II. POTENTIAL ENVIRONMENTAL IMPACTS

A. ENVIRONMENTAL IMPACTS OF TRANSMISSION PROJECTS GENERALLY

Q. HOW WOULD YOU CHARACTERIZE THE ENVIRONMENTAL IMPACTS OF TRANSMISSION SYSTEMS GENERALLY?

A. In the United States there are over 200,000 miles of high-voltage transmission lines such as the proposed Corona Gen-Tie System, and over 5,000,000 miles of distribution lines. Electrical transmission lines have relatively few significant negative environmental impacts, largely because transmission projects have a small physical impact relative to other forms of development and do not require the ROW to be converted entirely to industrial use. The few environmental impacts consist primarily of habitat modification and impacts to birds. Transmission projects are typically able to microsite around sensitive site-specific resources, such as archaeological and historical resources or wetlands and streams.

Q. PLEASE DESCRIBE IN BRIEF TERMS HOW TRANSMISSION LINES CAN IMPACT LOCAL HABITATS?

A. Because transmission lines are long, linear projects, they will inevitably bisect different habitats even if actual habitat modification is limited to portions of the transmission ROW. Habitat modification is primarily the result of vegetative clearing of a transmission ROW to ensure that appropriate structure clearances are maintained pursuant to the standardized requirements of the North American Electric Reliability Corporation ("NERC"). NERC establishes minimum clearance distances from vegetation to ensure the reliability of the North American bulk power system. The effects of habitat modification as a result of transmission lines are multiple, nuanced, and will vary widely across differing circumstances. Habitat modification can result in the permanent direct loss of preexisting habitat types across a ROW. This may occur, for example, where a transmission line crosses a heavily forested habitat in the Northeastern United States which requires clearing of vegetation for the operations and maintenance of the line in compliance with NERC.

Conversely, a transmission project in the desert Southwest is unlikely to require significant vegetative clearing within its ROW since habitat loss will largely consist of minimal areas for project structures, such as power poles. Transmission ROWs can also create valuable habitat for certain species utilizing edge habitat, such as pollinator insects and various passerine birds. Large-body predators may utilize cleared transmission ROWs for travel.

Like most large linear projects, transmission line ROWs can be sited to minimize impacts to sensitive habitats, such as playa lakes. Also, because the permanent physical footprint of a transmission project consists of power pole structures and aerial cables, power poles can further be micro-sited to avoid impacts to specific sensitive resources. This is true also of electrical substations. While avoidance of environmental impacts comes at an economic cost, careful siting can significantly reduce the already modest impacts caused by transmission projects.

Q. PLEASE DESCRIBE IN BRIEF TERMS HOW TRANSMISSION LINES CAN AFFECT AVIAN SPECIES?

A. Birds can be impacted by collision with or electrocution from powerlines. Electrocution risk can be managed in a variety of ways and it is an increasingly common practice to utilize the Avian Powerline Interaction Committee ("APLIC") electrocution guidelines to implement measures to reduce this risk. However, the 345-kV systems that will be used in connection with the Corona Wind Projects are large enough to remove the risk of electrocution.

Risk of collision exists for both distribution and transmission lines. The majority of birds colliding with transmission lines are small passerine species with high fecundity rates and short lifespans that are more resilient to mortality at the population level. Risk factors are

detailed in the APLIC collision guidelines, including proximity to agricultural fields, water resources, and parks. See Exhibit ACC-2 for the 2012 APLIC collision guideline, *Reducing Avian Collisions with Power Lines.*

I believe that the most effective measure for minimizing avian mortality at transmission lines, after a line has been sited, is the installation of bird diverters. Bird diverters are visual deterrents installed on transmission lines to make the lines stand out visually to flying birds. Bird diverters are installed in identified areas along a transmission project based on various risk factors detailed in the APLIC guidelines on transmission line conductors. They are designed to be visually conspicuous to birds. They can be very effective where used appropriately.

Q. HOW CAN TRANSMISSION LINES IMPACT CULTURAL RESOURCES?

A. Transmission lines can impact cultural resources through construction and placement of structures in close proximity to sensitive cultural resources, such as archaeological or historical sites. Transmission lines can generally be constructed to avoid archaeological and historical sites altogether through careful siting of a transmission ROW and subsequently by implementing the micro-siting of power pole structures to span, or avoid altogether, any impacts to a given resource.

B. EXISTING ENVIRONMENT OF THE CORONA WIND UPDATE AND UPDATED CORONA GEN-TIE SYSTEM

1. CORONA WIND UPDATE

Q. PLEASE DECRIBE THE CHANGES OCCURRING IN THE CORONA WIND UPDATE FROM THAT WHICH WAS DESCRIBED IN NMPRC CASE NO. 18-00065-UT.

A. The changes which are reflected in the Corona Wind Update are shown in detail in Exhibit ACC-3 to my testimony. These changes essentially include the addition of some additional lands with very good wind resources to the generation area for the Corona Wind Projects. While the addition of the lands reflected in the Corona Wind Update is not necessary for the successful development of the Corona Wind Projects, it does allow for the inclusion of additional high quality wind generation land to the projects resulting in a greater optimization of the Corona Wind Projects.

2. UPDATED CORONA GEN-TIE SYSTEM

Q. PLEASE DESCRIBE THE RECONFIGURED CORONA GEN-TIE SYSTEM.

A. The Reconfigured Corona Gen-Tie System is shown on Exhibit ACC-3 which is attached to my testimony. The maps I am sponsoring show the original Corona Gen-Tie System that the Commission approved and the Reconfigured Corona Gen-Tie System with deviations from the original route.

Q. PLEASE EXPLAIN THE NEED FOR THE RECONFIGURATION OF THE CORONA GEN-TIE SYSTEM OUTSIDE OF THE ONE-MILE CORRIDOR DISCUSSED IN NMPRC CASE 18-00065-UT.

A. While not necessary for the successful development of the Corona Wind Projects and, most specifically, the Corona Gen-Tie System, the reconfiguration of the Corona Gen-Tie System allows for a more efficient and optimized transmission system for the Corona Wind Projects. Adjustments in the proposed route for a transmission line are common in the industry and are a benefit to the

public as it enables the project developer to address unanticipated environmental conditions and to minimize impacts to those which were known.

Q. PLEASE DESCRIBE THE EXTENDED CORONA GEN-TIE SYSTEM

A. The Extended Corona Gen-Tie System is a 180-foot ROW and an approximately 35 mile 345-kV transmission system and associated transmission facilities that will be located within a 1-mile-wide corridor. The proposed route for the Extended Corona Gen-Tie System is shown on Exhibit ACC-3.

Q. IS THERE A REASON YOU DO NOT DESCRIBE THE LOCATION OF THE EXTENDED CORONA GEN-TIE SYSTEM WITH MORE SPECIFICITY WITHIN THE ONE-MILE CORRIDOR?

A. Yes. We have described and shown in maps our best approximation of the Extended Corona Gen-Tie System route at this time. However, the location of the Extended Corona Gen-Tie System is also dependent upon the final location of the Updated Corona Gen-Tie System in terms of the location of a particular 180-foot ROW. The siting of wind projects infrastructure is a data-driven process. While the Corona Gen-Tie System will ultimately be restricted to a 180-foot ROW, the Corona Wind Projects are still under active development. As part of the wind development process, we are constantly collecting data that is integrated into the design of our projects. Generally speaking, the more flexibility a project has to integrate site-specific data into project design, the better a project will tend to be at the end of the day.

The exact location of the ROW may change within our one-mile study corridor either due to micro-siting of the alignment of the Extended Corona Gen-Tie System itself, or through adjustments in the location of project turbines. These factors are sufficient to drive changes

in the location of project substations, which subsequently can result in changes to the overall alignment of the Corona Gen-Tie System and the Extended Corona Gen-Tie System. This one-mile corridor has been studied holistically in the Environmental Report to analyze the potential impacts of the Extended Corona Gen-Tie System anywhere within this corridor. Thereby, the one-mile corridor allows for micro-siting to occur later in the project development as final decisions are made after reviewing the data.

Q. WHEN IS THE UPDATED CORONA GEN-TIE SYSTEM EXPECTED TO BE IN SERVICE?

A. Assuming the Corona Wind Projects interconnect to Western Spirit at least a portion of the Corona Wind Update and Updated Corona Gen-Tie System is expected to be in service by the end of 2021 with the entirety to be in-service by the end of 2024.

Q. PLEASE EXPLAIN WHY THE UPDATED CORONA GEN-TIE SYSTEM REQUIRES A 180-FOOT ROW WIDTH.

A. The Joint Applicants propose to use a 180-foot ROW width to ensure compliance with safety codes; to provide adequate logistical space for construction, operations and maintenance of the transmission line; and, to provide sufficient flexibility for siting structures within the ROW. See the Direct Testimony of Greg Parent which addresses these factors for the Extended Corona Gen-Tie System and concludes that a 180-foot ROW width is necessary for the final design. Furthermore, it is my professional opinion that a sufficiently wide ROW, such as that requested in this Joint Application, can provide for greater micro-siting flexibility for resource avoidance if unanticipated resources are identified during final design and construction.

Q. WHAT IS THE EXISTING ENVIRONMENT OF THE EXTENDED CORONA GEN-TIE SYSTEM, INCLUDING THE PROPOSED CORRIDOR?

A. As detailed in the Exhibit ACC-1, Environmental Report, the existing environment within the Extended Corona Gen-Tie System Corridor is quite similar to the existing environmental within the previously approved Corona Gen-Tie System Corridor and largely consists of open savannah as well as pinon juniper habitat subject to ranching activities.

Q. WHAT IS THE EXISTING ENVIRONMENT OF THE RECONFIGURED CORONA GEN-TIE SYSTEM LOCATED OUTSIDE OF THE ORIGINAL CORONA GEN-TIE SYSTEM CORRIDOR CONSIDERED IN CASE NO. 18-00065-UT?

A. As detailed in the Environmental Report, the existing environment within the Reconfigured Corona Gen-Tie System Corridor is very similar to the existing environmental within the previously approved Corona Gen-Tie System Corridor and largely consists of open savannah as well as pinon juniper habitat subject to ranching activities.

III. PATTERN DEVELOPMENT AND ITS APPROACH TO PROJECT DEVELOPMENT AND ENVIRONMENTAL ISSUES.

A. PATTERN DEVELOPMENT'S ENVIRONMENTAL VALUES IN PROJECT DEVELOPMENT

Q. PLEASE PROVIDE THE COMMISSION WITH SOME BACKGROUND ON PATTERN DEVELOPMENT IN TERMS OF THEIR ENVIRONMENTAL VALUES AND TRACK RECORD.

A. Pattern Development has taken a leadership role in tackling the modest environmental impacts of the wind industry. We actively participate and provide funding in wind industry efforts to understand, study, and minimize the environmental impacts of wind energy and to advance the development of impact minimization technology and industry best management practices ("BMPs"). Pattern Development personnel participated in the public-private collaboration that led to the development of the USFWS Land-Based Voluntary Wind Energy Guidelines ("WEGs"). See Exhibit ACC-4. We have funded research into novel technologies for understanding and minimizing the environmental impacts of our projects. We are a founding and sustaining member of the American Wind Wildlife Institute, a coalition of wind industry companies and non-governmental organizations working to advance conservation values, scientific research, and wind energy development. We also routinely implement voluntary BMPs and mitigation strategies that further our environmental values. Recently, Pattern Energy Group Inc., an affiliate of Pattern Development (collectively, "Pattern Group"), played a leadership role in the American Wind Energy Association's efforts to raise funding for scientific research for understanding the impacts of wind-wildlife interactions, as well as supporting the implementation of bat mitigation measures during the autumn bat migration that have proven to substantially decrease bat mortality at the cost of reduced renewable energy generation. These examples are emblematic of our commitment to our statement of environmental values ("Statement of Environmental Values").

Q. DOES PATTERN DEVELOPMENT HAVE A FORMAL POLICY RELATING DIRECTLY TO THE PROTECTION OF THE ENVIRONMENT?

A. Yes. Pattern Development developed and followed the Statement of Environmental Values that outlines an iterative process for identifying, avoiding, minimizing, and addressing potential environmental impacts of renewable energy development and operations. See Exhibit ACC-5.

Q. PLEASE DESCRIBE HOW THE STATEMENT OF ENVIRONMENTAL VALUES AFFECTS THE WAY PATTERN DEVELOPMENT ADDRESSES THE ENVIRONMENTAL BENEFITS AND IMPACTS OF RENEWABLE ENERGY GENERATION AND TRANSMISSION DEVELOPMENT?

A. The Statement of Environmental Values outlines the following principles that guide our approach to environmental protection and renewable energy development:

- Identify and assess potential environmental impacts at all stages of the life cycle of our projects, incorporate them in our decision making, and explore creative mitigations to minimize any adverse impacts.
- Comply with all applicable environmental laws and regulations. Where there are limited regulations, we apply our more stringent standards.
- Engage relevant stakeholders, including community representatives and national resource agencies, during the planning process of our projects.
- Site and design projects in such a manner as to respect wildlife and their habitat.
- Construct and operate projects using best practices to prevent pollution and conserve natural resources.

- Work to continually improve overall environmental performance and ensure we are stewards of the environment.

Pattern Group strives to fulfill these principles in the construction and operation of all our projects by implementing the Statement of Environmental Values as standard practice on how we address environmental impacts in the United States. This dynamic ensures that a long-term approach is implemented from the earliest stage of development for addressing potential environmental concerns arising in the course of project development, construction, and operation. *Building Wildlife-Friendly Wind*, an infographic, explains how Pattern implements this approach to develop and operate its projects in an environmentally responsible way. Exhibit ACC-6 illustrates this stepwise approach.

Q. ARE THERE OTHER IMPORTANT VOLUNTARY GUIDELINES THAT EFFECT HOW PATTERN DEVELOPMENT ADDRESSES ENVIRONMENTAL PROTECTION AND STEWARDSHIP IN PROJECT DEVELOPMENT?

A. Yes. Pattern Development also follows the WEGs at all its projects across the United States and integrates into powerline siting decisions the APLIC guidelines for reducing avian mortality from powerlines. Please see Exhibit ACC-4 for the WEGs and Exhibit ACC-2 for the APLIC *Reducing Avian Collision with Power Lines* guideline.

Q. WHAT ARE THE WEGS?

A. The WEGs follow a tiered approach identifying, understanding, and addressing potential impacts of wind energy projects to the surrounding environment. Tier One entails an initial landscape-level site characterization relying on satellite imagery and publicly available databases. Tier Two identifies species and habitats of potential concern and different habitat types within a prospective project area that could be impacted by project

development. The Tier Two phase often corresponds to the initiation of informal consultation with the USFWS about the proposed project. In Tier Three, biological field studies are initiated and reviewed with USFWS and site-specific data is used to understand potential risks of impacts to sensitive species. These first three tiers of the WEGs cover the development and construction of a project. The subsequent tiers involve post-construction studies to understand potential and actual impacts of a project to be incorporated into project operations.

Q. HOW DO THE WEGS AFFECT THE WAY PATTERN DEVELOPMENT APPROACHES ENVIRONMENTAL ISSUES IN PROJECT DEVELOPMENT?

A. The WEGs' step-wise approach forms the basis of how we address environmental issues in renewable energy development, construction, and operations. Our Statement of Environmental Values, also structured around an iterative process, provides a natural complement to the WEGs and allows us to apply our own internal standards in addition to the industry-wide standards delineated in the WEGs.

Q. WHY ARE THE WEGS IMPORTANT TO UNDERSTANDING THE ENVIRONMENTAL IMPACTS OF TRANSMISSION LINES SPECIFICALLY?

A. The WEGs are important to the Updated Corona Gen-Tie System insofar as our implementation of this environmental review process in our projects includes equally the siting, designing, and operating of project-specific transmission "gen-tie" lines and wind turbines. Pattern Development has also migrated the lessons and methods learned through successfully implementing the WEGs in wind project development directly into our approach to developing of renewable generation and transmission projects.

Q. PLEASE EXPLAIN IN MORE DETAIL THE APLIC GUIDELINES?

A. The APLIC guidelines on electrocution and collision are voluntary guidance documents that are the result of industry, non-profits, and government agencies, such as USFWS, working together to create standardized processes for analyzing and minimizing risk of avian mortality as a result of collision with or electrocution by operating powerlines. These guidelines provide a stepwise methodology to assessing and minimizing impacts to birds from powerlines and are not associated with wind energy development per se.

Q. ARE THE APLIC COLLISION AND ELECTROCUTION GUIDELINES RELEVANT TO THE CORONA GEN-TIE SYSTEM?

A. The APLIC electrocution guidelines are not material to the Extended Corona Gen-Tie System. This is because the Extended Corona Gen-Tie System consists entirely of 345-kV transmission lines which, because of the design and larger dimensions of 345-kV lines, do not pose a material risk of electrocution.

Q. WHY DID THE CORONA WIND COMPANIES DECIDE TO IMPLEMENT THE APLIC GUIDELINES?

A. The Corona Wind Companies have elected to implement the APLIC guidelines because these guidelines have long served as an effective tool developed with diverse stakeholder input for addressing potential impacts from powerlines to avian species.

Q. HOW DO THE APLIC GUIDELINES AFFECT POWERLINE SITING DECISIONS BY PATTERN DEVELOPMENT?

A. The APLIC collision guidelines, *Reducing Avian Collision with Power Lines*, are more significant in this instance and help direct our siting and risk assessment of project gen-

ties. These guidelines help identify areas where the risk of avian collision is more or less likely.

Following the APLIC guidelines resulted in the development of an Avian Protection Plan ("APP") that has been produced to assess specifically the risks of avian mortality. An APP is a BMPs document following APLIC and USFWS guidelines to investigate and address powerline impacts to birds. For wind projects following the WEGs, a Bird and Bat Conservation Strategy is instead developed and structured around the tiered approach of the WEGs and additionally augmented by reference to the APLIC guidelines. However, for the benefit of the Commission, a separate APP was completed regarding the Corona Gen-Tie System ("Corona Wind APP"). The Corona Wind APP is being updated to reflect the changes to the Corona Gen-Tie System embodied in the Reconfigured Corona Gen-Tie System and a supplemental APP has been completed for the Extended Corona Gen-Tie System, which I will discuss in further detail in this testimony and is included here as Exhibit ACC-7.

B. PATTERN DEVELOPMENT ENVIRONMENTAL VALUES IN DEVELOPMENT OF THE CORONA WIND UPDATE AND THE UPDATED CORONA GEN-TIE SYSTEM

Q. PLEASE DESCRIBE HOW PATTERN DEVELOPMENT HAS DEVELOPED AND DESIGNED THE CORONA WIND UPDATE AND, SPECIFICALLY, THE UPDATED CORONA GEN-TIE SYSTEM WITH RESPECT TO POTENTIAL IMPACTS TO THE ENVIRONMENT?

A. As discussed earlier, Pattern Development implemented its Statement of Environmental Values. When we began work on the Corona Wind Projects in 2016, we also began an

analysis of the project and engaged Western Ecosystem Technology, Inc. ("WEST") to complete initial site assessments. In December 2016, we completed limited construction work at 30 preliminary turbine locations for the purpose of qualifying the projects for the federal production tax credit ("PTC"). These site assessments included surveys for cultural resources, wetlands and streams, and threatened and endangered species. Tier 1 and Tier 2 studies, per the WEGs, were completed by WEST in early 2017. These studies allowed us to understand not only the existing environment and possible species of concern within the Corona Wind Project Area, but also the likelihood of their presence or absence. Avian use surveys commenced in January 2017 and follows USFWS survey recommendations. These surveys are ongoing, and we have acquired over 2,000 hours of avian use surveys at this point. Raptor stick nest helicopter surveys were completed in the Spring of 2017, 2018, and 2019 and bat acoustic monitoring was also conducted between March and October of 2017.

Additional surveys have been completed and we have consulted with both the USFWS and New Mexico Department of Game and Fish relating to our survey efforts and findings. Since approval of the Corona Wind Projects in NMPRC Case No. 18-00065-UT and, specifically, the Corona Gen-Tie System, the results of the additional survey work that has been completed are consistent with the findings I discussed in my previous testimony. We have also commenced an initial phase of cultural resource surveys that are being used to microsite turbine locations and will be used to microsite the Updated Corona Gen-Tie System as design is finalized.

Q. PLEASE DESCRIBE THE CORONA WIND APP?

A. The Corona Wind APP is a project-specific third-party transmission line avian risk assessment. The Corona Wind APP has analyzed the risk posed to birds from collision with the Corona Gen-Tie System. The Corona Wind APP utilized three levels of risk to analyze segments of the Corona Gen-Tie System. Category One represents line spans with high habitat quality and/or high anticipated bird use. Category Two represents line spans with moderate habitat quality or high habitat quality and moderate anticipated bird use. Category Three represents line spans with disturbed areas, areas of high level of human influence, with areas of moderate to high anticipated bird use or moderate habitat quality with moderate anticipated bird use.

The Corona Wind APP did not identify any line spans in Categories One and Two. However, it identified six-line spans totaling less than 2.5 miles in Category Three and an additional span of just over 0.5 miles that did not meet the criteria for Category Three but had enough characteristics of Category Three that they were included in the Corona Wind APP after discussion with Pattern Development. The Supplemental Corona Wind APP did not identify any Category One- or Two-line spans but did identify two Category Three spans that totaled 1.3 miles and 0.4 miles.

Q. HOW DOES PATTERN DEVELOPMENT PLAN TO IMPLEMENT THE CORONA WIND APP INTO THE DESIGN AND OPERATIONS OF THE UPDATED CORONA GEN-TIE SYSTEM?

A. Pattern Development has elected on a strictly voluntary basis to mark with bird diverters all Category Three-line spans as well as the Two-line spans identified as close to but not Category Three. This decision is based entirely on company practice and does not represent

a determination that the Corona Gen-Tie System poses a significant risk to migratory birds in the absence of a decision to mark these areas with bird diverters.

With respect to the Extended Corona Gen-Tie System and the Supplemental Corona Wind APP, Pattern has elected to mark a span of at least 4 miles with bird diverters that includes both of the two Category Three line spans I discussed above. We will also update the entire Corona Wind APP subsequent to finalizing the precise design of the Updated Corona Gen-Tie System to fine tune the deployment of bird diverters and will meet or exceed any recommendations for marking in a similar fashion to how we have responded to the previous findings.

Q. PLEASE SUMMARIZE THE GOVERNMENT CONSULTATION ON ENVIRONMENTAL ISSUES THAT YOU HAVE COMPLETED IN FURTHERANCE OF THE UPDATED CORONA GEN-TIE SYSTEM.

A. We have consulted extensively with the relevant government entities to apprise them of the environmental impacts of the Extended Corona Gen-tie System to obtain their input on how best to minimize our modest impacts. Please refer to Exhibit ACC-8 for a table of federal and state agencies with whom Pattern Development has consulted to date. Consultation has been fruitful and positive and will be ongoing throughout the development of the Extended Corona Gen-Tie System and the Corona Wind Projects.

Q. DID ANY OF THE STATE AND FEDERAL AGENCIES WITH WHOM PATTERN DEVELOPMENT HAS CONSULTED RAISE CONCERNS OR PROVIDE RECOMMENDATIONS WITH RESPECT TO THE UPDATED CORONA GEN-TIE SYSTEM?

A. No. The Corona Wind Projects are not expected to have environmental impacts, and the potential environmental impacts of the Extended Corona Gen-Tie System, as I will discuss subsequently, are expected to be *de minimus*. Additionally, it is my belief that the siting practices and BMPs of Pattern Development, adopted by the Corona Wind Companies, which were also discussed with agencies, provide further indication that the Extended Corona Gen-Tie System potential impacts are unlikely to raise concerns.

IV. REQUESTED COMMISSION APPROVALS

Q. WHAT COMMISSION APPROVALS ARE THE JOINT APPLICANTS REQUESTING?

A. The Corona Wind Companies request that the Commission approve the location of the Corona Wind Update and the location of the Updated Corona Gen-Tie System pursuant to NMSA 1978, §62-9-3, ("Siting Statute") and Commission Rule 17.9.592 NMAC, ("Location Rule"). In addition, the Corona Wind Companies request that the Commission determine that a 180-foot ROW width for the entire Updated Corona Gen-Tie System is needed pursuant to NMSA 1978, §62-9-3.2. We already have approval for the 180-foot ROW for the portions of the Corona Gen-Tie System reviewed in NMPRC Case No. 18-00065-UT.

A. SITING STATUTE, NMSA 1978, §62-9-3

Q. WHY DOES THE CORONA WIND UPDATE REQUIRE LOCATION APPROVAL?

A. My understanding is that New Mexico's Siting Statute, specifically NMSA 1978, §62-9-3(B) requires prior approval by the Commission for construction within New Mexico of any generating plant designed for or capable of operation at a capacity of 300 MW or more

and for transmission lines and associated facilities designed for or capable of operations at a nominal voltage of 230-kV or more to be constructed in connection with said plant.

The Commission's location approval is required because the Corona Wind Projects generation facilities are collectively designed for or capable of operating up to 2300 MW of wind generation. Although our wind turbines will be spread over a relatively large area, the Joint Applicants are not attempting to characterize these as numerous smaller projects, but have treated this as a single large, generating facility.

The Commission's approval is also required for the Updated Corona Gen-Tie System since it will be designed for or capable of being operated at a nominal voltage of 345-kV and will be constructed in connection with, and to transmit electricity from, the Corona Wind Update to both the Western Spirits Transmission Line and the SunZia Project.

Q. PLEASE EXPLAIN YOUR UNDERSTANDING OF THE NEED TO COMPLY WITH STATE, COUNTY OR MUNICIPAL LAND USE.

A. I understand that NMSA 1978, §62-9-3(G) prohibits the Commission from approving a location control application that violates an existing state, county or municipal land use statutory or administrative regulation unless the Commission finds the regulation is unreasonably restrictive.

1. THE CORONA WIND PROJECTS

Q. PLEASE EXPLAIN YOUR UNDERSTANDING OF THE STATUTORY REQUIREMENTS FOR LOCATION APPROVAL FOR THE CORONA WIND UPDATE.

A. My understanding is that NMSA 1978, §62-9-3(E) of the Siting Statute requires the Commission to approve an application for location of a generating plant unless the Commission finds that the operation of the facilities will not comply with all applicable air and water pollution control standards existing and established by the New Mexico agency having jurisdiction over a particular pollution source. I understand that the New Mexico Environment Department has jurisdiction over air and water pollution.

Q. DOES THE CORONA WIND UPDATE COMPLY WITH THE REQUIREMENTS OF THE SITING STATUTE?

A. Yes, the Joint Application and supporting testimony and exhibits demonstrate that the Corona Wind Projects comply with these requirements. As the Corona Wind Companies' other witnesses and I explain in our testimonies, the Corona Wind Update will comply with all applicable air and water pollution control standards. Moreover, the existing state, county, and municipal land use statutory and administrative regulations allow for the installation of the Corona Wind Update.

2. THE CORONA GEN-TIE SYSTEM

Q. WHY DOES THE UPDATED CORONA GEN-TIE SYSTEM REQUIRE LOCATION APPROVAL?

A. My understanding is that New Mexico's Siting Statute, specifically NMSA 1978, §62-9-3(B) requires prior approval by the Commission for construction within New Mexico of any generating plant designed for or capable of operation at a capacity of 300 MW or more and for transmission lines and associated facilities designed for or capable of operations at a nominal voltage of 230-kV or more to be constructed in connection with said plant.

The Commission's approval is required for the Extended Corona Gen-Tie System since it will be designed for or capable of being operated at a nominal voltage of 345-kV and will be constructed in connection with, and to transmit electricity from, the Corona Wind Projects. The Commission's approval of the locations of the Reconfigured Corona Gen-Tie System outside of the original one-mile corridor presented in Case No. 18-00065 is also necessary since these locations were not considered in that proceeding.

Q. PLEASE EXPLAIN YOUR UNDERSTANDING OF THE STATUTORY REQUIREMENTS FOR LOCATION APPROVAL FOR THE UPDATED CORONA GEN-TIE SYSTEM.

A. My understanding is that NMSA 1978, §62-9-3(F) of the Siting Statute requires the Commission to approve an application for location of transmission lines unless it finds that the location will unduly impair important environmental values. In making that determination, NMSA 1978, §62-9-3(M) of the Siting Statute allows the Commission to consider the following factors:

(1) existing plans of the state, local government, and private entities for other developments at or in the vicinity of the proposed location;

(2) fish, wildlife, and plant life;

(3) noise emission levels and interference with communication signals;

(4) the proposed availability of the location to the public for recreational purposes, consistent with safety considerations and regulations;

(5) existing scenic areas, historic, cultural or religious sites and structures or archaeological sites at or in the vicinity of the proposed location; and,

(6) additional factors that require consideration under applicable federal and state laws pertaining to the location.

Q. DOES THE UPDATED CORONA GEN-TIE SYSTEM COMPLY WITH THE REQUIREMENTS OF THE SITING STATUTE?

A. Yes, the Joint Application and supporting testimony and exhibits demonstrate that the Updated Corona Gen-Tie System complies with these requirements. As the Corona Wind Companies' other witnesses and I explain in our testimonies, the existing state, county, and municipal land use statutory and administrative regulations allow for the installation of the Updated Corona Gen-Tie System and this system will not unduly impair important environmental values.

B. LOCATION RULE, 17.9.592 NMAC

1. THE CORONA WIND UPDATE

Q. WHAT IS YOUR UNDERSTANDING OF THE REQUIREMENTS OF THE COMMISSION'S LOCATION RULE, 17.9.592 NMAC, REGARDING APPLICATIONS FOR LOCATION OF GENERATION PLANTS?

A. Under the Location Rule, 17.9.592.9 NMAC for generating facilities ("Generation Location Rule") an applicant must file an application supported by written testimony and exhibits that contain the following information for generating plants for which location approval is required:

A. a description of the large capacity plant, including, but not limited to:

(1) a legal description of the property upon which the large capacity plant will be located;

(2) the size of the large capacity plant;

(3) fuel specifications including, but not limited to, the type of fuel to be used; and,

(4) a map showing the location of the large capacity plant;

B. identification of all applicable land use statutes and administrative regulations and proof of compliance or a statement of noncompliance with each;

C. identification of all applicable air and water pollution control standards and regulations and proof of compliance or a statement of noncompliance with each;

D. all written air and water quality authorizations necessary to begin construction of the large capacity plant;

E. all written air and water quality authorizations necessary to begin operation of the large capacity plant; if any such authorization cannot be obtained until after construction of the large capacity plant, proof of application for such authorization;

F. the expected date that the large capacity plant will be online;

G. proof that the application has been served on all local authorities in each county and township where the large capacity plant will be located, the New Mexico attorney general, the New Mexico environment department, and the New Mexico state engineer;

H. any other information, including photographs, which the applicant wishes to submit in support of the application.

Q. DOES THE CORONA WIND UPDATE COMPLY WITH THE REQUIREMENTS OF THE GENERATION LOCATION RULE?

A. Yes, the Joint Application, the previous testimony filed in NMPRC Case No. 18-00065-UT and the supporting testimony and exhibits we are submitting with this new Joint Application demonstrate that the Corona Wind Update comply with the requirements under the Generation Location Rule. In this regard our analysis reached the same conclusion as was presented in Case No. 18-00065-UT.

2. THE UPDATED CORONA GEN-TIE SYSTEM

Q. WHAT IS YOUR UNDERSTANDING OF THE REQUIREMENTS OF THE COMMISSION'S LOCATION RULE, 17.9.592 NMAC, REGARDING APPLICATIONS FOR LOCATION OF TRANSMISSION LINES?

A. Under the Location Rule, Rule 17.9.592.10 NMAC for transmission lines ("Transmission Location Rule") an applicant must file an application supported by written testimony and exhibits that contain the following information for transmission lines for which location approval is required:

A. a description of the transmission line including, but not limited to:

(1) the location of the transmission line;

(2) identification of the ownership of the land (such as private, bureau of land management, U.S. forest service, state trust, etc.) the transmission line will cross and the number of feet the transmission line will cross over each owner's land;

(3) the total length of each transmission line in feet;

(4) a description of interconnection facilities;

(5) a map showing the location of the transmission line; and

(6) a schematic diagram showing the transmission line and the interconnection of the transmission line to the transmission grid;

B. identification of all applicable land use statutes and administrative regulations and proof of compliance or statement of noncompliance with each;

C. if required under NEPA, an environmental assessment prepared in connection with the transmission line;

D. if required under NEPA, an environmental impact statement and record of decision or a finding of no significant impact, prepared in connection with the transmission line;

E. if preparation of a federal environmental assessment or environmental impact statement is not required under NEPA in connection with the transmission line, then a report, comparable to an environmental impact statement, in the format prescribed in 40 C.F.R. Section 1502.10;

F. all written federal, state, and local environmental authorizations necessary to begin construction of the transmission line;

G. all written federal, state, and local environmental authorizations necessary to begin operation of the transmission line; if any such authorization cannot be obtained until after construction of the transmission line, proof of application for such authorization;

H. testimony demonstrating that the transmission line will not unduly impair important environmental values; important environmental values include, but are not limited to, preservation of air and water quality, land uses, soils, flora and fauna, and water, mineral, socioeconomic, cultural, historic, religious, visual, geologic and geographic resources;

I. the expected date that the transmission line will be online;

J. proof that the application has been served on all local authorities in each county and township where the transmission line will be located, the New Mexico attorney general, the New Mexico environment department, and the New Mexico state engineer;

K. any other information, including photographs, which the applicant wishes to submit in support of the application.

Q. DOES THE UPDATED CORONA GEN-TIE SYSTEM COMPLY WITH THE REQUIREMENTS OF THE TRANSMISSION LOCATION RULE?

A. Yes, the Joint Application and supporting testimony and exhibits demonstrate that the Updated Corona Gen-Tie System complies with the requirements under the Transmission Location Rule.

C. RIGHT-OF-WAY STATUTE, NMSA 1978, §62-9-3.2

Q. WHAT IS YOUR UNDERSTANDING OF THE REQUIREMENT FOR ROW WIDTH APPROVAL?

A. My understanding is that NMSA 1978, §62-9-3.2 ("ROW Statute") provides that "unless otherwise agreed to by the parties, no person shall begin the construction of any transmission line requiring a width for right of way of greater than one hundred feet without first obtaining from the commission a determination of the necessary right-of-way width to construct and maintain the transmission line."

Q. DO YOU BELIEVE THAT THE UPDATED CORONA GEN-TIE SYSTEM SHOULD HAVE A 180-FOOT ROW?

A. Yes, based upon the results of the analysis from Greg Parent, who is submitting testimony on this issue in this proceeding, I believe that a 180-foot ROW is necessary for the Updated Corona Gen-Tie System.

V. COMPLIANCE WITH NEW MEXICO'S STATUTES AND REGULATIONS.

A THE CORONA WIND COMPANIES WILL REQUIRE THE CORONA WIND UPDATE TO COMPLY WITH ALL APPLICABLE AIR AND WATER POLLUTION CONTROL STANDARDS

Q. PLEASE CHARACTERIZE THE CORONA WIND UPDATE'S EXPECTED IMPACTS ON AIR QUALITY.

A. The Corona Wind Companies will comply with all applicable air quality laws and regulations. This is further discussed in the Corona Environmental Report.

Q. PLEASE CHARACTERIZE THE UPDATED CORONA WIND PROJECT'S EXPECTED IMPACTS ON WATER RESOURCES?

A. The Corona Wind Companies will comply with all applicable water quality and water resource laws and regulations and will not unduly impair water quality and water resources. This is further discussed in the Corona Environmental Report.

B. THE CORONA WIND COMPANIES WILL ASSURE THAT THE UPDATED CORONA GEN-TIE SYSTEM DOES NOT UNDULY IMPAIR IMPORTANT ENVIRONMENTAL VALUES

Q. HAVE THE CORONA WIND COMPANIES EVALUATED THE UPDATED CORONA GEN-TIE SYSTEM'S POTENTIAL IMPACTS ON THE FACTORS THE COMMISSION MAY CONSIDER IN DETERMINING WHETHER LOCATION OF A TRANSMISSION LINE WILL UNDULY IMPAIR IMPORTANT ENVIRONMENTAL VALUES?

A. Yes. The Corona Wind Companies have reviewed the factors provided in NMSA 1978, §62-9-3(M), Commission Rule 17.9.592.10 NMAC, and additional factors, including existing plans for development of the proposed location; fish, wildlife, and plant life; noise levels; interference with communication signals; availability for recreational purposes; scenic, historic, cultural or religious sites and structures or archeological sites; cemeteries and burials; schools; aviation; soils; minerals and mining; geologic and paleontological resources; roads; and geographic resources. The Corona Wind Companies considered these factors with respect to the Updated Corona Gen-Tie System. The Environmental Report provides further information on each of these resource areas. The protection measures included in the Environmental Report ("Protection Measures") provide detailed measures for resource impact avoidance and minimization that provide further evidence of the minimal impacts expected from the Updated Corona Gen-Tie System.

Q. PLEASE SUMMARIZE YOUR FINDINGS WITH RESPECT TO AIR QUALITY.

A. The Corona Wind Update and the Updated Corona Gen-Tie System will not unduly impair air quality and the Corona Wind Companies will comply with all applicable air quality laws and regulations. This is further discussed in the Corona Environmental Report.

Q. PLEASE SUMMARIZE YOUR FINDINGS WITH RESPECT TO WATER QUALITY AND WATER RESOURCES.

A. The Corona Wind Companies will comply with all applicable water quality and water resource laws and regulations and will not unduly impair water quality and water resources. This is further discussed in the Environmental Report. The impacts to surface waters, whether waters of the US or not, will be avoided to the maximum extent practicable.

Q. PLEASE SUMMARIZE YOUR FINDINGS WITH RESPECT TO LAND USES.

A. Existing land uses within the Updated Corona Gen-Tie System consist primarily of ranching activities on both private and state land. The Updated Corona Gen-Tie System is compatible with ranching activities. Revenue generated can be reasonably expected to be reinvested, to some extent, back into ranching activities, thus augmenting existing uses.

Q. PLEASE SUMMARIZE YOUR EFFORTS TO AVOID AND MINIMIZE IMPACTS WITH RESPECT TO FLORA AND FAUNA AT THE UPDATED CORONA GEN-TIE SYSTEM.

A. Pattern Development has worked extensively to limit impacts to flora and fauna. Our overall efforts have been described in the Environmental Report. The Updated Corona Gen-Tie System will not unduly impair flora and fauna.

Q. PLEASE SUMMARIZE YOUR FINDINGS WITH RESPECT TO NOISE IMPACTS.

A. The Updated Corona Gen-Tie System is not expected to contribute in a meaningful way to the noise levels of the existing environment. As discussed in the Environmental Report, the Updated Corona Gen-Tie System will not unduly impair noise quality.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM INTERFERE WITH COMMUNICATION SIGNALS?

A. The Updated Corona Gen-Tie System is not expected to interfere with communication signals. As discussed in the Environmental Report, the Updated Corona Gen-Tie System will not unduly impair communication signals.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM IMPACT RECREATIONAL USES?

A. No. Most of the Updated Corona Gen-Tie System is located on private land with participating landowners or public state land. Hunting is the primary recreational use in the area and the Updated Gen-Tie System is compatible with this activity. As discussed in the Environmental Report, the Updated Corona Gen-Tie System will not unduly impair recreational uses in the area.

Q. WHAT VISUAL IMPACT WILL THE UPDATED CORONA GEN-TIE SYSTEM HAVE?

A. Visual impacts will consist of the additional transmission structures. As discussed in the Environmental Report, the Updated Corona Gen-Tie System will not unduly impair visual uses in the area.

Q. WHAT IMPACT WILL THE UPDATED CORONA GEN-TIE SYSTEM HAVE ON HISTORIC AND ARCHEOLOGICAL RESOURCES?

A. As previously described, Pattern Development takes extensive precautions to minimize any impacts to cultural resources such as historical and archaeological resources. This is the result of company BMPs. Any impacts on historic and archaeological resources will be minimized through siting decisions and will not unduly impair these resources.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM IMPACT CEMETERIES OR BURIALS?

A. No. The Updated Corona Gen-Tie System will avoid cemeteries and burials and will not unduly impair these resources.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM IMPACT ANY SCHOOLS?

A. No. The Updated Corona Gen-Tie System will avoid schools. Thus, these resources will not be unduly impaired. Further, the Updated Corona Gen-Tie System is expected to be participating infrastructure in Industrial Revenue Bonds to be issued through local municipalities and counties resulting in payments-in-lieu of taxes that are likely to provide long-term revenue to schools in the area.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM IMPACT RELIGIOUS RESOURCES?

A. No. The Updated Corona Gen-Tie System will avoid religious resources and will not unduly impair these resources.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM ADVERSELY AFFECT GEOLOGIC OR PALEONTOLOGICAL RESOURCES?

A. As discussed in the Environmental Report, the Updated Corona Gen-Tie System will not unduly impair geologic or paleontological resources.

Q. WILL THE UPDATED CORONA GEN-TIE SYSTEM ADVERSELY AFFECT ROADS?

A. As part of the development of the Updated Corona Gen-Tie System county road use agreements will be entered with individual counties to ensure that all roads used will be repaired to a state that meets or exceeds the conditions prior to construction.

Q. HAVE THE CORONA WIND COMPANIES IDENTIFIED PROTECTION MEASURES TO AVOID AND MANAGE IMPACTS OF THE RESOURCES YOU HAVE DISCUSSED?

A. Yes. As discussed previously, Protection Measures will be implemented throughout the life of the Updated Corona Gen-Tie System. These Protection Measures are included in the Environmental Report and mirror those adopted by the Commission in NMPRC Case No. 18-00065-UT. Additionally, on a related note, I would add that now that Pattern has acquired the rights to the Mesa Canyons Project we will voluntarily apply these same Protection Measures to the areas covered by that project, though this is not a requirement of any Commission order.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. The Updated Corona Gen-Tie System has been developed and will be constructed and operated with the implementation of a robust set of BMPs, scientific studies, and Protection Measures. Further, in light of the robust practices set out above, the Updated Corona Gen-Tie System will stand out as a model of responsible development and most certainly will not unduly impair important environmental values.

C. LAND USE, LAND OWNERSHIP, AND COMPLIANCE WITH LAND USE STATUTES AND ADMINISTRATIVE REGULATIONS

Q. PLEASE DESCRIBE THE EXISTING LAND OWNERSHIP AND LAND USE ON THE UPDATED CORONA WIND PROJECT AREA.

A. The lands used in the Updated Corona Wind Project Area are privately held or owned by the State of New Mexico. Ranching is the predominant use of these lands. However, there is also some farming.

Q. WILL THESE USES CONTINUE FOLLOWING CONSTRUCTION OF THE UPDATED CORONA GEN-TIE SYSTEM?

A. Yes. Ranching and farming activities will continue since the land needed for both projects take up very little footprint. Also, the real estate leases with both the private landowners and the State of New Mexico do not restrict the owners from continuing ranching or farming activities.

Q. IN SUMMARY, WILL THE UPDATED CORONA GEN-TIE SYSTEM VIOLATE ANY EXISTING STATE, COUNTY, OR MUNICIPAL LAND USE STATUTORY OR ADMINISTRATIVE REGULATION?

A. No. The Corona Wind Companies will require contractors to comply with all state, county, or municipal land use statutory or administrative regulations.

D. COMPLIANCE WITH THE LOCATION RULE

1. THE CORONA WIND UPDATE

Q. DOES THE JOINT APPLICATION COMPLY WITH THE COMMISSION'S GENERATION LOCATION RULE?

A. Yes, as follows:

A. We have provided a description of the proposed generating plants, their size, and the fact that they are wind generating facilities. A legal description of the property and a map showing the location of the Corona Wind Projects Area is provided in Exhibits ACC-9 and Exhibit ACC-3, respectively.

B. My testimony explains Pattern Development's compliance with all applicable land use statutes and administrative regulations.

C. My testimony identifies all applicable air and water pollution control standards and regulations that apply to the Corona Wind Projects.

D. My testimony identifies all written air and water quality authorizations necessary to begin operation of the Corona Wind Projects, which are all construction phase permits typically issued shortly before construction. The Corona Wind Companies will provide notification of receipt of these permits as they are obtained.

E. I have further stated that there are no air or water quality authorizations necessary for operation of the Corona Wind Projects.

F. I have also testified that at least a portion of the Corona Wind Update and the Updated Corona Gen-Tie System is expected to be in service by the end of 2021 with the entirety to be in-service by the end of 2024.

G. Finally, the attached Certificate of Service demonstrates the Joint Application has been served on all local authorities in Lincoln, Torrance and Guadalupe Counties in New Mexico, the New Mexico Attorney General, the New Mexico Environment Department, and the New Mexico Office of the State Engineer

H. The Joint Application provides additional information to inform the Commission's decision-making on the Corona Wind Companies' request for location approval of the Corona Wind Update.

2. THE UPDATED CORONA GEN-TIE SYSTEM

Q. DOES THE JOINT APPLICATION COMPLY WITH THE COMMISSION'S TRANSMISSION LOCATION RULE?

A. Yes, as follows:

A. We have provided a description of the Updated Corona Gen-Tie System, including its location, private and state land ownership, estimated number of feet the Extended Gen-Tie System will cross over private and state land, a total length of the line, a description of

interconnection facilities, a location map, and representational schematic diagrams of the interconnection of the line.

B. My testimony identifies all applicable land use statutes and administrative regulations and provides that the Corona Wind Companies comply with each.

C. Because the Updated Corona Gen-Tie System does not require compliance with NEPA, an environmental assessment was not prepared.

D. The Environmental Report was prepared for the Corona Wind Companies in the format prescribed by 40 C.F.R. §1502.10.

E. As explained in my testimony, there are no zoning regulations in Guadalupe County. Lastly, and an amendment to the previously approved SUD will be obtained from Torrance County.

F. As explained in the Environmental Report and as summarized in my testimony, the Updated Corona Gen-Tie System will not unduly impair important environmental values, including resources associated with air and water quality, flora and fauna, water, land uses, visual and scenic, cultural, historic, and archaeological, religious, geological and paleontological, soils, mineral, socioeconomic, roads, noise, and communication.

G. My testimony states that assuming the Corona Wind Projects interconnect to Western Spirit at least a portion of the Corona Wind Update and Updated Corona Gen-Tie System is expected to be in service by the end of 2021 with the entirety to be in-service by the end of 2024.

H. The attached Certificate of Service demonstrates the Joint Application has been served on all local authorities in Lincoln, Torrance and Guadalupe Counties in New Mexico, the New

Mexico Attorney General, the New Mexico Environment Department, and the New Mexico Office of the State Engineer.

I. The Joint Application provides additional information to facilitate the Commission's decision-making on the Corona Wind Companies' request for location approval of the Updated Corona Gen-Tie System.

D. COMPLIANCE WITH THE ROW STATUTE

Q. DO THE CORONA WIND PROJECTS COMPLY WITH THE ROW STATUTE IN THE EVENT THE COMMISSION'S DETERMINATION IS REQUIRED?

A. Yes. The ROW Statute, requires that, unless all parties agree otherwise, the Commission determines whether a proposed ROW width in excess of 100 feet is necessary. As I noted previously, the Corona Wind Companies will locate the Corona Gen-Tie System on private land subject to agreements with landowners or on state lands subject to leases with the State of New Mexico. Further, this Joint Application and other witnesses' testimonies demonstrate that the proposed 180-foot ROW width is necessary for the safe construction, operation, and maintenance of the Corona Gen-Tie System.

VI. CONCLUSION

Q. PLEASE SUMMARIZE YOUR CONCLUSION.

A. The Joint Applicants provided a comprehensive environmental impact analysis for the initial proposed Corona Wind Project and Corona Gen-Tie System. The Commission approved that filing. Subsequently, a decision was made to modify the proposed route for the Corona Gen-Tie System and to extend the Corona Gen-Tie System. Additionally, the Joint Applicants are expanding the potential area for locating wind turbines beyond that which was previously approved in the last proceeding. We have performed a

comprehensive environmental analysis of the new areas being added to the Corona Wind Projects and the Corona Gen-Tie System and demonstrated that these additions will still be compliant with all statutes, regulations and orders of the Commission.

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit ACC-1

BURNS McDONNELL

Corona Wind Projects Environmental Report Supplement

Pattern

Pattern Energy Group 2 LP

Corona Wind Projects
Project No. 101335

12/18/2019

Corona Wind Projects
Environmental Report Supplement

prepared for

Pattern Energy Group 2 LP
Corona Wind Projects
New Mexico

Project No. 101335

12/18/2019

prepared by

Burns & McDonnell Engineering Company, Inc.
Centennial, Colorado

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AC	alternating current
ACSR	aluminum conductor steel reinforced
ACSS	aluminum conductor steel supported
APLIC	Avian Power Line Interaction Committee
BCI	Bat Conservation International
BGEPA	Bald and Golden Eagle Protection Act
BISON-M	Biota Information System
BLM	Bureau of Land Management
BMPs	Best Management Practices
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CO	Carbon monoxide
Commission	New Mexico Public Regulation Commission
dBA	A-weighted decibels
DNH	Determination of No Hazard
ECOS	Environmental Conservation Online Service
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency

Abbreviation	Term/Phrase/Name
FHWA	Federal Highway Administration
ft	feet
GAP	USGS Gap Analysis Program
GLO	General Land Office
GRT	Gross Receipts Tax
I	interstate
IBA	Important Bird Areas
IPaC	Information for Planning and Consultation
IRBs	Industrial Revenue Bonds
kcmil	Thousand Circular Mil
kV	kilovolt
LM	land mobile
m	meters
MBTA	Migratory Bird Treaty Act
MW	megawatt
NESC	National Electrical Safety Code
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NM CHAT	New Mexico Crucial Habitat Assessment Tool
NMCRIS	New Mexico Cultural Resource Information System
NMDGF	New Mexico Department of Game and Fish
NMDOT	New Mexico Department of Transportation

Abbreviation	Term/Phrase/Name
NMED-SWQB	New Mexico Environment Department Surface Water Quality Bureau
NMSA	New Mexico Statutes Annotated
NO_x	nitrogen oxide
NPS	National Park Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWP	Nationwide Permit
O&M	operations and maintenance
OHWM	ordinary high-water mark
OPGW	optic ground wire
PILOTs	provide payments in-lieu of taxes
PLJV	Playa Lakes Joint Venture
PM	particulate matter
PPAs	Power Purchase Agreements
RETA	Renewable Energy Transmission Authority
ROW	right-of-way
SGP CHAT	Southern Great Plains Crucial Habitat Assessment Tool
SLO	State Land Office
SPCC	Spill Prevention, Containment, and Countermeasures Plan
SPS	Special Protection System
SSURGO	USDA Soil Survey Geographic
Staff	Commission Staff

Abbreviation	Term/Phrase/Name
SO_2	sulfur dioxide
SWPPP	Stormwater Pollution Prevention Plan
USDA	U.S. Department of Agriculture
UDP	Unanticipated Discovery Protocol
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOCs	volatile organic compounds

1.0 SUMMARY

This report responds to the requirement of the New Mexico Public Regulation Commission (Commission) for a report, in the form provided in 40 C.F.R. Section 1502.10, for location of transmission lines of 230 kilovolt (kV) or greater associated with a large-capacity power plants capable of 300 megawatts (MW) or more of generation that do not require an Environmental Assessment or Environmental Impact Statement pursuant to the National Environmental Policy Act. The New Mexico location control statute, New Mexico Statutes Annotated (NMSA) 1978, Section 62-9-3F, provides that the Commission shall approve the location of the transmission line unless the Commission finds that the location will unduly impair important environmental values.

1.1 Background

1.1.1 2018 Approved Project

On October 3, 2018, the Commission approved the Application (Case No. 18-00065-UT) for Location Site Approval of the Corona Wind Projects, Corona Gen-Tie System, and Request for Right of Way Determination (2018 Approved Projects) submitted by Ancho Wind LLC, Cowboy Mesa LLC, Duran Mesa LLC, Red Cloud Mesa LLC, Tecolote Wind LLC, and Viento Loco LLC (Corona Wind Companies or Joint Applicants)[1], per the New Mexico location statute, NMSA 1978, Section 62-9-3, 62-9-3.2, and Commission Rule 17.9.592 NMAC. The 2018 Approved Projects consisted of wind generation facilities with capacity of up to 2,200 MW (Corona Wind Projects) as well as a transmission line and related substation facilities in Lincoln, Torrance, and Guadalupe Counties, New Mexico (Corona Gen-Tie System). The Corona Gen-Tie System is anticipated to consist of 345-kV alternating current (AC) lines and the associated right-of-way (ROW). As previously approved, the Corona Gen-Tie System would interconnect with several specific generation projects comprising the Corona Wind Projects. The Corona Gen-Tie System would consist of approximately 80 miles of transmission line located within a 1-mile study corridor (Corona Gen-Tie System Study Corridor) within the approximately 300,000-acre Corona Wind Projects (Corona Wind Project Area). As described in the 2018 approval, the Corona Wind Projects would interconnect to the SunZia Southwest Transmission Project (SunZia Transmission Project) via the Corona Gen-Tie System. The SunZia Transmission Project consists of an approximately 515-mile-long transmission corridor with possible configurations of two 500-kV AC or DC lines. In either case, the first

[1] The Corona Wind Companies were updated to include Gallinas Mountain Wind LLC as part of the Corona Wind Companies quarterly check on January 15, 2019.

phase of the SunZia Transmission Project will be a 500-kV AC or DC transmission line that would be utilized by the Corona Wind Projects.

Subsequent to the October 3, 2018 approval of the location of the Corona Wind Projects, and the location and ROW width of the Corona Gen-Tie System, Pattern Energy Group 2 LP (Pattern Development) acquired the Mesa Canyons Wind Project, a wind generation facility of up to 1,000 MW previously approved by the Commission for generation location control. At this time, Pattern Development also acquired Western Spirit Transmission LLC, which is co-developing Western Spirit with the New Mexico Renewable Energy Transmission Authority (RETA). Western Spirit is an approximately 165-mile 345-kV transmission project owned by RETA that terminates at its eastern switching station in Santa Fe County, New Mexico approximately 50 miles north of the previously approved Corona Gen-Tie System and will begin construction in the second quarter of 2020. Subsequently, the Clines Corners Wind Project received location control approval for a wind generation facility and an associated high-voltage transmission line located within a 1-mile corridor that would interconnect to the Western Spirit eastern switching station.

The Corona Gen-Tie System will require a ROW width of approximately 180 feet (ft) across primarily private land for which the Corona Wind Companies have obtained, or will obtain, agreements with the underlying landowners prior to commencement of construction.

1.1.2 Update to 2018 Approved Projects

This update to the 2018 Approved Projects involves a proposal by the Corona Wind Companies to update the location of the Corona Wind Projects and the Corona Gen-Tie System. This update consists of 1) an addition of certain property in Lincoln County, New Mexico (Corona Wind Update) to the Corona Wind Projects; 2) an additional transmission line (Extended Corona Gen-Tie System) that would extend the Corona Gen-Tie System north, providing interconnection to the new Western Spirit Transmission Project Switching Station in Torrance County, and 3) a reconfiguration of the previously approved Corona Gen-Tie System within the Corona Wind Project Area (Reconfigured Corona Gen-Tie System).

The Corona Wind Update would add 11,736 acres to the Corona Wind Project Area (Updated Corona Wind Project Area). The Extended Corona Gen-Tie System is approximately 30 miles long and includes approximately 9 miles of land within the Corona Wind Project Area, 9 miles within the El Cabo Wind Project Area[2] with approximately 20 miles of length located on property not previously analyzed. The Extended Corona Gen-Tie System would be located within a 1-mile corridor (Extended Corona Gen-Tie System Corridor). The Reconfigured Corona Gen-Tie System consists of 2 segments, Option A or Option

[2] Separately approved for location control approval by the Commission.

B, each totaling approximately 64 miles of the Corona Gen-Tie System, with 44 miles located within the previously approved Corona Gen-Tie System Corridor and 19 miles located within a 1-mile corridor (Reconfigured Corona Gen-Tie System Corridor) outside of the previously approved Corona Gen-Tie System. Figure 1-1 below provides an overview of the update (Updated Corona Wind Projects) to the 2018 Approved Projects. The Reconfigured Corona Gen-Tie System is located entirely within the previously approved Corona Wind Project Area. Together, the Extended Corona Gen-Tie System and the Reconfigured Corona Gen-Tie System comprise the Updated Corona Gen-Tie System. The Updated Corona Gen-Tie System would be located within a 1-mile corridor comprised of the Extended Corona Gen-Tie System Corridor, the Reconfigured Corona Gen-Tie System Corridor, and remaining portions of the Corona Gen Tie-System Corridor (collectively, the Updated Corona Gen-Tie System Corridor). The Updated Corona Wind Project Area includes both the wind generation area of the Corona Wind Update as well as the Updated Corona Gen-Tie System Corridor.

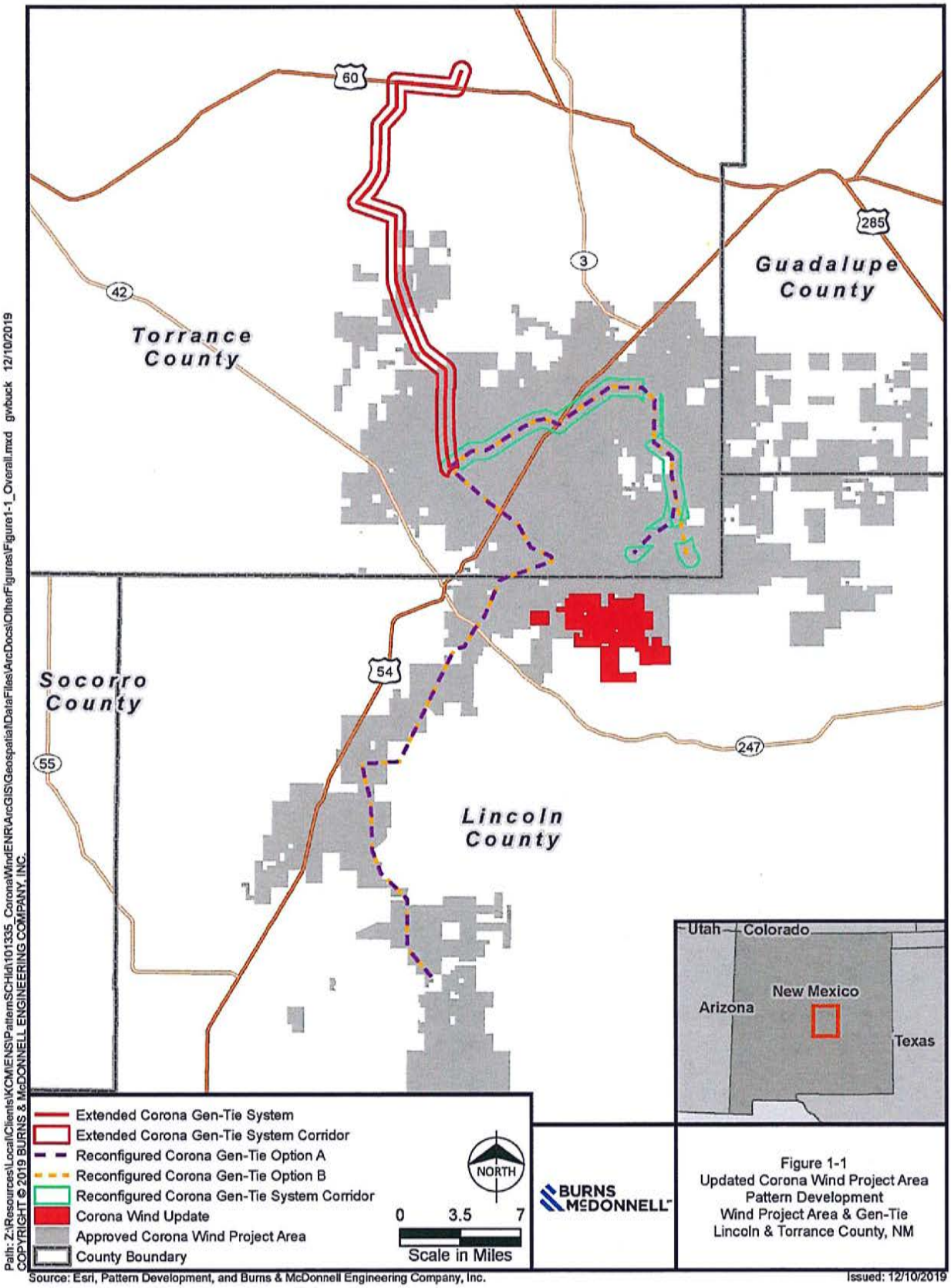
The Updated Corona Gen-Tie System will interconnect the Updated Corona Wind Projects to the Western Spirit eastern switching station. The Updated Corona Gen-Tie System consists of approximately 54 miles (Option A or Option B) of transmission line falling partially within the 2018 Approved Projects' approximate 300,000-acre Corona Wind Project Area. The Updated Corona Gen-Tie System would extend northwest from the Updated Corona Wind Project Area's northwest boundary within Torrance County.

Consistent with the Commission's previous ROW width approval, the Updated Corona Gen-Tie System requires a ROW width of approximately 180 ft across primarily private land for which the Corona Wind Companies have obtained, or will obtain, agreements with the underlying landowners prior to commencement of construction. The Corona Wind Companies are requesting a ROW width determination pursuant to NMSA 1978, §62-9-3.2 to the extent such approval may be required by law.

This Environmental Report (ER) provides a review of the existing environment within the Corona Wind Update (within the Updated Corona Wind Project Area) and analyzes the potential impact of the Extended Corona Gen-Tie System and Reconfigured Corona Gen-Tie System outside previously approved areas within the Updated Corona Gen-Tie System. The affected environment (existing condition) for the environmental values provided in NMSA 1978 Section 62-9-3.M, Commission Rule 17.9.592 NMAC, and additional resource areas identified to be of interest by Commission Staff (Staff) are evaluated in this ER. The resources addressed in this ER include: air resources; water resources; biological resources; land use (including recreation and schools); visual and scenic; cultural, historic, and archeological resources; religious resources; geology and paleontology; soils; minerals and mining;

socioeconomic; roads; noise; communication signals; military activities and aviation; geographic resources; radioactive waste and radiation hazard; hazardous materials; and safety.

The discussion for each resource includes data sources used, current regional conditions, and conditions within the Updated Corona Gen-Tie System Corridor, three step-up substations, and one adjacent switchyard. The environmental consequences (potential impacts) for the resources identified above were addressed to determine whether the proposed transmission line, step-up substation(s) and switchyard (Updated Transmission Line Facilities) would, "unduly impair important environmental values," as provided in NMSA 1978, Section 62-9-3.F. Impact evaluations for each resource are discussed in the context of the Updated Corona Gen-Tie System Corridor alongside Best Management Practices (BMPs) that can help manage impacts.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285
3
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Guadalupe County
Torrance County
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Socorro County
55
247
Lincoln County
Utah
Colorado
New Mexico
Arizona
Texas
Extended Corona Gen-Tie System
Extended Corona Gen-Tie System Corridor
Reconfigured Corona Gen-Tie Option A
Reconfigured Corona Gen-Tie Option B
Reconfigured Corona Gen-Tie System Corridor
Corona Wind Update
Approved Corona Wind Project Area
County Boundary
NORTH
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Scale in Miles
BURNS McDONNELL
Figure 1-1
Updated Corona Wind Project Area
Pattern Development
Wind Project Area & Gen-Tie
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2.0 INTRODUCTION AND PURPOSE AND NEED

The Corona Wind Companies are proposing to locate the Updated Corona Gen-Tie System in Lincoln and Torrance County, New Mexico. Approximately 54 miles of transmission line (Option A or Option B) and related substation facilities with possible configurations of 345-kV AC lines (Exhibit 1) additional gen-tie system is being proposed in Torrance County, New Mexico. Although information about the Updated Corona Wind Project Area as a whole is discussed herein to provide overall project context, the New Mexico statutes only require evaluation of the Updated Corona Gen-Tie System.

2.1 Purpose and Need

The purpose and need of the Updated Corona Gen-Tie System is to connect the first phase of the Updated Corona Wind Projects to the Western Spirit Transmission Project. Western Spirit is a RETA project that would allow renewable energy from the Corona Wind Projects to interconnect to the electrical grid. Additionally, Pattern Development applied for and has been granted 800 MW of transmission service on the Western Spirit line once it is completed. Subsequent phases of the Updated Corona Wind Projects will also have the ability to interconnect to the SunZia Transmission Project via the Updated Corona Gen-Tie System.

2.2 Decisions to be Made

The New Mexico location statute, NMSA 1978, Section 62-9-3.F provides the Commission shall approve the location of the transmission line unless the Commission finds that the location will unduly impair important environmental values. This ER addresses the important environmental values the Commission has identified in its location rule 17.9.592 NMAC, as well as other issues identified by Staff.

3.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.1 Alternatives Considered

The Corona Wind Companies are proposing to construct an overhead 345-kV transmission line to connect the Updated Corona Wind Projects to the Western Spirit Transmission Project, to be located within the Updated Corona Gen-Tie System Corridor. The final transmission line route will be determined with respect to several factors, such as, the final turbine layout, siting of the step-up substations and switchyards based on the final turbine layout, interconnection requirements, landowner coordination, geographic features, and micro-siting of poles. Measures would be undertaken to reduce impacts to important environmental resources to the extent practicable.

3.2 Proposed Project (Proponent Preferred)

The proposed action is to construct, operate, and maintain a new 345-kV transmission line located within the Updated Corona Gen-Tie System Corridor. It is anticipated that there will be approximately 54 miles of 345-kV transmission line (Option A or B) along with the related substation facilities that would transport electricity generated at the Corona Wind Projects to the Western Spirit Transmission Project. The proposed action also includes construction, operation, and maintenance of the required step-up substations within the Updated Corona Gen-Tie System Corridor. These step-up substations would convert lower voltage (34.5-kV) electricity generated at the Corona Wind Projects and increase it to higher voltage electricity (345-kV) for interconnection to the transmission line. A switchyard would also be constructed within the Updated Corona Gen-Tie System Corridor to connect individual projects together for interconnection into the Western Spirit Transmission Project at a single point.

3.2.1 Transmission Line

Electricity generated by the wind turbines would be gathered via buried electrical collection system lines that will be charged at 34.5-kV. The collection system circuits would be gathered at one of the Corona Wind Projects' step-up substations where the voltage would be increased from 34.5-kV to 345-kV via large power transformers. The Corona Wind Projects' step-up substations would be connected to each other via a 345-kV transmission line that could connect to not only the SunZia Transmission Project but also the Western Spirit Transmission Project. The decision on the number of 34.5 to 345-kV step-up substations would be made prior to construction and would be determined by design efficiencies that reduce total electrical infrastructure needed and minimize electrical losses. The transmission line(s) would consist of an overhead line operated at 345-kV. The length of the transmission line would depend on final design. The transmission line would require a ROW width of about 180 ft.

3.2.1.1 Structures

The proposed transmission structure types for the 345-kV transmission line would be wood or steel monopole, two-pole H-frame, and/or three-pole angle structures. Most structures would be self-supporting; however, in some areas, structures would be guyed to provide additional structural support. In areas that require long spans between structures, such as riparian or stream crossings, a taller, larger structure would typically be used. In areas where the line turns, the transmission line could be supported by three-pole angle transmission structures or a structure with guy wires. Typical transmission structure heights for the tangent (structures that hold the line up, but bear little tension), dead-end (structure that bears tension), and angle transmission structures (structure that supports change in line direction and bears tension) would be approximately 80 to 130 ft above the existing ground, depending on terrain and span length.

Structures spans would typically be 600 to 900 ft in length. In most cases, transmission structures would be directly embedded into the ground. Additional foundation support, such as drilled pier concrete foundations may be used in special design cases depending on geotechnical conditions. The diameter of the transmission structure poles would be approximately 3 to 5 ft, depending on framing configuration and the angle to adjacent transmission structures.

3.2.1.2 Conductors and Associated Hardware

The 345-kV transmission line would consist of three phases with each phase consisting of bundled conductors composed of two 954-Thousand Circular Mil (kcmil) aluminum conductor steel supported (ACSS) cables or conductors of comparable capacity. An ACSS consists of 7 steel wires surrounded by 54 aluminum strands. Each conductor is approximately 1.2 inches in diameter. Minimum conductor height above the ground for the 345-kV transmission line would be 30.3 ft, at 167 degrees Fahrenheit based on National Electrical Safety Code (NESC) standards and Special Protection System (SPS) standards. At road crossings, minimum clearance would typically increase to approximately 37.3 ft above ground. Similar sized aluminum conductor steel reinforced (ACSR) cables or conductors also could be used.

3.2.1.3 Fiber Optics

Fiber optic ground wire (OPGW) cable for substation-to-substation control would be installed on top of each transmission structure in the shield wire. The outer strands would consist of aluminum wire and the entire OPGW would be approximately 0.55 inch in diameter.

3.2.2 Step-Up Substation and Adjacent Switchyard

More than one new step-up substation would be constructed within the Updated Corona Gen-Tie System Corridor. The step-up substation(s) would consist of transformers; circuit breakers; switching devices; auxiliary equipment; control enclosure containing equipment for proper control; protection, monitoring; and communications; and associated equipment and facilities. The final location(s) would be determined upon the micrositing and geotechnical examinations of proposed wind turbine locations. The principal function of the substation is to increase the voltage from the collector system (34.5-kV) to the voltage of the Updated Corona Gen-Tie System transmission line (345-kV). The Updated Corona Gen-Tie System would allow for the delivery of the electricity of the proposed Updated Corona Wind Projects to either the Sunzia Transmission Project (where the voltage would then be increased to 500-kV) or the Western Spirit Transmission Project (345-kV). The step-up substation(s) would be located within a fenced area. The fence would be designed in accordance with industry standards to provide safety and security.

A switchyard and 345- to 500-kV step-up substation would be located adjacent to the Western Spirit Transmission Project. The switchyard and step-up substation would connect the electricity to the existing transmission system.

3.2.3 Right-of-Way Acquisition

ROW width for the transmission line would be 180 ft (90 ft each side of the transmission line). A 180-foot wide ROW would accommodate the anticipated structure types, span lengths, and heights for the transmission line; would comply with electrical safety codes; would provide adequate logistical space for construction, operations, and maintenance of the line; and would provide sufficient flexibility for siting structures in the ROW. Final design will determine the structure locations and characteristics. Easements for the transmission line ROW, temporary work areas, and temporary access roads would be required for the transmission line and substations. Some public road upgrades may be necessary and will be negotiated through the Torrance County Roads Maintenance Departments and private landowners. The Updated Corona Gen-Tie System on private lands would be obtained as private easements or ROWs.

3.2.4 Access Roads

The Updated Corona Gen-Tie System would use existing roads and overland travel wherever feasible for access in order to reduce new disturbance. Some new permanent or temporary access/short spur roads may be required to access structure locations within the ROW. New access roads within the existing ROW would retain access for maintenance. Portions of existing access roads located outside of the proposed ROW may require improvements as well as new access roads (temporary or permanent). To reduce ground disturbance and/or reduce visual contrast with the landscape, the alignment of any new

temporary access roads or cross-country routes would follow landform contours in designated areas where practicable, provided that such alignment does not impact other resource values additionally. All temporary access roads would be revegetated with native or similar grasses and forbs following construction. Where ground disturbance is substantial, surface preparation and reseeding would occur. The method of restoration would normally consist of loosening the soil surface, reseeding, installing cross drains for erosion control, placing water bars in the former access road, and filling temporary ditches and swales. Impacts and protection measures for disturbance resulting from the Updated Corona Gen-Tie System to soils, water resources, flora and fauna, and visual resources are discussed in Sections 5.5, 5.7, 5.8, and 5.11 of Chapter 5.0.

All new access that is not required for maintenance would be closed with concurrence of the landowner. Gates, where present or if installed, would be closed and/or locked, depending on the agreement with each landowner. Access roads on private property may be maintained with mutual consent of the landowner. A discussion of impacts and protection measures related to land use along the Updated Corona Gen-Tie System is included in Section 5.12 of Chapter 5.0.

3.2.5 Laydown / Material Staging Areas

Temporary laydown material staging areas would be required to store materials and equipment and to assemble structures for the duration of construction of the Updated Corona Gen-Tie System. The staging areas would be up to 20 acres in size and located at level areas in close proximity to existing roads within the area. The laydown staging areas would be used to store material and equipment prior to delivery to the structure sites, park vehicles, and, possibly, station a portable construction trailer. The staging areas would be surveyed for potential environmental impacts, and if any are found, the staging areas would be relocated or shifted to avoid such sensitive areas. The staging areas would be revegetated and reclaimed after completion of the Updated Corona Gen-Tie System. Impacts and protection measures related to micrositing staging areas and impacts due to disturbance are discussed below in Section 5.8 of Chapter 5.0.

3.2.6 Construction Activities

The proposed Updated Corona Gen-Tie System will use standard construction and operation procedures used for other transmission projects in the western United States. Construction of the Updated Corona Gen-Tie System is expected to take approximately 12-18 months, depending on the results of interconnection studies and final design. The Updated Corona Gen-Tie System's construction schedule projects activity commencing early 2020 and concluding by the end of 2021. The Corona Wind Projects and Updated Corona Gen-Tie System will be in full operation by the end of 2021.

3.2.6.1 Sequence of Activities

The construction of the Updated Corona Gen-Tie System is expected to follow the sequence of: (1) new structure locations surveyed and staked; (2) laydown/materials yard and work areas cleared, as needed; (3) access roads improved or built where necessary; (4) materials distributed along centerline; (5) structure holes dug and poles framed and erected; (6) conductors installed; and (7) site cleaned-up and reclaimed. The timing of construction activities may occur at different locations throughout the construction process. This may require several crews operating simultaneously at different locations.

Temporary laydown/material staging areas would be located on existing disturbed areas or other areas on private lands along the line route with negotiated access rights from private landowners. The yards would serve as field offices, reporting locations for workers, parking space for vehicles and equipment, or sites for temporary marshalling of construction materials.

3.2.6.2 Surveying

Construction survey work for the proposed Updated Corona Gen-Tie System consists of ascertaining soil and geotechnical conditions for foundations, determining specific pole locations, and delineation of ROW and work area boundaries, and, in some areas, roads to access work areas.

3.2.6.3 Access Road Construction

The Updated Corona Gen-Tie System would be located in close proximity to many public roads in order to facilitate access the ROW, to the extent practicable. The construction of temporary construction access roads or overland travel may be required to allow access of construction equipment in the transmission line corridor. This may involve clearing vegetation and crushing vegetation for overland travel. In construction areas where re-contouring is not required, disturbance would be limited to overland driving, where feasible, to minimize changes in the original contours. Large rocks and vegetation may be moved within these areas to allow vehicle access. Impacts and protection measures resulting from access road construction to soils, flora and fauna, and visual resources are discussed in Sections 5.5, 5.8, and 5.11 of Chapter 5.0

Equipment to construct the access roads would include hand tools, bulldozers, and graders. Specific BMPs would be implemented to reduce construction impacts. For example, roads would be built at right angles to streams to the extent practicable, to limit the impact of stream crossings; existing public roads would be utilized to the extent possible; appropriately sized culverts would be installed where needed; and road construction would include dust-control measures during construction, as required. Standard design techniques, such as installing water bars and dips to control erosion, would be included in areas

with slopes. In addition, measures would be taken to reduce impacts such as rutting and soil compaction in specific locations and during certain periods of the year. Discussion of impacts and protection measures for water resources resulting from construction of the Updated Corona Gen-Tie System is included in Section 5.7 of Chapter 5.0.

3.2.6.4 Structure Holes

Excavations for structure holes would be generally made with truck-mounted power auger equipment or a standard sized backhoe or large excavator. Where the soil and geotechnical conditions permit, a truck-mounted power auger would be used. The foundation excavation and installation require equipment access to the foundation sites. Structure hole excavation and installation require access to the site by a power auger or drill, a crane, and material trucks.

Structure holes left temporarily open or unguarded during construction would be covered and/or fenced where practical to protect the public, livestock, and wildlife. Soil removed from foundation holes would be stockpiled on the work area and replaced or disposed, in consultation with landowners.

3.2.6.5 Structure Framing and Assembly

Pole sections, pole framing, and associated hardware would be shipped to each laydown/materials yard site by truck. Structures may be assembled offsite and transported to the appropriate pole locations by truck or helicopter. Insulator strings and stringing sheaves are installed at each ground wire and conductor position while the pole is on the ground. Stringing sheaves (pulleys) are used to guide the conductor during the stringing process for attachment onto the insulator strings. The assembled pole would then be hoisted into place by a crane. Helicopter assisted construction may be utilized for portions of the line.

3.2.6.6 Conductor Installation

Once structures are in place, a pilot line would be pulled (strung) from structure to structure and threaded through the stringing sheaves on each insulator. A larger diameter, stronger line would then be attached to the pilot line and strung. This is called the pulling line. This process is repeated until the ground wire and conductor is pulled through all insulator sheaves.

Conductor would be strung using powered pulling equipment at one end and powered braking or tensioning equipment at the other end. For public protection during wire installation, guard structures would be erected over roadways, transmission and distribution lines, structures, and other obstacles. Guard structures would consist of H-frame poles temporarily placed on either side of an obstacle. These structures prevent ground wire, conductor, or equipment from falling on an obstacle. Equipment for erecting guard structures includes augers, line trucks, pole trailers, and cranes. Guard structures may not

be required for small roads where other safety measures such as barriers, flagmen, or other traffic control devices would be used. Impacts and protection measures pertaining to safety are included in Section 5.17 of Chapter 5.0.

Conductor splicing would be required at the end of a conductor spool or if a conductor is damaged during stringing. The work would occur on work areas for the poles or pulling tensioning sites.

3.2.6.7 Helicopter Use

Access is required to each transmission structure site for construction activities, and helicopters may be used to support construction activities on unique areas that limit vehicle access. Gen-Tie construction activities potentially facilitated by helicopters may include:

- Transport of equipment and materials to transmission structure sites.
- Transmission structure placement.
- Hardware installation.
- Wire and conductor stringing operations.

All helicopter operations would be coordinated with and approved by the Federal Aviation Administration (FAA).

3.2.6.8 Step-up Substations and Switchyard

Following survey and staking of the substation and switchyard site, erosion control measures would be installed, as necessary. Site access would be prepared, including installation of culverts in drainages, if needed, to install a gravel driveway. The substation and switchyard site would be graded and fenced. Concrete pads and footing for equipment would be installed. Aggregate would be spread throughout the fenced area. Equipment would be delivered to the site and generally stored inside the fenced area, although some materials may need to be stored on the property outside the fence due to size or safety considerations. Equipment such as circuit breakers, bus work, capacitors, and dead-ends would be assembled and installed. Transformers would be delivered to the site and installed. Substation control house and supervisory control and data acquisition equipment would be installed. Upon completion of construction activities, disturbed areas outside the fence would be restored and erosion control measures removed.

3.2.6.9 Construction Waste Disposal

Construction sites, laydown and material storage yards, and access roads would be kept in an orderly condition throughout the construction period. Refuse and trash would be removed from the sites and

disposed of in an approved manner, including recycling options. Oils and fuels would be hauled to an approved site for disposal. No open burning of construction trash would occur at any time.

3.2.6.10 Site Reclamation

Work sites would be reclaimed using excess materials, native or similar vegetation, and topsoil stockpiled for that purpose. The contractor would dispose of excess soil materials, rock, and other objectionable materials that cannot be used in reclamation work.

Disturbed areas, with the exception of access roads, would be reclaimed, to the extent possible, to their original contour and reseeded where appropriate. Ripping and other surface scarification on construction roads or other areas would be done as necessary. Depending on the amount of soil compaction and vegetation destruction, ripping may not be required for reclamation. This would be determined on a case-by-case basis. Discussion of impacts and protection measures for disturbance resulting from the Updated Corona Gen-Tie System to soils and flora and fauna are discussed in Sections 5.5 and 5.8 in Chapter 5.0.

3.2.6.11 Protection of Private Property and Environmental Resources

Existing improvements would be repaired or replaced if they are damaged by construction activities. All existing roads would be left in a condition generally equal to or better than their condition prior to the construction of the transmission line. Fences and gates would be installed or repaired and replaced (if they are damaged by construction activities) to their original conditions as required by the landowner.

Temporary gates would be installed only with the permission of the landowner and would be restored to original condition following construction unless otherwise agreed with the landowner. Gates would be closed and locked, depending on the agreement with the private landowners.

Prior to construction, all supervisory construction personnel would be instructed on the protection of ecological and cultural resources. To assist in this effort, the construction contract would address: (a) federal, state, and local laws regarding wetlands, vegetation, wildlife, and cultural resources; (b) the importance of these resources and the purpose and necessity of protecting them; and (c) methods for protecting sensitive resources.

All waste products, including food garbage, from construction sites would be deposited in a covered waste receptacle, or removed daily. Garbage would be hauled to a suitable and appropriately permitted disposal facility.

To reduce the number of sensitive features disturbed in designated areas, transmission poles would be sited during the engineering design process so as to avoid sensitive features such as, but not limited to, riparian areas and watercourses and/or to allow conductors to clearly span the features, within limits of standard pole design. A discussion of impacts and protection measures for the environmental resources present in the Updated Corona Gen-Tie System are included in Chapter 5.0.

3.2.7 Operation and Maintenance

Operation and maintenance (O&M) of the Corona Wind Projects is anticipated to include the following.

3.2.7.1 Operation

After the constructed Updated Corona Gen-Tie System has been energized, land uses compatible with safety regulations and activities associated with O&M would be permitted within and adjacent to the ROW. Existing land uses such as agriculture and grazing are generally permitted within the ROW. Incompatible land uses include construction of permanent dwellings and any use requiring changes in surface elevation that would affect NESC electrical clearances of existing or planned facilities.

Safety is a primary concern in the planning and design of the Updated Corona Gen-Tie System. An AC transmission line would be protected with power circuit breakers and related line relay protection equipment. If a conductor failure occurs, power would be automatically removed from the line. Lightning protection would be provided by overhead static and grounding wires along the length of the line. All fences, metal gates, pipelines, etc., that cross or are within the Updated Corona Gen-Tie System ROW would be grounded to prevent electrical shock and to meet NESC requirements. A discussion on impacts and protection measures regarding safety are included in Section 5.17 of Chapter 5.0.

3.2.7.2 Maintenance

Maintenance of the transmission line would be performed as needed. When access is required for non-emergency maintenance and repairs, the same precautions taken during construction activities would be implemented to the extent practicable. Landowners would be contacted when access to their lands is required for maintenance activities on transmission lines.

Emergency maintenance would involve prompt movement of crews to repair or replace any damage. Crews would be instructed to protect vegetation, wildlife, and other environmental resources to the extent possible. Reclamation procedures following completion of repair work would be similar to those prescribed for normal construction.

3.2.7.3 Traffic Safety

Minimal additional vehicular traffic would occur on public roads in the area as a result of transmission line construction and O&M of the transmission line. Because of the low number of vehicles accessing the transmission line, minimal impacts are anticipated. The transmission line would cross U.S. Highways 54 and 60 in Torrance County. County road use and crossings in Torrance County would also be required and would be coordinated with the New Mexico Department of Transportation (NMDOT) and the Torrance County Roads Maintenance Department. Final engineering design would determine specific road crossing requirements (see additional discussion in Section 5.20).

3.2.8 Decommissioning

Decommissioning of the Corona Wind Projects will involve removal of all wind facilities. Pattern Development will take appropriate measures to restore the development area to its pre-existing conditions. Pattern Development's removal and restoration efforts will generally involve:

- **Wind turbines (including towers and pad-mount transformers):** Wind turbines will be cleared, cleaned and removed from the Corona Wind Projects site. Any liquids, greases, etc. contained therein will also be removed safely from the site in accordance with then-existing laws and regulations.

- **Tower foundations and pad mount transformer foundations:** All foundations installed in the ground, the foundations will be cleared, cleaned and removed from the ground to at least four ft below the grade. Holes or cavities created in the ground, as a result of such removal, will be filled with topsoil of the same or similar type found at the site.

- **Overhead power and/or communication lines:** Overhead power and/or communication lines owned by Pattern Development and no longer in use will be cleaned and removed from the Corona Wind Projects site.

- **Substations:** Substations will be cleared, cleaned and removed from the Corona Wind Projects site and any liquids, greases, etc. contained in the substations will be removed safely from the site in accordance with then-existing laws and regulations.

- **Buried cables (power and/or communication):** All buried cables (power, fiber-optic, communication, etc.) installed in the ground will be cleared, cleaned at least three ft below the grade of the land affected. Pattern Development will ensure that any holes or cavities created in

the ground as a result of such removal are filled with topsoil of the same or similar type found at the Corona Wind Projects site.

- **O&M building**: Will be cleared, cleaned and removed from the Corona Wind Projects site. Pattern Development may request that the O&M building be assigned to a new owner.

- **Restoration of property:** To the extent reasonably practicable, the Corona Wind Projects site will be returned to pre-existing conditions. Pattern Development will ensure that any holes or cavities created in the ground are filled with topsoil of the same or similar type found at the Corona Wind Projects site and to the extent reasonably practicable, the surface is returned to the same condition as before the holes or cavities were dug.

4.0 AFFECTED ENVIRONMENT

4.1 Introduction

The affected environment is described below for the environmental values provided in NMSA 1978 Section 62-9-3.M, Commission Rule 17.9.592 NMAC, and additional resource areas identified to be of interest by Staff. These are: air resources; noise, geology and mineral resources; soil resources; paleontological resources; water resources; flora and fauna; cultural and historic archaeological resources; religious and cemetery sites; socioeconomics and environmental justice; communication signals; radioactive waste and radiation hazards; hazardous materials; safety; geographic resources; military activities and aviation; and roads. The discussion for each resource includes data sources used, current regional conditions, and conditions within the Extended Corona Gen-Tie System Corridor and the Reconfigured Corona Gen-Tie System Corridor as well as the Corona Wind Update. The Corona Wind Update is shown in Exhibit 2 alongside the Updated Corona Gen-Tie System Corridor. Final siting of transmission facilities will depend upon the results of SPP interconnection studies and other factors such as landowner preferences.

This section of the ER describes the existing conditions of certain relevant resources. The primary focus is on the resources potentially affected by an electric transmission line that will enable certain wind generation systems to connect to electric markets. This area of potentially affected resources is defined as the parcels of land within the 180-foot ROW of the transmission line and associated facilities, including areas of interconnection (substations) and access roads for maintenance or operation of the line, 1-mile buffer, and is called the Updated Corona Gen-Tie System Corridor. This area is shown in Exhibit 2. In an effort to provide additional context, this section also presents the existing conditions of resources that could potentially be affected by the wind generation systems.[3] This area of consideration is called the Corona Wind Update and is also shown in Exhibit 2.

4.2 Air Resources

4.2.1 Data Sources

The following data sources were reviewed to assess the existing air quality conditions of Torrance and Lincoln Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

3 Note that, to the extent that resource avoidance (e.g., cultural, wetland resources) drives micro-siting outside of the transmission corridor, such changes would still remain within the Corona Wind Project Area.

- New Mexico Environmental Department. Air Quality Bureau, *Air Monitoring Network.* Accessed September 2019 from: https://www.env.nm.gov/air-quality/air-monitoring-network-2/.
- U.S. Environmental Protection Agency (EPA) in New Mexico. Accessed September 2019 from: https://www.epa.gov/nm.

4.2.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

Air quality in Torrance County in which the Updated Corona Gen-Tie System Corridor is located is generally considered very good. For all criteria pollutants, the county is in attainment. New Mexico Environmental Department (NMED), Air Quality Bureau reports in Torrance County are in attainment of all national and state ambient air quality standards. The attainment status for Torrance County is reflective of low population density and land use dominated by agriculture. Torrance County is below national and New Mexico state averages reported to EPA (EPA, 2019a) for air quality index scores, levels of ozone, and levels of particulate matter (PM), all of which are indicative of good regional air quality above the national and state averages.

4.2.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

No unique air quality conditions are known to occur in Lincoln County where the Corona Wind Update is located. Air quality conditions within the Corona Wind Update (Lincoln County) would be similar to what is described above for Torrance County based on low population density and land use in the areas.

4.3 Noise

4.3.1 Data Sources

The following data sources were reviewed to assess the existing noise conditions of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- U.S. Census Bureau, *Quick Facts*. Accessed September 2019 from: https://www.census.gov/quickfacts/fact/table/US/PST045217.
- Lincoln County Comprehensive Plan. (August 2007). Sites Southwest LLC.
- Comprehensive Land Use Plan for Torrance County, New Mexico. (July 29, 2003).

4.3.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

Lincoln and Torrance Counties are rural counties located in central New Mexico with population density below the state and national averages. The counties generally have relatively low ambient noise levels due to the rural setting. Noise in the Updated Corona Gen-Tie System Corridor typically ranges from very quiet with natural sounds and wind dominating to noisy in localized areas near towns, at highway crossings, and in agricultural areas during cultivation activities. Additional noise is also created by aircraft within the airspace.

4.3.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

No unique noise is known to occur within the Corona Wind Update. Lincoln County is a rural county of central New Mexico with low population density and ambient noise. Noise within the Corona Wind Update would be similar to what is described above for the Updated Corona Gen-Tie System Corridor, based on low population density and land uses present in the area.

4.4 Geology and Mineral Resources

4.4.1 Data Sources

The following data sources were reviewed to assess geological and mineral resources of Lincoln, and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- Broadhead, R.F. 1997. *Subsurface geology and oil and gas potential of the Estancia Basin, New Mexico*. New Mexico Bureau of Geology and Mineral Resources Bulletin 157, 54p. Socorro, New Mexico.
- *Preliminary Geotechnical Engineering Report Sunzia Wind Project*, New Mexico. (Barr Engineering Company. October 2017).
- *The Drillings*. 2019. Lincoln and Torrance Counties, New Mexico. Accessed September 2019 from https://thedrillings.com/usa/new-mexico/.

4.4.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The Corona Wind Projects are located on the west side of the Great Plains physiographic province. The signature geologic deposit of the Great Plains is the Ogallala Formation, and it has been largely eroded away in the area by the Pecos River. The resulting landscape is largely a piedmont – thin to non-existent

soil over a gently sloping bedrock surface. In places there are remnants of the Ogallala and younger river sediments. The bedrock itself is mostly Permian aged sedimentary rock that had been deposited in the ocean on a continental shelf. In the western and southern margins of the Corona Wind Project Area there are some highlands with cores of igneous intrusive rocks.

In general, a 2017 field investigation conducted by Barr Engineering Company encountered a thin layer of soil overlying the bedrock surface. In places there are remnants of the Ogallala Formation (contains varying proportions of sand, gravel, silt, clay, and caliche) and younger river sediments. The bedrock generally consists of sedimentary rock (sandstone, limestone, siltstone, and dolomite), however isolated areas of igneous bedrock (rhyolite) were encountered in the southern portion of the Corona Wind Project Area. In most cases a weathered bedrock unit was observed immediately below the cover soil, which was underlain by more competent rock (Exhibit 3). Karst features, including open voids, were encountered at one geotechnical boring location and documented with a borehole camera.

There are no identified hydrocarbon extraction activities within Option A and one gas well within the 1-mile corridor of Option B that is plugged along the Updated Corona Gen-Tie System. There are no mining activities within the Updated Corona Gen-Tie System Corridor. In Torrance County there are 2,469 exploration leases (The Drillings, 2019). Some of the exploration wells have located very deep oil and gas deposits in the Estancia Basin in the northern portion the Corona Wind Project Area (Broadhead, 1997); however, these deposits have yet to be exploited.

4.4.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

Geological conditions for the Corona Wind Update are the same as previously described for the Updated Corona Gen-Tie System Corridor. In addition, closed topographic depressions or surficial karst features were observed near a number of locations across the Corona Wind Project Area, specifically in the northern and northeastern extents.

There are currently 3,192 oil/natural gas leases in Lincoln County on BLM administered lands (The Drillings, 2019). Most of these leases are to support exploration drilling projects for hydrocarbons; however, there are no major oil and natural gas basins in the county. There are currently no major exploration activities or oil wells within the Corona Wind Update (Exhibit 4).

Mining has always been important to the economies of these two counties, but due to many of the mineral deposits being limited or the extraction process too expensive, all mines within the Corona Wind Update have been shut down. Lincoln County has had 8,829 registered mines extracting iron, gold, silver, copper

and fluorine but only 188 of the mines are currently active (The Drillings, 2019). Torrance County has had 2,711 registered mines extracting iron, potassium, uranium, barium and silver and only 53 mines are currently active (The Drillings, 2019). It is to be noted that the areas around the abandoned mines may contain contaminated soils originating from extraction and processing activities (Exhibit 5).

4.5 Soil Resources

4.5.1 Data Sources

The following data source was reviewed to assess the existing soil resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) Database for New Mexico (2019). Accessed September 2019 from: http://apps.cei.psu.edu/soiltool/.

4.5.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The soils at the site have low to moderate shrink-swell potential based on visual classification during logging and laboratory test results. The following Table **Error! Reference source not found.** summarizes the existing soil resources located within the Updated Corona Gen-Tie System Corridor for Option A and Option B. For a visual representation of the soil locations within the Updated Corona Gen-Tie System Corridor, refer to Exhibit 6. As the Updated Corona Gen-Tie System Corridor does not extend into Guadalupe or Lincoln Counties, the existing soil resources within these regions are not shown in the table below.

Table 4-1: Torrance County Soil Coverage Types

Soil Type	Acres (Option A)	Acres (Option B)
Chilton-La Fonda complex, 1 to 9 percent slopes	626	626
Clovis loam, 0 to 5 percent slopes	974	974
Clovis soils, 0 to 5 percent slopes, eroded	97	97
Clovis-Dean loams, 0 to 5 percent slopes	335	335
Dean loam, 1 to 9 percent slopes	3,002	3,002
Gravel pit	3	3
Harvey loam, 1 to 9 percent slopes	262	262
Harvey-Dean loams, 1 to 9 percent slopes	2.397	2,397
Ildefonso fine sandy loam, 0 to 5 percent slopes	1	1

Soil Type	Acres (Option A)	Acres (Option B)
Karde-Willard loams, saline	28	28
Kech gravelly loam, 1 to 9 percent slopes	254	254
Kim-Otero-Pastura complex	474	474
Kim-Pastura-Tapia loams	4,243	4,318
La Fonda loam, 1 to 9 percent slopes	1,333	1,333
La Fonda-Rock outcrop complex	2,314	2,314
Laporte-Rock outcrop complex	2331	233
Manzano loam, 0 to 1 percent slopes	195	195
Manzano loam, saline substratum, 0 to 1 percent slopes	86	86
Otero and Palma soils	524	570
Pastura loam, 1 to 9 percent slopes	691	647
Pastura loam, 9 to 25 percent slopes	33	33
Pedrick loamy fine sand	333	333
Penistaja fine sandy loam, 1 to 6 percent slopes	1,180	1,180
Penistaja-Dean fine sandy loams, 1 to 5 percent slopes	224	224
Pinon channery loam, 3 to 20 percent slopes	204	216
Playas	6	6
Prewitt and Manzano soils	414	414
Rance-Gypsum land complex	234	234
Rock land	488	488
Rock outcrop-Pinon-La Fonda complex	199	199
Steep rock land	267	267
Tapia and Dean soils, eroded	298	298
Tapia loam, 0 to 5 percent slopes	3,359	3,359
Tapia-Dean loams, 0 to 5 percent slopes	5,175	5,107
Willard loam, strongly saline	1,455	1,455

Source: SSURGO Database for New Mexico, 2019

4.5.3 Current Conditions and Trends, Regional Overview – Supplemental Corona Wind Update

Table 4-2 summarizes the existing soil resources located within the Corona Wind Update in Lincoln County. For a visual representation of the soil locations within the Corona Wind Update, refer to Exhibit 6.

Table 4-2: Lincoln County Soil Coverage Types

Soil Type	Acres
Penistaja-Travessilla association, gently sloping	5,662
Plack-Dioxice association, gently sloping	139
Plack-Penistaja association, gently sloping	1,835
Rock outcrop-Stroupe-Deama association, extremely steep	2,251
Sampson loam, 0 to 5 percent slopes	53
Tortugas-Asparas-Rock outcrop association, moderately sloping	72
Tortugas-Rock outcrop association, moderately sloping	1,725

Source: SSURGO Database for New Mexico, 2019

4.6 Paleontological Resources

4.6.1 Data Sources

The following data sources were reviewed to assess paleontological resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- Anderson, O.J., Jones, G.E., and Green, G.N. 1997. *Geological map of New Mexico: U.S. Geological Survey (USGS) Open-file Report 97-52.* Accessed September 2019 from: http://pubs.er.usgs.gov/publications/ofr9752.
- Paleobio database. Accessed September 2019 from: https://paleobiodb.org/#/.

4.6.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

No formal paleontological work has been completed in the Updated Corona Gen-Tie System Corridor. The geology in the area consists of Permian deposits of the Yeso Formation, the Tertiary Ogallala Formation, and several deposits of the Quaternary Period including piedmont alluvium, aeolian deposits, and lacustrine/playa lake deposits, all unconsolidated. The Yeso formation was deposited during the Permian Period (298.9 – 252.17 my). Since that period, the original deposits of sandstone and limestone have metamorphosed into dolomite and other types of rocks that are called *textually mature*; fossils have not survived that metamorphosis. The only fossils that are recovered from the Permian are either in very fine silts or in now-coal formations; neither of which are found in this area of New Mexico. The Ogallala Formation consists of alluvial and aeolian deposits, and petrocalcic soils. This formation has been known to contain scattered megafaunal fossils. The alluvial deposits consist of sand and gravels that were deposited during the Lower Pleistocene into the Holocene. These deposits have been known to contain

megafaunal finds, but they are rare. Any discoveries which may occur during construction would be managed through an Unanticipated Discovery Protocol (UDP).

4.6.3 Current Conditions and Trends, Regional Overview – Supplemental Corona Wind Update

The potential for paleontological resources in the Corona Wind Update is similar to that of the Updated Corona Gen-Tie System Corridor; however, the south-central area of Corona Wind Projects crosses the Mancos Shale and Chinle Formation exposures in Lincoln County. The Mancos Shale is known to contain marine invertebrate and shark fossils, while the Chinle Formation in other areas of New Mexico is known to contain dinosaur fossils; local deposits in the Chinle Formation are known to contain large amounts of silicified wood (Lucas, 1993).

4.7 Water Resources

4.7.1 Data Sources

The following data sources were reviewed to assess the existing water resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- 2011 National Land Cover Database (NLCD). Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, *Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354
- Anderson, O.J., Jones, G.E., and Green, G.N. 1997. *Geological map of New Mexico: USGS Open-file Report 97-52*. Accessed September 2019 from: http://pubs.er.usgs.gov/publications/ofr9752.
- EPA in New Mexico. Accessed September 2019 from: https://www.epa.gov/nm.
- EPA. Ecoregions. Accessed September 2019 from: https://www.epa.gov/eco-research/ecoregions.
- Playa Lakes Joint Venture (PLJV). 2019. Maps of Probable Playas, Roosevelt, New Mexico. Accessed September 2019 from: http://pljv.org/for-habitat-partners/maps-and-data/interactive-playa-map/.
- Federal Emergency Management Agency (FEMA) *Flood Map Service Center*. Accessed September 2019 from: https://msc.fema.gov/portal/search.

- U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Data Mapper (USFWS, 2019a). Accessed September 2019 from: https://www.fws.gov/wetlands/data/mapper.html.
- USGS National Hydrography Dataset (NHD) (USGS, 2019b). Accessed September 2019 from: https://nhd.usgs.gov/tools.html.

4.7.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The Updated Corona Gen-Tie System Corridor occurs mostly within the Southwestern Tablelands Level III Ecoregion (EPA, 2019b) and more specifically within Central New Mexico Plains, Pinyon-Juniper Woodlands and Savannahs, and Pluvial Lake Basins ecoregions containing short-grass prairie and pinyon-juniper woodland plant communities. Common vegetation of the Southwestern Tablelands includes grama grasses (*Bouteloua gracilis*), buffalo grass (*B. dactyloides*), piñon pine (*Pinus spp*), junipers (*Juniperus spp*), and scrub oak (*Quercus gambelii*).

A review of the 2011 NLCD (NLCD, 2011; Homer et al., 2015) identified two major cover types in the Updated Corona Gen-Tie System Corridor (Option A): Grassland/Herbaceous 66 percent and Shrub/Scrub 33 percent, and 65 percent and 34 percent respectively for Option B of the Updated Corona Gen-Tie System Corridor. Table 4-3 below summarizes the NLCD cover types in the Updated Corona Gen-Tie System Corridor for Options A and B.

The Updated Corona Gen-Tie System Corridor is situated in various watersheds throughout the area of development (Exhibit 7). Specifically, development would occur within the Camaleon Draw (HUC 1306000302), Town of Cedarvale (HUC 1305000202), City of Encino (HUC 1305000201), Pueblo Blanca Canyon (HUC 1305000107), Cola de Gallo Arroyo (HUC 1306000602). Surface water features in the vicinity of the Updated Corona Gen-Tie System Corridor include intermittent drainages and stream channels, and ponds.

Table 4-3: National Land Cover Database Type Updated Corona Gen-Tie System Corridor Acreage

Land Cover	Acres (Option A)	Acres (Option B)	Percent
Barren Land	<1	<1	<1%
Developed, High Intensity	<1	<1	<1%
Developed, Low Intensity	5	5	<1%
Developed, Medium Intensity	<1	<1	<1%

Land Cover	Acres (Option A)	Acres (Option B)	Percent
Developed, Open Space	218	218	1%
Emergent Herbaceous Wetlands	4	4	<1%
Evergreen Forest	45	45	<1%
Grasslands/Herbaceous	21,200	20,773	66% (65% Option B)
Shrub/Scrub	10,442	10,892	33% (34% Option B)
Open Water	2	2	<1%
Total	**31,918[a]**	**31,942[a]**	**100%[a]**

Source: 2011NLCD, 2017
(a) Acreages and percentages are rounded up to the next whole number.

Wetlands, floodplains, and streams were inventoried for the Updated Corona Gen-Tie System Corridor. The NWI data documented 188 acres of wetlands within Option A and 184 acres of wetlands for Option B within the Updated Corona Gen-Tie System Corridor (see **Error! Reference source not found.**). The NWI identified wetlands included three wetland types: freshwater emergent wetland, freshwater pond, and riverine for both Option A and B (Exhibit 8). According to the NWI data, Option A of the Updated Corona Gen-Tie System Corridor has approximately 59-miles of mostly unnamed intermittent stream features and Option B has 58 miles of unnamed intermittent stream features (data from NHD). There are no ephemeral or perennial streams, and approximately 1 mile of artificial paths and connectors present in Options A and B. Of the NWI identified wetland areas, there are more than 37 wetlands that appear to be potentially jurisdictional.

Table 4-4: Updated Corona Gen-Tie System Corridor Wetland Table Based on the U.S. Fish and Wildlife Service National Wetland Inventory Data

Wetland Type	Sum of Acres (Option A)	Sum of Acres (Option B)	Percentage
Freshwater Emergent Wetland	36	36	19%
Freshwater Pond	9	8	<1%
Riverine	143	140	76%
Total	**188[a]**	**184[a]**	**100%[a]**

Source: USFWS, 2019
(a) Acreages and percentages are rounded up to the next whole number.

The Updated Corona Gen-Tie System Corridor is part of the Southeastern Plains which slope gradually eastward and southeastward. This part of these eastern plains lies within the Pecos River and flows

southward through the Southeastern Plains into Texas, and then southeastward to join the Rio Grande. Summer rains fall almost entirely during brief, but frequently intense thunderstorms. July and August are the rainiest months over most of the State, with 30 to 40 percent of the year's total moisture falling at that time. During the warmest six months of the year, May through October, total precipitation averages 80 percent of the annual total.

General floods are seldom widespread in New Mexico. Heavy summer thunderstorms may bring several inches of rain to small areas in a short time. Because of the rough terrain and sparse vegetation in many areas, runoffs from these storms frequently cause local flash floods. Normally dry arroyos may overflow their banks for several hours, halting traffic where water crosses highways; damaging bridges, culverts, and roadways; and if in an urban area, possible causing considerable property damage. Snowmelt during April to June, especially in combination with a warm rain, and heavy general rains during August to October may occasionally cause flooding of the larger rivers.

Playa lakes are shallow, clay-lined ephemeral rainwater basins occurring throughout the Great Plains ecoregion. There are estimated to be over 4,000 playa lakes in eastern New Mexico, none of which occur within the Updated Corona Gen-Tie System Corridor or Corona Wind Update (PLJV, 2019). Approximately 229 acres of known FEMA mapped floodplain fall within the Updated Corona Gen-Tie System Corridor (Option A and Option B). Approximately 19,737 acres (Option A) and 19,758 acres (Option B) of the Updated Corona Gen-Tie System Corridor are unmapped FEMA areas (FEMA, 2019) (Exhibit 9).

4.7.3 Current Conditions and Trends, Regional Overview – Supplemental Corona Wind Update

The Corona Wind Update includes the water resource features generally similar to those described above for the Updated Corona Gen-Tie System Corridor. The Corona Wind Update is situated in various watersheds throughout the area of development (Exhibit 7). Specifically, development would occur within the Headwaters Gallo Arroyo watershed (HUC 1306000603), and Cola de Gallo Arroyo watershed (HUC 1306000602), which are tributaries of the Pecos River (EPA, 2019). The Corona Wind Update has approximately 54 acres of NWI wetlands, approximately 22 miles of mostly unnamed intermittent streams, less than 0.5 mile of artificial paths, and approximately 11,736 acres of mapped floodplain FEMA. Table 4-5 below indicates the various wetland types within the Corona Wind Update.

Table 4-5: Corona Wind Update Wetland Table Based on the U.S. Fish and Wildlife Service National Wetland Inventory Data

Wetland Type	Sum of Acres	Percentage
Freshwater Emergent Wetland	<1	<1%
Freshwater Pond	2.26	<1%
Riverine	52	96%
Total	**54[a]**	**100%[a]**

Source: USFWS, 2019
(a) Acreages and percentages are rounded up to the next whole number.

A review of the 2011 NLCD (NLCD, 2011; Homer et al., 2015) identified three major cover types in the Corona Wind Update: Shrub/Scrub 94 percent, Grassland/Herbaceous 2 percent and Evergreen Forest 4 percent. Table 4-3 below summarizes the NLCD cover types in the Corona Wind Update.

Table 4-6: National Land Cover Data Summary for the Corona Wind Update

Land Cover	Acres	Percent
Evergreen Forest	483	4%
Grasslands/Herbaceous	231	2%
Shrub/Scrub	11,020	94%
Total	**11,734[a]**	**100%[a]**

Source: 2011 NLCD, 2017
(a) Figures and percentages are rounded up to the next whole number.

4.8 Flora and Fauna

4.8.1 Data Sources

The following data sources (based on the 2017 WEST reports) were reviewed to assess the existing biological resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- 2011 NLCD Data Downloads. Accessed September 2019 from: https://www.mrlc.gov/nlcd2011.php.
- *Critical Issues Analysis for the Proposed Ancho Wind Project* (Report, WEST, Inc., March 2017a).
- *Critical Issues Analysis for the Proposed Cowboy Mesa Wind Project* (Report, WEST, Inc., March 2017b).
- *Critical Issues Analysis for the Proposed Viento Loco Wind Project* (Report, WEST, Inc., March 2017c).

- eBird, an online database of bird distribution and abundance. Accessed September 2019 from: https://ebird.org/.
- New Mexico Crucial Habitat Assessment Tool (NM CHAT). Accessed September 2019 from: http://nmchat.org/data.html.
- NMDGF Biota Information System (BISON-M). Accessed September 2019 from: http://www.wildlife.state.nm.us/conservation/wildlife-species-information/threatened-andendangered-species/.
- PLJV Maps of Probable Playas Accessed September 2019 from: https://pljv.org/for-habitat-partners/maps-and-data/maps-of-probable-playas/.
- *Raptor Nest Survey, Pattern Wind Energy Project* (Report, WEST, Inc., August 2017d).
- *Site Characterization Study, Pattern Wind Energy Project* (Report, WEST, Inc., August 2017e).
- Southern Great Plains Crucial Habitat Assessment Tool (SGP CHAT). Accessed September 2019 from: https://kars.ku.edu/geodata/maps/sgpchat/.
- The National Audubon Society (Audubon) Important Bird Areas (IBA) Accessed September 2019 from: http://www.audubon.org/important-bird-areas.
- USFWS Environmental Conservation Online System Species Profiles (USFWS, 2019b). Accessed September 2019 from: https://www.fws.gov/southeast/conservation-tools/environmental-conservation-online-system/.
- USFWS Information forPlanning and Consultation (IPaC) (USFWS, 2019c). Accessed September 2019 from: https://ecos.fws.gov/ipac/.
- USGS Gap Analysis Program (GAP) Protected Areas of the U.S. database (USGS, 2019a). Accessed September 2019 from: https://gapanalysis.usgs.gov/padus/.
- USGS NHD. (USGS, 2019b) Accessed September 2019 from: https://nhd.usgs.gov/tools.html.
- *Waters of the U.S. and Biological Resources Assessment for 10 Proposed Wind Turbine Locations and Access Roads at the Ancho Wind Project*, Lincoln County, New Mexico (Report, Blanton & Associates, Inc., 2017a).
- *Waters of the U.S. and Biological Resources Assessment for 11 Proposed Wind Turbine Locations and Access Roads at the Viento Loco Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017b).
- *Waters of the U.S. and Biological Resources Assessment for 15 Proposed Wind Turbine Locations and Access Roads at the Duran Mesa Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017c).

- *Waters of the U.S. and Biological Resources Assessment for 16 Proposed Wind Turbine Locations and Access Roads at the Tecolote Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017d).
- *Waters of the U.S. and Biological Resources Assessment for 21 Proposed Wind Turbine Locations and Access Roads at the Red Cloud Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017e).
- Western Bat Working Group. Accessed September 2019 from: wbwg.org/matrices/species-matrix/.
- Bat Conservation International (BCI). Accessed September 2019 from: http://www.batcon.org/our-work/regions/usa-canada/wind2.
- USFWS NWI Data Mapper. Accessed September 2019 from: https://www.fws.gov/wetlands/data/mapper.html.

4.8.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The NM CHAT is a habitat classification system for crucial habitat using a relative, six-level prioritization scheme, where 1 represents areas most crucial and 6 represents areas least crucial. The NM CHAT identified none of the overall area of development (Updated Corona Gen-Tie System Corridor) as Rank 1 for Wildlife Corridors for the cougar (*Puma concolor*), which are defined as areas that link core habitats for sustaining populations across landscapes (NM CHAT, 2019). These crucial habitat areas are located to the west and northwest of the Updated Corona Gen-Tie System Corridor; no crucial cougar wildlife corridors fall within the Updated Corona Gen-Tie System Corridor. Approximately 95 percent of the overall area was either Rank 3 or Rank 4, which is defined as areas that may provide high-priority wildlife corridors, mid-level priority wetland/riparian habitat, or mid-level habitat for species of concern.

The likelihood of a special-status animal or plant species that may occur was determined by considering the species' range, habitat suitability, species' mobility, population size, and records of occurrence within or adjacent to the Updated Corona Gen-Tie System Corridor. Based on these factors, the likelihood of occurrence was defined for each special-status species using the following categories:

- **None** – outside the species known range, no suitable habitat within the Updated Corona Gen-Tie System Corridor, restricted mobility and small population size;
- **Not likely** – outside the species known range and suitable habitat appears absent within the Updated Corona Gen-Tie System Corridor; however, due to the species mobility and population

size, species may occur within the Updated Corona Gen-Tie System Corridor during migration or other times of the year;

- **Possible** – is located within the range of the species but contains marginal suitable habitat; species highly mobile and may occur year-round;
- **Likely** – is located within the range of the species and contains suitable habitat; records of species occurrence in the surrounding area but no records from the Updated Corona Gen-Tie System Corridor; and
- **Occurs** – records of species occurrence within the Updated Corona Gen-Tie System Corridor based on USFWS/WDFW data or other survey data.

Brief species accounts are written for special-status and other protected species whose likelihood of occurrence was either possible, likely, or occurs.

4.8.2.1 Federally Listed Species

One animal species that is federally listed under the Endangered Species Act (ESA) may potentially occur in the Updated Corona Gen-Tie System Corridor (USFWS, 2019b). The Mexican spotted owl (*Strix occidentalis lucida*) is listed as federally threatened (Table 4-7). The other listed species, yellow-billed cuckoo (*Coccyzus americanus*) is considered unlikely to be impacted due to their specific habitat not occurring within the updated transmission line area.

Table 4-7: Federally Listed Species in the Updated Corona Gen-Tie System Corridor

Common Name	Scientific Name	Federal Status[a]	Likelihood of Occurrence
Birds			
Mexican spotted owl	*Strix occidentalis lucida*	T	**Possible.** Project is located with the elevational and ecological range for the owl. Designated critical habitat for the owl is approximately 40 miles west of the Project. Evergreen forest within the Project may provide suitable nesting or wintering habitat.
yellow-billed cuckoo (western population)	*Coccyzus americanus*	T	**Not likely.** Project is not likely to include riparian, wetlands, riverine, lacustrine, or otherwise suitable habitat. There is at least some potential for the species to migrate through the area.

Source: USFWS, 2019b
(a) T=Threatened

4.8.2.2 State-listed Species

State-listed endangered or threatened wildlife species are identified for Torrance County in which the Updated Corona Gen-Tie System Corridor is located (NMDGF, 2019), as shown in Table 4-8. These species include four birds: southwestern willow flycatcher, bald eagle (*Haliaeetus leucocephallus*), Baird's sparrow (*Ammodramus bairdii*), and peregrine falcon (*Falco peregrinus* and Arctic subspecies *F. p. tundrius*).

Table 4-8: State Listed Wildlife Species

Common Name	Scientific Name	State Status[a]	Likelihood of Occurrence
Birds			
bald eagle	*Haliaeetus leucocephallus*	T	**Likely.** Species likely to occur within the Project as occasional winter visitor.
peregrine falcon	*Falco peregrinus*	T	**Likely.** Peregrine likely to occur in Project as occasional year-round resident and migrant.
Baird's sparrow	*Ammodramus bairdii*	T	**Possible.** Species may occur in the Project during migration; Project is outside species' breeding range.
southwestern willow flycatcher	*Empidonax traillii extimus*	E	**Not Likely.** Project does not appear to contain suitable riparian breeding habitat; some potential for species to migrate through Project.

Source: NMDGF, 2019
(a) E=Endangered, T=Threatened

4.8.2.3 Bats

Potentially 31 bat species in New Mexico have ranges in the vicinity of and overlapping the Updated Corona Gen-Tie System Corridor and Corona Wind Update (Western Bat Working Group, 2017). BCI states that at least 24 species of bats have been reported as killed by wind turbines, however, they do not provide a species-specific list (2019). BCI does specifically identify the hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), and silver bat (*Lasiurus noctivagans*), and all migratory tree dwelling bats as accounting for nearly 78 percent of fatalities north of Mexico. None of those species are federally protected.

Potential roosting habitat within the Updated Corona Gen-Tie System Corridor and Corona Wind Update is found primarily in the form of trees and man-made structures; however, these habitats are limited in the Updated Corona Gen-Tie System Corridor and Corona Wind Update. No known bat colonies were identified as occurring in the Updated Corona Gen-Tie System Corridor and Corona Wind Update.

Bats generally forage over water and other open spaces, such as agricultural fields, grasslands, streams, and wetlands/ponds. Insects often concentrate over wet areas associated with wetlands and streams, which may in turn concentrate foraging bats. Within the Updated Corona Gen-Tie System Corridor and Corona Wind Update, bat use is likely to be greater in areas around ponds and other water sources within the Updated Corona Gen-Tie System Corridor and Corona Wind Update when these areas have some available water, as bats would likely concentrate around these features to forage and drink. Although bats may also forage throughout the drier grasslands and shrublands within the Updated Corona Gen-Tie System Corridor and Corona Wind Update, they are likely to do so at much lower densities.

4.8.2.4 Birds

Passerines, raptors, waterfowl, and waterbirds likely migrate through the Updated Corona Gen-Tie System Corridor. Grassland and cropland provide stopover habitat during migration or during post breeding dispersal and may attract a broad suite of birds. Waterfowl and waterbirds (including shorebirds) would primarily be attracted to the small emergent wetlands and open water as stopover habitat during migration, these resources comprise less than 1 percent of the Updated Corona Gen-Tie System Corridor.

The Baird's sparrow is a state-threatened grassland bird species that breeds in the tall grasses of the northern Great Plains and winters in northern Mexico and the southern-most areas of Arizona and New Mexico. While the Updated Corona Gen-Tie System Corridor is outside of the breeding range of the species, it does fall within the migratory pathway of Baird's sparrow and there is at least some potential for the species to occur within the Updated Corona Gen-Tie System Corridor area during migration.

4.8.2.4.1 Bald Eagle

Bald eagles are state listed as threatened and protected under the Bald and Golden Eagle Protection Act (BGEPA). Bald eagles are known to occur in New Mexico year-round, with larger densities during both spring and fall migration, and during the winter (eBird, 2019). Bald eagles are uncommon breeders in New Mexico, with no more than nine known breeding sites documented in New Mexico since the 1980s (NMDGF, 2012). In New Mexico, bald eagle nests are placed in large cottonwoods or ponderosa pines, typically in the vicinity of water and often also in close proximity to concentrations of small mammals such as prairie dogs (NMDGF, 2012), none of which exist in the Updated Corona Gen-Tie System Corridor. The nearest bald eagle observation was over 50-miles northwest of the Corona Wind Projects in October 2018 (eBird, 2019). Bald eagles are also regularly seen along the Rio Grande River, which is approximately 60 miles east of the area where the Corona Wind Projects will be developed (eBird 2019; WEST, 2017b). Additionally, no prairie dog towns or other areas that might provide foraging opportunities occur in the immediate vicinity of the Corona Wind Projects (WEST, 2017b). Potential bald

eagle occurrence within the Corona Wind Update and Updated Corona Gen-Tie System Corridor would be infrequent, due to the lack of large trees for perching and lack of optimal foraging habitat. However, bald eagles may occur occasionally as migrants or transient wintering birds, and grasslands and ponds in the Updated Corona Gen-Tie System Corridor and Corona Wind Update may attract foraging bald eagles.

4.8.2.4.2 Raptors

Based on raptor distribution maps, 15 species of diurnal raptors, 9 owl species, and 1 vulture species may occur within or near the Updated Corona Gen-Tie System Corridor and Corona Wind Update. The Updated Corona Gen-Tie System Corridor contains limited breeding habitat for most raptors because it lacks much mature forested area, which is preferred breeding habitat for many tree-nesting raptor species. Tree-nesting species would resort to nesting in man-made structures in open herbaceous areas that encompass the Updated Corona Gen-Tie System Corridor. Additionally, there are few topographic features such as ridges and large bodies of water present that would attract migrating raptors. The Updated Corona Gen-Tie System Corridor contains foraging habitat for many grassland- and wetland-associated species. Raptors could use open fields and small bodies of water where prey are present for hunting in the Updated Corona Gen-Tie System Corridor.

Two state-listed threatened species, the bald eagle and peregrine falcon, have potential to occur in the Updated Corona Gen-Tie System Corridor. As discussed in Section 4.8.4.2.1 above, bald eagle habitat is lacking, but bald eagles may occur occasionally as migrants or transient wintering birds. The peregrine falcon is one of the largest falcons in North America. Peregrine falcons are associated with habitats from sea level to 13,000 ft (4,000 meters [m]), including plains, grasslands, shrublands, forests, and deserts (WEST, 2017a). Peregrine falcons show little preference for specific ecological communities, but their hunting behavior makes them most adapted to open or partially wooded habitats (WEST, 2017a). In New Mexico, the species may nest in cliffs and hunt in a variety of woodland, grassland, and shrub/scrub habitats. The Clines Corners Gen-Tie System Corridor and Wind Farm, north of the Corona Wind Projects, appears to contain suitable foraging habitat and cliffs within the surrounding area provide potential nesting habitat. There is potential for peregrine falcons to occur within the Clines Corners Gen-Tie System Corridor and Wind Farm any time of year.

4.8.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

The NM CHAT is a habitat classification system for crucial habitat using a relative, six-level prioritization scheme, where 1 represents areas most crucial and 6 represents areas least crucial. The NM CHAT identified one of the overall areas of development (Corona Wind Update) as Rank 1 for Wildlife

Corridors for the cougar, which are defined as areas that link core habitats for sustaining populations across landscapes (NM CHAT, 2019). These crucial habitat areas are located to the west and southwest of the Corona Wind Update; no crucial cougar wildlife corridors fall within the Corona Wind Update. Approximately 92 percent of the overall area was either Rank 3 or Rank 4, which is defined as areas that may provide high-priority wildlife corridors, mid-level priority wetland/riparian habitat, or mid-level habitat for species of concern.

4.8.3.1 Federally Listed Species

The Corona Wind Update includes six animals and one plant species that are either federally listed or candidate species (four birds, two mammals, and one plant) from those noted in this section. The Corona Wind Update includes the yellow-billed cuckoo, Mexican spotted owl, southwestern willow flycatcher (*Empidonax traillii extimus*), northern aplomado falcon (*Falco femoralis septentrionalis*), New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), Peñasco least chipmunk (*Tamias minimus atristriatus*), and Kuenzler hedgehog cactus (*Echinocereus fendleri var. kuenzleri*) based on the IPaC report (USFWS, 2019c). There is a possibility for the Mexican spotted owl, northern aplomado falcon and Kuenzler hedgehog cactus to occur within the Corona Wind Update; the yellow-billed cuckoo, southwestern willow flycatcher, New Mexico meadow jumping mouse, and Peñasco least chipmunk are considered unlikely to be present due to the lack of suitable habitat (Table 4-9).

Table 4-9: Federally Listed Species in the Corona Wind Update

Common Name	Scientific Name	Federal Status*	Likelihood of Occurrence
Birds			
yellow-billed cuckoo (western population)	*Coccyzus americanus*	T	**Not likely.** Project is not likely to include riparian, wetlands, riverine, lacustrine, or otherwise suitable habitat. There is at least some potential for the species to migrate through the area.
Mexican spotted owl	*Strix occidentalis lucida*	T	**Possible.** Project is located with the elevational and ecological range for the owl. Designated critical habitat for the owl is approximately 30 miles from the southern end of the Project. Evergreen forest within the Project may provide suitable nesting or wintering habitat.
southwestern willow flycatcher	*Empidonax traillii extimus*	E	**Not likely.** Project is not likely to include dense riparian, riverine, lacustrine, or otherwise suitable habitat; however, this species may migrate through the region.
northern aplomado falcon	*Falco femoralis septentrionalis*	EXPN	**Possible.** This species forages in open terrain with scattered shrubs, which is likely present in portions of the Project area.
Mammals			
New Mexico meadow	*Zapus hudsonius luteus*	E	**Not likely.** Project is not likely to include dense riparian, riverine, lacustrine, or otherwise suitable habitat.

Common Name	Scientific Name	Federal Status*	Likelihood of Occurrence
jumping mouse			
Peñasco least chipmunk	*Tamias minimus atristriatus*	C	**Not likely.** The Project is not located within the known range of the subspecies.
Plants			
Kuenzler hedgehog cactus	*Echinocereus fendleri var. kuenzleri*	E	**Possible.** Updated Corona Gen-Tie System Corridor is likely to include suitable habitat.

Source: USFWS, 2019b
(a) E=Endangered, T=Threatened, C=Candidate

4.8.3.2 State-listed Species

State-listed endangered or threatened wildlife species in Lincoln County in which the Corona Wind Update is located (NMDGF, 2019) are shown in Table 4-10. These species include eight birds: broad-billed hummingbird (*Cynanthus latirostris*), brown pelican (*Pelecanus occidentalis*), southwestern willow flycatcher, bald eagle, Baird's sparrow, peregrine falcon, common black hawk (*Buteogallus anthracinus*), and gray vireo (*Vireo vicinior*). Two mammals are listed: Oscura Mountains Colorado chipmunk (*Tamis quadrivittatus oscutaensis*) and Peñasco least chipmunk (*Tamias minimus atristriatus*). One fish species is listed: White Sands pupfish (*Cyprinodon tularosa*).

Table 4-10: State Listed Wildlife Species in the Corona Wind Update

Common Name	Scientific Name	State Status[a]	Likelihood of Occurrence
Birds			
brown pelican	*Pelecanus occidentalis*	E	**Not Likely**. Species primarily inhabits marine areas and is a rare visitor to New Mexico. Project does not contain large water bodies or major rivers that may attract the species.
common black hawk	*Buteogallus anthracinus*	T	**Not Likely.** Project is not likely to contain suitable riparian woodland habitat.
bald eagle	*Haliaeetus leucocephallus*	T	**Likely.** Species likely to occur within the Project as occasional winter visitor.
peregrine falcon	*Falco peregrinus*	T	**Likely.** Peregrine likely to occur in Project as occasional year-round resident and migrant.
broad-billed hummingbird	*Cynanthus latirostris*	T	**Not Likely.** Project does not appear to contain suitable riparian woodland habitat; only a single observation known from Lincoln County.
gray vireo	*Vireo vicinior*	T	**Possible.** Species may occur in the Project as summer resident or migrant.

Common Name	Scientific Name	State Status[a]	Likelihood of Occurrence
Baird's sparrow	*Ammodramus bairdii*	T	**Possible.** Species may occur in the Project during migration; Project is outside species' breeding range.
southwestern willow flycatcher	*Empidonax traillii extimus*	E	**Not Likely.** Project does not appear to contain suitable riparian breeding habitat; some potential for species to migrate through Project.
Mammals			
Oscura Mountains Colorado chipmunk	*Tamis quadrivittatus oscutaensis*	T	**Not Likely.** Project is outside of known range for this species (Oscura Mountains)
Peñasco least chipmunk	*Tamias minimus atristriatus*	E	**Not Likely.** Project is outside the known range of this species (Sacramento Mountains)
Fish			
White Sands pupfish	*Cyprinodon tularosa*	T	**Not Likely.** Project is outside of species' known range.

Source: NMDGF, 2019
(a) E=Endangered, T=Threatened

4.8.3.3 Bats

As indicated in Section 4.8.2.3 above, potentially 31 bat species in New Mexico have ranges in the vicinity of and overlapping the Updated Corona Gen-Tie System Corridor and Corona Wind Update (Western Bat Working Group, 2017). BCI states that at least 24 species of bats have been reported as killed by wind turbines, however, they do not provide a species-specific list (2019). BCI does specifically identify the hoary bat, eastern red bat, and silver bat, and all migratory tree dwelling bats as accounting for nearly 78 percent of fatalities north of Mexico. None of those species are federally protected.

4.8.3.4 Birds

Similar to the Updated Corona Gen-Tie System Corridor, passerines, raptors, waterfowl, and waterbirds likely migrate through the Corona Wind Update. When full, the complex of small ponds throughout the Corona Wind Update may attract migrating waterfowl, waterbirds, and raptors (PLJV, 2019). Harvested crops are rare in the Corona Wind Update. Breeding Bird Survey routes near the Corona Wind Projects are shown on Exhibit 10.

4.8.3.4.1 Bald Eagle

Similar to the Updated Corona Gen-Tie System Corridor, documented bald eagle nests are typically in areas with major rivers supporting high fish populations and with mature trees (NMDGF, 2012), none of

which exist in the Corona Wind Update. The nearest bald eagle observation was over 50-miles northwest of the Corona Wind Projects in October 2018 (eBird, 2019). Potential bald eagle occurrence within the Corona Wind Update and Updated Corona Gen-Tie System Corridor would be infrequent, due to the lack of large trees for perching and lack of optimal foraging habitat. However, bald eagles may occur occasionally as migrants or transient wintering birds, and grasslands and ponds in the Corona Wind Update and Updated Corona Gen-Tie System Corridor may attract foraging bald eagles.

4.8.3.4.2 Raptors

Based on raptor distribution maps, 15 species of diurnal raptors, 9 owl species, and 1 vulture species may occur within or near the Corona Wind Update and Updated Corona Gen-Tie System Corridor. Of these 25 species, 17 have the potential to breed in the Corona Wind Project Area, based on potential breeding habitat and reports of their presence in the area during the breeding season (eBird, 2019). Two state-listed raptor species potentially occur in or near the Corona Wind Update: the bald eagle and peregrine falcon (NMDGF, 2012). All raptor species are protected under the Migratory Bird Treaty Act (MBTA) (1918), and both bald and golden eagles are protected under the BGEPA (1940).

The Corona Wind Update contains limited breeding habitat for most raptors. The Corona Wind Update lacks much mature forested area, which is preferred breeding habitat for many tree-nesting raptor species. Breeding by tree-nesting species in the open herbaceous areas typically would be limited to manmade structures, such as power poles, livestock windmills, barns, and other infrastructure, or isolated trees associated with these structures. The Corona Wind Update and Updated Corona Gen-Tie System Corridor contain foraging habitat for many grassland- and wetland-associated species. While no large reservoirs or lakes occur in the Corona Wind Update, there are many small ponds that, when full, potentially attract concentrations of waterfowl, shorebirds, waterbirds, and raptors utilizing open fields for hunting (e.g., American kestrel [*Falco sparverius*], rough-legged hawk [*Buteo lagopus*], red-tailed hawk [*Buteo jamaicensis*], and northern harrier [*Circus hudsonius*]) (WEST, 2017a). The Corona Wind Update does include a small percentage of forest habitat which could support numbers of *Accipiters* (e.g., Cooper's hawk [*Accipiter cooperii*], sharpshinned hawk [*Accipiter striatus*], buteos (e.g., red-tailed hawk, rough-legged hawk), or owls (e.g., long-eared owl [*Asio otus*], great horned owl [*Bubo virginianus*]). Few topographic features (e.g., prominent ridges, large bodies of water) occur in the Corona Wind Update that would regularly attract high concentrations of migrating raptors.

4.9 Cultural Historic and Archaeological Resources

4.9.1 Prehistoric Cultural

4.9.1.1 Data Sources

The following data sources were reviewed to assess the prehistoric cultural, historic, and archeological resources of Lincoln and Torrance Counties; the Corona Wind Update; and the Updated Corona Gen-Tie System Corridor.

- New Mexico Cultural Resource Information System ([NMCRIS], 2019). Accessed September 2019 from: https://nmcris.dca.state.nm.us.
- Bureau of Land Management (BLM) General Land Office (GLO) plats (BLM, 2019). Accessed September 2019 from: https://glorecords.blm.gov/.
- Anderson, O.J., Jones, G.E., and Green, G.N. (1997). *Geological map of New Mexico: USGS Open-file Report 97-52*. Accessed September 2019 from: http://pubs.er.usgs.gov/publications/ofr9752.

4.9.1.2 Current Conditions and Trends, Regional Overview - Updated Corona Gen-Tie System Corridor

In general, little archaeological work has been conducted within the Updated Corona Gen-Tie System Corridor; a total of two sites have been previously recorded. Most of the previous survey projects have been conducted for small hydrocarbon well pad areas with associated access roads and larger linear projects such as roads, pipelines, and transmission lines. The linear survey areas account for the recording of the sites that have been recorded within the Updated Corona Gen-Tie System Corridor.

There have been 8 prehistoric sites located within the Updated Corona Gen-Tie System Corridor. Only one site has been recorded along the Updated Corona Gen-Tie System. The prehistoric site is a small lithic scatter, and the eligibility to the National Register of Historic Places (NRHP) is not specified. The soil and geology studies of the Updated Corona Gen-Tie System Corridor indicate that undocumented cultural materials, both prehistoric and historic, may be located within the area, particularly around the major drainages and their tributaries.

4.9.1.3 Current Conditions and Trends, Regional Overview - Corona Wind Update

In general, little archaeological work has been conducted within the Corona Wind Update; a total of 82 prehistoric sites have been previously recorded. Most of the previous survey projects have been conducted for small hydrocarbon well pad areas with associated access roads and larger linear projects such as roads, pipelines, and transmission lines. The largest projects have been a series of block surveys in Lincoln County for vegetation clearance to increase livestock grazing areas. These block survey areas account for approximately half of the sites that have been recorded within the Corona Wind Update.

Most prehistoric sites that have been recorded are associated with Jornada-Mogollon culture or with the Southern Archaic culture. The soil and geology studies of the Corona Wind Update indicates that undocumented cultural materials may be located within the Corona Wind Update, particularly around the major drainages and their tributaries.

4.9.2 Historic Cultural Resources

4.9.2.1 Data Sources

- NMCRIS. (2019). Accessed September 2019 from: https://nmcris.dca.state.nm.us.
- BLM GLO plats (BLM, 2019). Accessed September 2019 from: https://glorecords.blm.gov/.
- Anderson, O.J., Jones, G.E., and Green, G.N. (1997). *Geological map of New Mexico: USGS Open-file Report 97-52*. Accessed September 2019 from: http://pubs.er.usgs.gov/publications/ofr9752.

4.9.2.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

In general, little archaeological work has been conducted within the Updated Corona Gen-Tie System Corridor. A total of 10 historic sites have been recorded within the Updated Corona Gen-Tie System Corridor, of those 10 sites, only two are located within the direct corridor of the Updated Corona Gen-Tie System. Most of the previous survey projects have been conducted for small hydrocarbon well pad areas with associated access roads and larger linear projects such as roads, pipelines, and transmission lines. The linear survey areas account for the recording of the sites that have been recorded within the Updated Corona Gen-Tie System Corridor.

Of the two historic sites that have been recorded along the Updated Corona Gen-Tie System Corridor, one site is the Atchison-Topeka Railroad Right of Way and has been recommended as being eligible for

listing on the NRHP, the second is the remains of a foundation and associated trash scatter and has been recommended not to be eligible. The soil and geology studies of the Updated Corona Gen-Tie System Corridor indicate that undocumented cultural materials, both prehistoric and historic, may be located within the area, particularly around the major drainages and their tributaries.

4.9.2.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

There have been 24 historic sites which have been recorded throughout the Corona Wind Update, these primarily consist of isolated historic trash dumps or ruins of structures associated with ranching activities. No area historic research activities have been conducted within the Corona Wind Update, and as such, none of the structures have been researched for their contributions of the historical development of the local area. The USGS maps of the area have several structures marked as "ruins" that probably are additional abandoned structures associated with ranching activities which have not been formally recorded.

Data obtained from the available GLO plats for the area indicates that the Corona Wind Update were surveyed by the USGS between 1882 and 1922. The majority of objects identified from the plats are unnamed trails and roads. Neither the GLO plats or the USGS maps identified any abandoned historic-aged towns (ghost towns) or ranches.

4.10 Religious and Cemetery Sites

4.10.1 Data Sources

The following data sources were reviewed to assess the existing religious and cemetery sites in Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- Cemeteries of Torrance County. Accessed September 2019 from: http://www.americancemeteries.org/new-mexico/torrance-county.
- Churches of Torrance County. Accessed September 2019 from: https://newmexico.hometownlocator.com/features/cultural,class,church,scfips,35057.cfm.
- NMCRIS. Accessed September 2019 from https://nmcris.dca.state.nm.us/NMCRISt/Security/SignIn.aspx.
- Cemeteries of Lincoln County. Accessed September 2019 from: http://www.americancemeteries.org/new-mexico/Lincoln-county.

- Churches of Lincoln County. Accessed September 2019 from: https://newmexico.hometownlocator.com/features/cultural,class,church,scfips,35027.cfm.
- NMCRIS. Accessed September 2019 from: https://nmcris.dca.state.nm.us/NMCRISt/Security/SignIn.aspx.

4.10.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

No churches are located near the Updated Corona Gen-Tie System Corridor. Four cemeteries are known to be within the Updated Corona Gen-Tie System Corridor. Two of the cemeteries are located to the south and southeast of Duran, and the other two are located at Piños Wells. Unidentified formal and informal cemeteries associated with active and abandoned ranches could be within the footprint of the proposed Updated Corona Gen-Tie System Corridor. Churches and cemeteries within portions of the Updated Corona Gen-Tie System Corridor within the Corona Wind Update are identified below in Section 4.10.3.

4.10.3 Current Conditions and Trends, Regional Overview –Corona Wind Update

The Corona Wind Update contains a small number of abandoned and active ranches. Most of the churches that serve the area are either in Carrizozo or Vaughn, New Mexico. However, within the vicinity of the Corona Wind Update, there are no known churches.

One formal cemetery is identified within the vicinity of the Corona Wind Update, the Corona Cemetery is located approximately 0.5 mile to the southeast of the town within the footprint of the Corona Wind Update. Additional unidentified formal and informal cemeteries associated with the active and abandoned ranches could be throughout the Corona Wind Update (Exhibit 11).

4.11 Visual and Scenic Resources

4.11.1 Data Sources

The following data sources were reviewed to assess the existing visual and scenic conditions of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update:

- EPA Ecoregions (EPA, 2019b). Accessed September 2019 from: https://www.epa.gov/eco-research/ecoregions-north-america.
- NMDOT. Accessed September 2019 from: https://www.dot.state.nm.us/content/nmdot/en/byways.html.
- Federal Highway Administration (FHWA). Accessed September 2019 from: https://www.fhwa.dot.gov/byways/.

4.11.2 Overview

The combined Updated Corona Gen-Tie System Corridor and Corona Wind Update encompasses approximately 176,021 acres (Option A) and 176,043 acres (Option B) of private, BLM, and state lands within the Southwestern Tablelands and Arizona/New Mexico Mountains Level III Ecoregion (EPA, 2019b), located within Torrance and Lincoln Counties. This combined area is bounded by the northern extent of the Sacramento Mountains to the south, including the Jicarilla, Capitan and Vera Cruz ranges, and the Gallinas Mountains to the west. East and north of the combined area, the landscape transitions to mixed Chihuahuan Desert grassland. Non-private lands in proximity to the combined area include portions of the Mountainair District of the Cibola National Forest, Smokey Bear District of the Lincoln National Forest, State Trust Lands administered by the New Mexico State Land Office (SLO), and BLM lands (Exhibit 12).

According to the EPA Ecoregions (EPA, 2019b): the Arizona/New Mexico Mountains ecoregions:

> *...are distinguished from neighboring mountainous ecoregions by their lower elevations and an associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location. Forests of spruce, fir, and Douglas-fir, common in the Southern Rockies and the Wasatch and Uinta Mountains, are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands occur at lower and middle elevations, and the higher elevations are mostly covered with open to dense ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in Arizona and New Mexico can be considered biogeographical islands.*

In addition, the U.S. Environmental Protection Agency Ecoregions (2019) put forth the following description for the Southwestern Tablelands:

> *The Southwestern Tablelands flank the High Plains with red hued canyons, mesas, badlands, and dissected river breaks. Unlike most adjacent Great Plains ecological regions, little of the Southwestern Tablelands is in cropland. Much of this region is in sub-humid grassland and semiarid range land. The potential natural vegetation is grama-buffalo grass with some mesquite-buffalo grass in the southeast, juniper-scrub oak-midgrass savanna on escarpment bluffs, and shinnery (midgrass prairie with open low and shrubs) along the Canadian River.*

4.11.3 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

Topography within the Updated Corona Gen-Tie System Corridor is variable, including relatively flat grassland, gentle slopes, small ridgelines, canyons, hills, mesas, canyons, and steep slopes. Herbaceous/grassland cover types dominate the landscape, with shrub/scrub and evergreen forest vegetation communities covering smaller areas of the 2018 Approved Projects. Land use within the Updated Corona Gen-Tie System Corridor is primarily open range livestock grazing. Elevation within the

Updated Corona Gen-Tie System Corridor ranges from 6,020 to 6,771 ft (1,835 to 2,064 m) above mean sea level (see Exhibit 13).

Lincoln and Torrance Counties both have low population densities. The population density for Lincoln County is approximately 4.2 inhabitants per square mile, with most of the population in the county's southern portion in the Greater Ruidoso Area. Torrance County is a large and rather sparsely populated county located in central New Mexico, southeast of the City of Albuquerque. Over 95 percent of the population resides in the western half of the county. Several inhabitable residences are within the Updated Corona Gen-Tie System Corridor, and other scattered rural residences and small communities are nearby. Travelers in proximity to the Updated Corona Gen-Tie System Corridor would include local or regional traffic along U.S. Highways 54 and 60, and county roads.

Existing transmission lines (100-kV or above) in the vicinity of the 2018 Approved Projects include: the Willard to Duran 115-kV line, situated along the northwest portion of the 2018 Approved Projects; the Corona to Blackwater 500-kV line, situated east of the area where the 2018 Approved Projects will be developed; and the Pinal Central (Pinal South) to SunZia East 500-kV line, situated along the southwest portion of the 2018 Approved Projects (Exhibit 14).

No designated federal or state scenic routes or byways are in the vicinity of the Updated Corona Gen-Tie System Corridor (NMDOT, 2019; FHWA, 2019) (see Exhibit 15). The nearest scenic route is Historic Route 66, which is more than 20 miles north of the Updated Corona Gen-Tie System Corridor. Salt Missions trail is approximately 28 miles to the west of the route.

Additionally, no national parks or state parks are in the vicinity of the Updated Corona Gen-Tie System Corridor. The closest national park is Salinas Pueblo Missions National Monument, which is approximately 28 miles west of the Updated Corona Gen-Tie System Corridor. The closest state parks are the Santa Rosa Lake State Park, Sumner Lake State Park, and Manzano Mountains State Park, all located more than 40 miles from the Updated Corona Gen-Tie System Corridor. Manzano Mountains State Park is the closest at 40 miles away. No known visually sensitive, cultural resource sites are in the vicinity of the Updated Corona Gen-Tie System Corridor. No known organized tourism activities are in or near the Updated Corona Gen-Tie System Corridor.

4.11.4 Current Conditions and Trends, Regional Overview – Corona Wind Update

The existing visual and scenic resources previously described for the Updated Corona Gen-Tie System Corridor are generally similar for the Corona Wind Update. Travelers in proximity to the Corona Wind

Update, would include local or regional traffic along U.S. Highway 54 and New Mexico State Road 247. The nearest scenic route is the Salt Missions Trail, which is 30 miles west of the Corona Wind Update. The closest national park is Salinas Pueblo Missions National Monument, which is approximately 35 miles west of the Corona Wind Update. The closest state park is the Valley of Fires State Park, approximately 46 miles southwest of the Corona Wind Updated. Additionally, the Santa Rosa Lake State Park, Sumner Lake State Park, and Manzano Mountains State Park are all located more than 50 miles from the Corona Wind Update. The Lincoln Station Airport is located about 15 miles southwest of the Corona Wind Update. The community of Ruidoso contains the largest population within Lincoln County and is located approximately 58 miles south of the Corona Wind Update. The community of Corona is the closest populated area, roughly 7-miles west of the Corona Wind Update. The closest school in vicinity of the Corona Wind Project Area (approximately 7 miles), is the Corona High School and Elementary School (same building).

4.12 Land Use, Including Farm, Range, and Recreational Resources

4.12.1 Data Sources

The following data sources were reviewed to assess the existing land use, including farm, range and recreational resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- 2011 NLCD.
- The National Map (USGS, 2019c).
- Lincoln County Comprehensive Plan (August 2007) (Lincoln County, 2017).
- Lincoln Soil and Water Conservation District Land Use Plan (Lincoln County, 2015).
- Torrance County Comprehensive Plan (July 2003) (Mid-Region Council of Governments, 2003).
- Torrance County Zoning Ordinance (revised 2016) (The Board of County Commissioners of Torrance County, 2016).
- East Torrance Soil and Water Conservation District Long Range Plan (2009 - 2019) (East Torrance Soil and Water Conservation District, 2009).
- John C. Tysseling PhD, *The Economic and Fiscal Impact of the Corona Wind Project in New Mexico* (2017).

4.12.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

4.12.2.1 Torrance County

Torrance County is a large and rather sparsely-populated county located in central New Mexico, southeast of the City of Albuquerque. Over 95 percent of the population resides in the western half of the county. Farming and ranching have been the traditional economic activities of the county, but are diminishing as the population grows in the Estancia Valley. Today, there are growing sectors of non-agricultural commerce and business. Most of the agricultural products that are produced in the area where the Corona Wind Projects will be developed come from Torrance County, but given the rural character of the three counties encompassing the Corona Wind Projects, agricultural businesses still play a large role in all three counties. Much of Torrance County is situated within the, "commuter shed," of the Albuquerque metropolitan region and is therefore growing in scattered residential subdivisions and housing developments.

Various jurisdictions and special territories within the Torrance County boundaries include five incorporated municipalities, significant lands held in state and federal ownership, and a small area within the Isleta Indian Reservation. Also, there are all or portions of four Mexican Land Grants in the county. The principal transportation structure in Torrance County is comprised of roads and highways. The county is traversed by an interstate (I) highway (I-40) and several state and federal highways forming the base road network for the county. Relatively good east-west and north-south corridors are in the county, although they are widely spaced.

The community of Moriarty contains the largest population within Torrance County and is located approximately 24 miles northwest of the Updated Corona Gen-Tie System Corridor. The community of Duran is the closest populated area, roughly 2 miles from the Updated Corona Gen-Tie System and 1.5 miles from the 1-mile corridor of the Updated Corona Gen-Tie System Corridor. Several other small towns are scattered throughout the county. Major state and federal properties in the county include Manzano Mountains State Park, Gallinas National Forest, Cibola National Forest, and scattered BLM parcels (Exhibits 16, 17, 18, and 19). No military bases are located in the county. Large-scale irrigated agriculture has become a major feature in the central portion of the Estancia Valley. Although these agricultural croplands rely solely on groundwater pumping, there is a reluctance to eliminate such land uses. Lastly, the expansive, but semi-arid rangelands throughout the county have attracted a ranching livelihood for a small but dispersed segment of the population.

The Torrance County Comprehensive Plan (July 2003) governs all land use planning in the county and provides the rationale and guidance for specific land use regulations and projects developed by the local government (Mid-Region Council of Governments, 2003). It establishes a basis for regulations and programs necessary to manage current and future land development within the jurisdiction of Torrance County. The Torrance County Comprehensive Plan promotes consistency and continuity in making decisions to carry out the programs, projects, and operations of Torrance County. The county presently administers the comprehensive land use management program supported by regulatory ordinances and enforcement powers. Actual implementation of the Torrance County Comprehensive Plan is subject to the policy directives and actions of the Board of County Commissioners as deemed appropriate.

In accordance with the Torrance County Comprehensive Plan, the Torrance County Zoning Ordinance (revised 2016), establishes comprehensive zoning regulations for the unincorporated areas of Torrance County (The Board of County Commissioners of Torrance County, 2016). It is designed to promote health and the general welfare of the county; secure safety from fire, flood, and other dangers; protect local water resources; facilitate adequate provisions for transportation, solid waste management, water and wastewater systems, schools, parks, and other community requirements; conserve the value of property; and provide for the compatible development of land and other natural resources in the county.

The East Torrance Soil and Water Conservation District Long Range Plan (2009-2019) promotes stewardship of natural resources by providing leadership, education, technical, and financial assistance to the residents of the District (East Torrance Soil and Water Conservation District, 2009).

The Estancia Elementary/Middle/High School serves approximately 890 students and covers grades pre-kindergarten through 12th grade. This school is the closest school to the Updated Corona Gen-Tie System Corridor boundary within Torrance County, located approximately 22 miles away. The closest school, however, is the Corona Elementary/High School (located in Lincoln County) which is located about 10 miles southwest of the Updated Corona Gen-Tie System Corridor boundary.

Torrance County has natural and scenic resources. The "Laguna de Perro," and surrounding salt lakes are historically and culturally valuable to Torrance County.

4.12.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

The existing conditions previously identified for the Updated Corona Gen-Tie System Corridor for land use also apply for the Corona Wind Update. However, the Corona Elementary/High School is located 7 miles north of the Corona Wind Update; the Vaughn Elementary/High School is located approximately 27

miles northeast of the Corona Wind Update; and the Estancia Elementary/Middle/High School is located approximately 50 miles northwest of the Corona Wind Update.

4.13 Socioeconomics

4.13.1 Data Sources

The following data source was reviewed to assess the existing socioeconomic conditions of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- John C. Tysseling PhD, *The Economic and Fiscal Impact of the Corona Wind Project in New Mexico* (2017).

4.13.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The area where the Corona Wind Projects will be developed is a largely a rural region of central New Mexico, dominated by high-desert range lands and forested mountain landforms on the western margins of the area. The largely rural area has significant access to major urban economic and cultural centers, with relatively close access to recreation and resort facilities in the Ruidoso and related mountain communities to the south and west, regional trade centers in Roswell and Alamogordo to the south, and the state's largest metropolitan area comprising the Albuquerque and middle Rio Grande suburban communities approximately a 2-hour drive from the Updated Corona Gen-Tie System Corridor. These larger population centers, combined with the traditional ranching communities found within the area where the Corona Wind Projects will be developed, provide wide ranging economic and cultural resources, which will support Project activities.

Lincoln County has the largest population and the largest geographic area. Torrance County, however, has the greatest population density of the two counties. An overview of the area's population demographics is shown in Table 4-11.

Table 4-11: Study Area Counties

County	Population	Geographic Area (Square Miles)	Population Density (people/square mile)
Torrance	15,302	3,346	4.6
Lincoln	16,622	4,832	3.4
Study Area Total	**31,924**	**8,178**	**4 (Avg.)**

Source: Tysseling, 2017

Lincoln County has several large communities — the county seat, Carrizozo (population 938); Capitan (population 1,388); and the county's commercial center, Ruidoso (population 7,770). Torrance County has its primary population centers along the I-40 corridor, with the county seat in Estancia (population 1,584) and Moriarty (population 1,786). Importantly, these 2016 population estimates also demonstrate a population decline, in the area where the Corona Wind Projects will occur, of nearly 6.2 percent per annum since 2010. The area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed, as a whole, comprises 1.74 percent of New Mexico's population.

The area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed has a total non-farm labor force reported in 2016 of 15,592, and employment of 14,494 (approximately 1.66 percent of statewide employment). The unemployment rate in the area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed is 7.0 percent, which is somewhat higher than the unemployment rate in the state (6.2 percent) in 2016.

2016 total wages and salaries for covered employment (non-farm) in the area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed was an estimated average annual compensation of $29,618 per employee. The New Mexico statewide average compensation is $42,599 per year, revealing that reported wages and salaries in the area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed are approximately 70 percent of the state average. Additionally, the estimated per capita income of $20,292 for the area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed compares with $24,012 for the state of New Mexico. The higher proportion of the area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed per capita income (in relationship to New Mexico as a whole, and as compared to the compensation data previously discussed) is likely reflecting the role of investment and retirement income in the somewhat older profile of the population for the area where the 2018 Approved Projects and Updated Corona Wind Projects will occur.

The largely rural, sparsely populated area where the 2018 Approved Projects and Updated Corona Wind Projects will occur has dominant land use which is focused on agricultural business enterprises (particularly ranching), but the dominant economic activities (measured by reported employment and output) are related to retail trade, hospitality, and health care.

Private firms comprise about 83 percent of the business entities in the area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed. However, this data excludes agricultural employment, which is recognized to be a significant component of the rural economy in the

area where the 2018 Approved Projects and Updated Corona Wind Projects would be developed. Due to the population and predominantly rural nature of the counties' land area, most of the establishments in the area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed are quite small, with a limited number of employees.

Excluding the agricultural sectors, the statistics suggest that the area economy, where the 2018 Approved Projects and Updated Corona Wind Projects will occur, is largely driven by retail; accommodations and food services; healthcare and social assistance; and public administration. These four sectors alone comprise around two-thirds of total annual employment by industry for the area where the 2018 Approved Projects and Updated Corona Wind Projects will occur.

Table 4-12 presents an agricultural profile for the area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed; the table does not include forestry data, as this data was not included in the 2007 and 2012 censuses.

Table 4-12: 2012 and 2007 New Mexico Project Area Farm Demographics

2012 and 2007 Farm Demographics					
Number of Farms	**2012**	**2007**	**Average Farm Size (acres)**	**2012**	**2007**
	1,323	1,180		3,826	4,195
2012 Market Value of Agricultural Products Sold ($ millions)					
Crops		**Livestock and Poultry**		**Total**	
$24.26		$68.84		$93.10	
26.1%		73.9%			
2012 Values of Sales by Commodity Group ($ millions)					
Grains, Dry Beans and Peas	**Corn**	**Other Crops**	**Cattle and Calves**	**Other Livestock and Poultry**	
$9.99	$9.44	$4.81	$56.47	$12.37	

Source: Tysseling, 2017

The role of agriculture in the area economy, where the 2018 Approved Projects and Updated Corona Wind Projects will be developed, is best reflected in comparing the reported $93.1 million agricultural production to the $972.8 million of reported Taxable Gross Receipts. Agriculture is an important foundation of the area economy, where the 2018 Approved Projects and Updated Corona Wind Projects will be developed, but that the previously identified non-agricultural sectors provide for the dominant employment and income in the regional economy.

The area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed, had over $72.6 million in Gross Receipts Tax (GRT) collections, providing 1.83 percent of the total GRT collections in the state of New Mexico. The economic sector reporting the highest levels of GRT, in the area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed, is the Retail Trade sector, with revenues from the sales in this sector constituting 24 percent of the GRT collections. This is followed by the Construction sector, which boasts 20 percent of the total GRT. Construction is 20 percent of the GRTs, and only 7 percent of the employment, in the area where the 2018 Approved Projects and Updated Corona Wind Projects will be developed, highlights the ready supply of construction firms and workers from the larger population centers surrounding the Updated Corona Gen-Tie System Corridor and Corona Wind Update.

4.13.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

The existing socioeconomics and economy previously described for the Updated Corona Gen-Tie System Corridor are similar for the Corona Wind Update.

4.14 Communication Signals

4.14.1 Data Sources

The following data sources were reviewed to assess the existing communication signals of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- Federal Communications Commission (FCC) info (FCC, 2019); based on publicly available data from the FCC. Accessed on September 2019 from: http://www.fccinfo.com/disclaimerphp.

4.14.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

Lincoln and Torrance Counties are rural counties in central New Mexico with population densities below the state and national averages. A review of coordinates at the north, south, east, and west points of the Updated Corona Gen-Tie System Corridor, with an expanded search to 35 miles from the edge of the Updated Corona Gen-Tie System Corridor endpoints boundary, indicates that 500 microwave towers, 114 antenna structure registration towers, 434 land mobile (LM) towers, 34 cell towers, 4 paging towers, and 1 AM/FM/TV towers are present (Exhibit 20).

4.14.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

Communication signal conditions within the Corona Wind Update are similar to what is described above for the Updated Corona Gen-Tie System Corridor.

4.15 Radioactive Waste and Radiation Hazards

Electric transmission line and substation infrastructure do not generate or contain radioactive waste or radiation hazards. The Updated Corona Gen-Tie System and Corona Wind Update would not generate radioactive waste or radiation hazards and, therefore, they are not addressed further in this ER.

4.16 Hazardous Materials

Prior to construction, a Phase I Environmental Site Assessment will be performed to identify any hazardous materials, substances, or facilities in the Updated Corona Gen-Tie System Corridor. Chapter 5, Section 5.16 describes potential hazardous materials associated with construction, operation, and maintenance of a transmission line, substation, and switchyard as well as protection measures to reduce impacts from hazardous materials.

4.17 Safety

The Updated Corona Gen-Tie System Corridor does not contain any known safety concerns. Chapter 5, Section 5.17 describes potential safety concerns associated with construction, operation, and maintenance of a transmission line, substation, and switchyard as well as protection measures to reduce safety impacts.

4.18 Geographic Resources

4.18.1 Data Sources

The following data sources were reviewed to assess the existing geographic resources of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- National Park Service (NPS) Physiographic Provinces (NPS, 2019).
- 2011 NLCD (NLCD, 2017).
- The National Map (USGS, 2019c).

4.18.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

The area where the Corona Wind Projects will be developed is located within the Great Plains physiographic province (NPS, 2019). The Great Plains extend from Texas north to Montana and are

bordered to the west by the Rocky Mountains and to the east by the Central Lowlands. The Great Plains slope downward to the east, with maximum heights in the foothills of the Rockies at 5,500 ft, decreasing to 2,000 ft. The bedrock is horizontal beds of sandstones, shales, limestones, conglomerates, and lignite. Coal, petroleum, and natural gas are all mined extensively throughout the Great Plains. National Parks and Monuments of the Great Plains in New Mexico include Carlsbad Caverns National Park, Fort Union National Monument, and Capulin Volcano National Monument. None of these items are within or near the Updated Corona Gen-Tie System Corridor or the Corona Wind Update.

No national parks or state parks are in the vicinity of the Updated Corona Gen-Tie System Corridor. The closest national park is Salinas Pueblo Missions National Monument, which is approximately 28 miles west of the Updated Corona Gen-Tie System Corridor. The closest state parks are the Santa Rosa Lake State Park, Sumner Lake State Park, and Manzano Mountains State Park, all located more than 40 miles from the Updated Corona Gen-Tie System Corridor.

4.18.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

No additional geographic resources are within the Corona Wind Update; however, 24 historic sites have been recorded throughout the Corona Wind Update, which primarily consist of isolated historic trash dumps or ruins of structures associated with ranching activities.

4.19 Military Activities and Aviation

4.19.1 Data Sources

The following data sources were reviewed to assess the existing military and aviation conditions of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- Digital Aviation LLC. (2019). *VFR Map*. Accessed September 2019 from: http://vfrmap.com/tos.html.
- New Mexico Military Bases Map (Military Bases, 2019). Accessed September 2019 from: https://militarybases.com/new-mexico/.

4.19.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

No military bases occur within the Updated Corona Gen-Tie System Corridor; three military training routes intersect the Updated Corona Gen-Tie System Corridor (Exhibit 21). Pattern Development would

request Determination of No Hazard (DNH) from the FAA for any transmission line structures over 200 ft (transmission line structures of this height are very unlikely for the Corona Wind Projects).

4.19.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

No military bases occur within the Corona Wind Update. Exhibit 21 identifies military training routes that intersect the Updated Corona Gen-Tie System Corridor and Corona Wind Update, occurring within the northeast portion of development. Pattern Development would request DNH from the FAA for any transmission line structures over 200 ft (transmission line structures of this height are very unlikely for the Corona Wind Projects).

4.20 Roads

4.20.1 Data Sources

The following data sources were reviewed to assess the road conditions of Lincoln and Torrance Counties; the Updated Corona Gen-Tie System Corridor; and the Corona Wind Update.

- NMDOT. (20012). Transportation Maps. Accessed September 2019 from: https://www.dot.state.nm.us/content/nmdot/en/Maps.html#m_par_text.

4.20.2 Current Conditions and Trends, Regional Overview – Updated Corona Gen-Tie System Corridor

Torrance County is a rural county in central New Mexico with a sparse network of U.S. Highways, county, and private roads within the area where the Updated Corona Gen-Tie System will be developed. Pattern Development will work with NMDOT and the Torrance County Road Maintenance Departments to determine current road conditions for construction access prior to the start of any construction. U.S. Highways 60, 54, and several east-west and north-south segments of county roads traverse the Updated Corona Gen-Tie System Corridor.

4.20.3 Current Conditions and Trends, Regional Overview – Corona Wind Update

Lincoln County is a rural county in central New Mexico with a sparse network of U.S. Highway, state, county, and private roads surrounding the area where the Corona Wind Update will be developed. Pattern Development will work with NMDOT and the Lincoln County Road Maintenance Departments to

determine current road conditions for construction access prior to the start of any construction. No state highways or county roads traverse the Corona Wind Update.

5.0 ENVIRONMENTAL EFFECTS

5.1 Introduction

This chapter addresses whether the proposed Updated Corona Gen-Tie System Corridor and Updated Transmission Line Facilities would "unduly impair important environmental values," as provided in NMSA 1978, Section 62-9-3F. Potential consequences, or impacts, on the environment that could result from the location of the proposed Updated Transmission Line Facilities are described, including construction, operation, and maintenance activities. Each of the resource areas provided in NMSA 1978 Section 62-9-3M, Commission Rule 17.9.592.10 NMAC are addressed, as well as additional resource areas identified by Staff. These resources are: air resources; noise; geology and mineral resources; soil resources; paleontological resources; water resources; flora and fauna resources; cultural and historic archaeological resources; religious and cemetery sites; socioeconomics and environmental justice; communication signals; radioactive waste and radiation hazards; hazardous materials; safety; geographic resources; military activities and aviation; and roads. Impact evaluations for each resource are discussed below in the context of the Extended Corona Gen-Tie System Corridor and the Reconfigured Corona Gen-Tie System Corridor within the Updated Corona Gen-Tie System Corridor together with BMPs that can help manage impacts.

Implementation of the proposed Updated Transmission Line Facilities could affect the existing condition of the environment. Effects can occur directly or indirectly within the Updated Corona Gen-Tie System Corridor. Direct effects are those that occur through direct or immediate interaction of the proposed Updated Transmission Line Facilities with environmental components. Indirect effects are those that are somewhat distant from the Updated Transmission Line Facilities in time, space, or both.

Short-term impacts are considered those impacts that occur during construction and are generally anticipated to return to a preconstruction condition, at or within 3 to 5 years following construction. Environmental effects that would be anticipated to remain for the life of the Updated Corona Gen-Tie System (approximately 30 years) were considered long-term impacts. Permanent impacts are those that would be anticipated to remain for the life of the Updated Corona Gen-Tie System and beyond.

For each resource area review below, this report: describes the potential ground disturbance and environmental effects that may occur due to the Updated Transmission Line Facilities; identifies the protection measures the Corona Wind Companies proposes to avoid and minimize impacts; and summarizes the potential for the Updated Transmission Line Facilities to result in undue impairment of important environmental values.

5.2 Air Resources

5.2.1 Impact Assessment Methods

Assessment of impacts to air resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally short term and temporary in nature for air resources.

5.2.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

5.2.2.1 Construction

The large equipment used during construction would likely be powered with diesel or gasoline. These combustibles include pollutants such as nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), PM, small amounts of sulfur dioxide (SO_2), and trace amounts of hazardous air pollutants. Construction contractors and their equipment would be required to comply with all emissions standards. If an onsite concrete (a batch plant) is required for transmission line facility construction, the proper state and county location and air quality permitting would be obtained by Pattern Development prior to construction. Therefore, air quality impacts associated with construction of the Updated Transmission Line Facilities would primarily be limited to fugitive dust.

Fugitive dust arises from land clearing, grading, excavation, and vehicle traffic on unpaved roads. The amount of fugitive dust depends on the amount of vehicular traffic, construction activities, moisture content of the soil, and wind speed. During dry periods with high winds, fugitive dust would be much more prevalent than during wet periods with low winds. Dust suppression methods such as watering are planned to be used in construction zones during dry periods to minimize fugitive dust impacts.

As the fugitive dust emissions and emissions from combustion engines would be temporary (limited to the construction period), limited to the construction area, and transient and likely controlled with watering, these sources would not significantly contribute to reduced air quality levels in the Updated Corona Gen-Tie System Corridor.

5.2.2.2 Operations and Maintenance

During operation of the Updated Transmission Line Facilities, the primary emissions are expected to be fugitive dust from worker and maintenance vehicles traveling intermittently on unpaved roads. In addition, there would be emissions from the vehicles themselves. Such emissions are not anticipated to be

substantial, and, therefore, only minimal impacts to air quality are anticipated during the operation of the Updated Transmission Line Facilities.

5.2.3 Protection Measures

Protection measures would be implemented to reduce potential impacts to air quality from construction activities. Emissions are only anticipated to arise from ground disturbing activities, equipment movement, fuel combustion, and a concrete batch plant, if required. These emissions would be temporary and localized. Protection measures to address construction-related impacts to air quality resources would include:

Air-1: Maintaining all fossil fuel-fired construction equipment in accordance with manufacturers' recommendations to minimize construction-related combustion emissions.

Air-2: Controlling combustion emissions through engine manufacturing requirements for both mobile sources and portable equipment such as air compressors.

Air-3: Limiting the idling time of equipment, unless idling must be maintained for proper operation (e.g., drilling, hoisting, and trenching).

Air-4: Limit the speed of vehicles within construction sites and along the utility ROW during construction to reduce the amount of fugitive dust generated.

Air-5: Water trucks will be utilized as necessary to reduce fugitive dust from construction activities.

5.2.4 Conclusion

Considering the limited and transient nature of emissions resulting from construction, operation, and maintenance of the Updated Transmission Line Facilities, as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair air resources.

5.3 Noise

5.3.1 Impact Assessment Methods

Assessment of impacts to noise conditions from the Supplemental Transmission Line Facilities construction, operation and maintenance within the Updated Corona Gen-Tie System Corridor of consideration follows the impact assessment methodology described in Section 5.1 above and is discussed

below. Construction, operations, and maintenance impacts are generally low, short term, and temporary in nature for noise.

5.3.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

The existing noise levels in the Updated Corona Gen-Tie System Corridor within rural parts of Torrance County is relatively low. The primary existing sources of noise in the Updated Corona Gen-Tie System Corridor are traffic along U.S. highways, local county roads, and some agricultural machinery. Localized noise associated with equipment operation during construction and maintenance activities would increase local noise levels in the Updated Corona Gen-Tie System Corridor. Noise impacts from construction of Updated Transmission Line Facilities would be localized, short term, and temporary, and all applicable state and local noise regulations would be complied with. After construction, operating noise from the Updated Transmission Line Facilities would be greatly reduced and cause negligible impacts.

5.3.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative noise impacts from construction activities include:

Noise-1: Restrict construction activity near residences to normal business hours.

Noise-2: Audible noise due to wind energy facility operations shall not exceed fifty (50) A-weighted decibels (dBA) for any period of time, when measured at any occupied residence, school, hospital, church or public library existing on the date of approval of the wind energy facility.

5.3.4 Conclusion

Based on localized, low, short term impacts, compliance with regulated noise limits during operation, negligible impacts during operation, as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair noise.

5.4 Geology and Mineral Resources

5.4.1 Impact Assessment Methods

Assessment of impacts to geological and paleontological resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below.

5.4.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

There are no identified operational hydrocarbon facilities or unique geological features located within the Updated Corona Gen-Tie System Corridor, and impacts from the construction, operation, and maintenance of the Updated Transmission Line Facilities are not anticipated. There are no known faults or landslide areas in the Updated Corona Gen-Tie System Corridor, and, therefore, impacts from the construction, operation, and maintenance of the Updated Transmission Line Facilities are not anticipated.

5.4.3 Protection Measures

No protection measures are needed for geology resources. This is due to the lack of unique geological features, faults, or landslide areas in the Updated Corona Gen-Tie System Corridor.

5.4.4 Conclusion

Due to no unique geological features, faults, or landslides; the types of bedrock in the area; and the proposed activities for the Updated Transmission Line Facilities, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair geological sites.

5.5 Soil Resources

5.5.1 Impact Assessment Methods

Assessment of impacts to soil resources from the Updated Transmission Line Facilities from construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally low, short term, and temporary in nature for soil resources. A small amount of soil would be lost due to the permanent footprint of the Updated Transmission Line Facilities and is discussed below in Section 5.5.2.3.

5.5.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Construction activities affecting soils include permanent and temporary land-disturbance activities such as structure work areas, wire-pulling, tensioning and splicing sites, construction yards, and temporary and permanent roads.

5.5.2.1 Temporary Erosion

Ground disturbance during construction may increase the potential for erosion. For example, removal of protective vegetation may expose soil to potential wind and water erosion. Certain soils within the Updated Corona Gen-Tie System Corridor would be more sensitive to soil erosion impacts. The primary soil erosion factor is water erosion and wind erosion on bare soils.

Potential erosional effects from the Updated Corona Gen-Tie System operations would consist of soil disturbances necessary to maintain the Updated Transmission Line Facilities in working order and conduct necessary repairs. Potential stormwater BMPs, including erosion and sediment control structures, as well as new culverts, might require inspection, maintenance, and/or repair throughout the operational life of the Updated Transmission Line Facilities to reduce soil erosion or sedimentation to surface water. Temporary access, not retained for operations, would be seeded with a native grass mix and allowed to revegetate, thereby minimizing the surface exposed to erosive conditions.

The areas used for construction would be reclaimed as soon as possible, which may include regrading to original land contours, topsoil replacement, and revegetation. Implementation of a Stormwater Pollution Prevention Plan (SWPPP)—a stormwater management program from the EPA under National Pollutant Discharge Elimination System that would protect water and soil resources—and use of appropriate soil mitigation measures and BMPs would reduce the effects of erosion.

5.5.2.2 Accidental Spills

During construction, use of trucks, heavy equipment, and stored supplies could result in accidental discharge of fuel, lubricants, and automotive fluids. Although the potential exists, any spills would be accidental, occasional, and of limited extent and would be considered minor to negligible and temporary in duration. BMPs for construction housekeeping, spill prevention, and cleanup would be used to prevent and remediate accidental spills. Therefore, accidental spills would not result in widespread or long-term effects to soils.

5.5.2.3 Permanent Soil Loss

The area within the footprint of the Updated Transmission Line Facilities would result in minor long-term loss of acreage to other productive soil uses. The total permanent footprint of Updated Transmission Line Facilities would range from approximately 50 to 60 acres inside the Updated Corona Gen-Tie System Corridor, equaling less than one-tenth of 1 percent of the Updated Corona Gen-Tie System Corridor.

5.5.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative soil impacts from construction activities include:

Soil-1: Construction crews will reduce the amount of soil compaction by using equipment with more tires and wider tires to distribute the weight of the vehicle and tilling the severely compacted areas after construction is completed or using ground mats when the ground is wet.

Soil-2: To the extent possible, topsoil will be placed separately from sub-soils/bedrock during excavation and not comingled. Pattern Development will replace soil in reverse order, to help preserve topsoil.

Soil-3: Pattern Development will reduce erosion by applying and maintaining standard erosion and sediment control methods. These may include using certified weed-free straw wattles, bale barriers, and silt fencing, which would be placed at construction boundaries and where soil would be disturbed near a wetland or water body. Specific erosion and sediment control measures and locations will be specified in a SWPPP.

5.5.4 Conclusion

Based on BMPs to minimize and stabilize disturbed soils, BMPs to reduce accidental spills, the small amount of permanent soil loss as well as the protection detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair soil resources.

5.6 Paleontological Resources

5.6.1 Impact Assessment Methods

Assessment of impacts to paleontological resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below.

5.6.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Construction activities that may affect paleontological resources include excavation, heavy equipment usage and movement, drilling, and trenching for utilities. Grading for access roads could also directly impact paleontological resources. The geology in the area consists of Mesoproterozoic plutonic rocks, Permian deposits of the Yeso Formation, the Tertiary Ogallala Formation, and several deposits of the Quaternary Period including piedmont alluvium, aeolian deposits, and lacustrine/playa lake deposits, all unconsolidated, all of which would have a low probability for the presence of paleontological deposits. The greatest possibility of discovery of paleontological resources would be from Ogallala Formation, however these would be rare. However, any grading and excavation during site preparation and construction would have potential to impact paleontological resources that may be present within the boundaries of the Updated Corona Gen-Tie System Corridor. As previously mentioned, any discoveries which may occur during construction would be managed through a UDP.

5.6.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative impacts from construction activities include:

Paleo-1: Follow a UDP, providing protection for unknown sites.

5.6.4 Conclusion

Due to the low probability for the presence of paleontological deposits in the area and the fact that no ground disturbance activities would be completed prior to paleontological survey work being completed, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair paleontological sites.

5.7 Water Resources

5.7.1 Methods and Impact Types

Assessment of impacts to water resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally low, avoidable, short term, and temporary in nature for water resources.

5.7.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

5.7.2.1 Surface Water

The potential sources of surface water resource impacts from the Updated Transmission Line Facilities include permanent and temporary soil-disturbance activities from structure work areas, wire-pulling, tensioning and splicing sites, construction yards, and temporary and permanent roads as well as potential accidental spills of hazardous materials from these activities. Short-term impacts from soil disturbances that increase erosion (or water runoff in areas with compacted soils) would potentially result in an increase in suspended sediments within adjacent waterbodies and accidental spills of hazardous materials that could wash into and pollute surface water. Based on the short construction duration, the small ground disturbance area, and minimal amount of surface water present in the Updated Corona Gen-Tie System Corridor, low impacts to surface water are anticipated from the Updated Transmission Line Facilities.

In addition to soil-disturbance activities, impacts to surface waters may include stream crossings by Updated Transmission Line Facilities or access roads. All streams would be spanned by the transmission

line, and individual structures would be located outside the stream bank ordinary high-water mark (OHWM) to avoid potential impacts. Where available, existing road-stream crossings would be utilized for access; however, new stream crossings may be required in certain areas. These activities would be permitted through the applicable agencies. Low impacts to streams would occur from the Updated Transmission Line Facilities based on the low number of streams in the Updated Corona Gen-Tie System Corridor and the ability to avoid stream resources through aerial spanning.

Stormwater BMPs would be used during construction to reduce potential impacts from erosion, sedimentation, and turbidity in surface waters during construction. A SWPPP would be developed and implemented for the Updated Transmission Line Facilities, which would meet the construction stormwater discharge permit requirements of the New Mexico Environment Department Surface Water Quality Bureau (NMED-SWQB). The SWPPP would include a number of measures to control runoff and to reduce erosion and sedimentation at construction sites. In addition, a Spill Prevention, Containment, and Countermeasures Plan (SPCC) would be implemented to prevent pollution of surface waters from accidental spills of hazardous materials.

5.7.2.2 Floodplains

It is reasonable to assume that all watercourses that convey natural flows, whether or not mapped by FEMA as floodplains or flood hazard areas, present some level of flood hazard. Encroachment of a structure into a flood path could result in flooding of or erosion damage to the encroaching structure and diversion of flows. The Updated Transmission Line Facilities would be set back from channel banks to avoid impacts (such as channel alteration and flow modification) and, therefore, impacts to floodplains would be low.

5.7.2.3 Groundwater

It is unlikely the Updated Transmission Line Facilities would affect groundwater to any extent. Any impacts to groundwater would be low impacts for a short duration and consist mainly of temporary sedimentation. Excavations for Updated Transmission Line Facilities may contact shallow groundwater; however, the groundwater contact would be unlikely to adversely impact this resource, unless an accidental spill of fuel or petroleum from construction equipment (which is very unlikely) occurs near an open excavation or is not cleaned up in a timely manner.

No water wells would be drilled for the Updated Transmission Line Facilities. All water used for construction (e.g., dust control or concrete production) would come from existing offsite sources, which would be identified and secured prior to construction.

5.7.2.4 Wetlands

A desktop assessment utilizing existing maps and data to identify potentially jurisdictional waters of the U.S., including wetlands that could potentially be affected by construction, was conducted to address compliance with Sections 404 and 401 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Based on the desktop assessment using NWI data, there are more than 37 wetlands that appear to be potentially jurisdictional waters of the U.S. Wetland presence based only on NWI data cannot be assumed to be an accurate assessment of potentially occurring jurisdictional wetlands and waterbodies. Wetland identification criteria differ between the USFWS and the USACE. As a result, wetlands shown on an NWI map may not be under the jurisdiction of the USACE, and all USACE jurisdictional wetlands are not always included in NWI data. A wetland delineation would be conducted to identify any wetlands or other water bodies that may be present within the Updated Corona Gen-Tie System prior to construction of the Updated Transmission Line Facilities. This information would be provided to the design team so direct impact to wetlands can be avoided.

No wetlands or water bodies are anticipated to be impacted by construction within the Updated Corona Gen-Tie System Corridor or access roads, as currently designed. All wetlands would be avoided or spanned by the transmission line to avoid direct impacts. Substations and switchyards would not be located in wetlands or playas. Work areas and wire pulling and tensioning sites would be sited to avoid wetlands to the extent practicable. Therefore, a Section 404 permit, Section 10 permit, or Section 401 water quality certification would not likely be required. However, only the U.S. Army Corps of Engineers can make final official jurisdictional determinations. If wetlands cannot be avoided, matting and other temporary protective measures would be used, and proper permits would be obtained. No permanent loss of wetlands or playas would occur from the Updated Transmission Line Facilities based on the following protection measures.

5.7.3 Protection Measures

Protection measures that would be implemented to reduce potential negative water resource impacts from construction activities include:

Water-1: Develop and implement a SWPPP. The SWPPP will include measures such as: silt barrier fences to control runoff, sediment traps and basins, and minimizing exposed soils by using temporary and permanent seeding and mulching.

Water-2: Disturbed areas will be restored to their original condition to the extent practicable. Seed mix and seeding rates will be developed through consultation with the local agency and landowner preference.

Water-3: Equipment will be properly maintained to avoid fluid leaks.

Water-4: Fuels and petroleum will be stored away from excavated areas.

Water 5: Spills will be cleaned up immediately.

Water-6: Matting and other temporary protective measures will be used on wetlands that cannot be avoided.

Water-7: Impacts will be evaluated against the requirement of the U.S. Army Corps of Engineers for a Nationwide Permit (NWP).

Water-8: Establish an appropriate buffer zone around wetlands, as necessary to reduce disturbance.

5.7.4 Conclusion

Based on the limited amount of water resources in the Updated Corona Gen-Tie System Corridor, avoidance of water resources by the Updated Transmission Line Facilities, and the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair water resources.

5.8 Flora and Fauna

5.8.1 Methods and Impact Types

Assessment of impacts to biological resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Section 5.1 above and is discussed below. Construction and maintenance impacts would be generally short-term and temporary. Operation impacts would be low for biological resources; a small amount of permanent habitat loss would occur due to the permanent footprint of transmission line structures and substation and switchyard components.

5.8.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

The Updated Corona Gen-Tie System Corridor is dominated by open grassland grazing. Plant and wildlife species adapted to shortgrass lands are present within the Updated Corona Gen-Tie System Corridor.

Increased noise and equipment movement during construction might temporarily displace wildlife species from the area in which construction is occurring. These impacts are considered low and short-term. Most wildlife movements would be expected to resume to preconstruction levels a short time after construction is completed. Potential long-term impacts include those resulting from habitat modifications and/or fragmentation. Pattern Development would work to minimize potential habitat fragmentation by paralleling the Updated Transmission Line Facilities with existing linear features (e.g., road and existing transmission lines) and avoid paralleling water features (such as streams or wetlands) when feasible. Construction activities might also impact plants and small, immobile, or fossorial (living underground) animal species through direct impact or from the alteration of local habitats. Direct impact on these species might occur due to equipment or vehicular movement on the ROW or due to the compaction of the soil if the species is fossorial. Potential impacts of this type would likely be low and isolated to an individual. Population-level impacts are not likely. Therefore, low impacts to local wildlife populations may occur due to habitat disturbance and localized potential for direct mortality to individuals during construction.

5.8.2.1 Federally and State Listed Species

One animal species that is federally listed under the ESA may potentially occur in Updated Corona Gen-Tie System Corridor (USFWS, 2019b). The Mexican spotted owl is listed as federally threatened. The other listed species (yellow-billed cuckoo) is considered unlikely to be impacted due to their specific habitat not occurring within the updated transmission line area. State-listed endangered or threatened wildlife species are identified for Torrance County in which the Updated Corona Gen-Tie System Corridor is located (NMDGF, 2019), as shown in Table 4-8 above. These species include four birds: southwestern willow flycatcher, bald eagle, Baird's sparrow, and peregrine falcon. The peregrine falcon, a state-threatened species, is likely to occur in the Updated Corona Gen-Tie System Corridor as an occasional year-round resident and migrant. The Clines Corners Gen-Tie System Corridor and Wind Farm appears to contain suitable foraging habitat and cliffs within the surrounding area provide potential nesting habitat. Potential bald eagle occurrence within the Updated Corona Gen-Tie System Corridor would be infrequent, due to the lack of large trees for perching and lack of optimal foraging habitat. However, bald eagles may occur occasionally as migrants or transient wintering birds, and grasslands and ponds in the Updated Corona Gen-Tie System and Corona Wind Update may attract foraging bald eagles.

The Updated Corona Gen-Tie System Corridor is currently dominated by grazed shortgrass prairie. Unaltered native habitats are sparse due to land use practices. If any species or suitable habitat for threatened and endangered species is identified during a field survey, Pattern Development would further coordinate with USFWS and NMDGF to determine avoidance or minimization strategies, if necessary. Impacts to federal and state protected species would be low based on low potential for species occurrence; the limited amount and quality of species habitat present, and short construction duration for the Updated Transmission Line Facilities in the Updated Corona Gen-Tie System Corridor.

5.8.2.2 Raptors, Eagles, and Birds

Raptor, eagle, and migratory bird species are known to use the Updated Corona Gen-Tie System Corridor for breeding, foraging, and migration (WEST, 2017b). If Updated Transmission Line Facilities construction occurs during bird nesting season, potential impacts could occur to migratory bird eggs and/or nestlings. Increases in noise and equipment activity levels during construction could also potentially disturb breeding or other activities of bird species nesting in adjacent areas. Pattern Development proposes to complete all clearing and construction activities to reduce potential impacts and in alignment with the MBTA. Pre-construction MBTA surveys would be completed by Pattern Development and/or construction activities would occur outside of breeding seasons for MBTA protected species. Furthermore, in accordance with the BGEPA, Pattern Development would avoid placing the Updated Transmission Line Facilities near active eagle nests. Construction activities would also be limited to a safe distance around active nests. Nests identified during preconstruction surveys and are determined active would be flagged for an established protection buffer.

The Updated Transmission Line Facilities can present additional hazards to birds due to electrocutions and/or collisions. However, no electrocution risk to perching birds would apply to the 345-kV transmission line, given the phase-to-phase and phase-to-ground clearances (Avian Power Line Interaction Committee [APLIC], 2018). Potential water resources are limited to stock ponds and intermittent drainages that may be inundated during wet seasons. A number of birds may migrate through the area, but few waterbirds or waterfowl potentially at risk of overhead line collisions would occur in the Updated Corona Gen-Tie System Corridor (APLIC, 2018). Collision risks to waterbirds or waterfowl would only apply during wet periods during the spring and fall migration as migrating birds may descend or ascend to access stopover habitats.

Pattern Development would follow Avian Power Line Interaction Committee (APLIC) guidance to implement measures to minimize collision risk with proper siting, and electrocution risk with proper transmission line engineering design. The electrocution risk to birds should not be significant since the

engineering design distance between conductors, conductor to structure, or conductor to ground wire for the proposed transmission line is greater than the wingspan of any bird potentially within the area (i.e., greater than 8 ft). While the conductors are typically thick enough to be seen and avoided by birds in flight, the shield wire (upper most wire) is thinner and can present a risk for avian collision. In areas of greater risk (e.g., near wetlands) for avian collisions, Pattern Development would install bird diverters to minimize collision risk for avian species.

5.8.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative biological resource impacts from construction activities include:

Bio-1: Properly disposing of trash and food debris in secured containers.

Bio-2: Allowing wildlife that has entered the work area to leave the area on their own.

Bio-3: Providing environmental awareness training to all construction personnel working on the Project.

Bio-4: Checking for wildlife under vehicles and equipment that have been stationary for more than 1 hour and each morning prior to moving or operation.

Bio-5: Checking trenches, excavations, and uncapped pipe segments for wildlife.

Bio-6: Complying with posted speed limits.

Bio-7: Conducting tree/vegetation clearing outside the nesting season where feasible, to discourage birds from establishing nests in Project work areas.

Bio-8: Conducting pre-construction nest surveys prior to initiating construction activities, unless vegetation clearing has been completed prior to the nesting season.

Bio-9: Establishing an appropriate buffer zone around occupied raptor nests, as necessary to minimize disturbance.

Bio-10: Design transmission line facilities to APLIC guidance or similar in order to minimize electrocution and collision risk.

Bio-11: Micrositing will be completed during engineering design to avoid sensitive biological resources.

Bio-12: Setbacks from sensitive biological resources will be implemented to protect species habitat and time critical periods (e.g., breeding season).

Bio-13: Install bird diverters near areas with increased risk for avian-collision, to minimize collision risk for avian species.

5.8.4 Conclusion

Based on the amount of disturbed habitat, landscape dominated by grazed grassland, the lack of quality species habitat, and low likelihood for federal and state protected species to occur in the Updated Corona Gen-Tie System Corridor; as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair biological resources.

5.9 Cultural, Historic, and Archaeological Resources

This section is intended to support the Application for Location Approval of Transmission Line under NMAC Title 17 Chapter 9 Part 592. The power generation portion of the project, occurring within the Updated Corona Wind Project Area, would, as a whole, avoid or minimize impacts to environmental resources. Although studies have been conducted on the Updated Corona Wind Project Area, that portion of the project previously described in the Existing Conditions section is not required by NMAC 17.9.592.10 to be analyzed within this report.

The amount of ground that could be disturbed as a result of the Updated Transmission Line Facilities was estimated based on the typical design characteristics of this 345-kV line. Short-term disturbance estimates included structure work areas for the staging and installation of the transmission line structures as well as the conductor pulling and tensioning sites. Long-term disturbance estimates included structure base areas and associated access roads. Qualitative and quantitative variables of resource sensitivity, resource quantity, and estimated ground disturbance were considered in predicting the extent and magnitude of impacts. What constitutes an impact level on a resource varies by resource as well as the assumptions for analysis for each resource. Protection measures were identified and include action that will reduce potential impacts to a resource from the Updated Transmission Line Facilities.

5.9.1 Methods and Impact Types

Assessment of impacts to cultural, historic, and archaeological resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System

Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally low, avoidable, short term, and temporary in nature for cultural, historic, and archaeological resources. Cultural resources surveys would be completed for all areas of anticipated ground disturbance for the Updated Corona Gen-Tie System Corridor prior to any ground disturbance on public as well as private property.

5.9.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Two historic archaeological resources are reported with the Updated Corona Gen-Tie System Corridor. One site is associated with the railroad and the second is a small prehistoric lithic scatter. Impacts to known locations of cultural resources would be low because the Updated Transmission Line Facilities are intended to be designed around these areas. Cultural resource field surveys would be completed prior to any construction activity to reduce potential impacts from the Updated Transmission Line Facilities to unlocated sites. Any discoveries which may occur during construction would be managed through an UDP.

5.9.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative cultural, historic, and archaeological impacts from construction activities include:

Cul-1: The Transmission Line Areas will be designed to avoid known sites.

Cul-2: Cultural surveys in known areas of ground disturbance for the final transmission line facilities will be completed ahead of construction. No ground disturbance activities will be completed prior to cultural survey work being completed.

Cul-3: If sites are found at the location of planned infrastructure, micrositing techniques will be used to move around and/or span sites to the greatest extent practicable.

Cul-4: Follow a UDP, providing protection for unknown sites.

5.9.4 Conclusion

Based on the protection measures listed above, the proposed location of the Updated Transmission Line Facilities would not unduly impair cultural, historic, and archaeological resources. Impacts to cultural resources are expected to be *de minimis,* if at all.

5.10 Religious and Cemetery Sites

5.10.1 Methods and Impact Types

Assessment of impacts to religious resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally low, avoidable, short term, and temporary in nature for religious resources.

5.10.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Within the Updated Corona Gen-Tie System Corridor, there are no known churches and four cemeteries. No impacts to known locations of religious resources are expected to occur because religious resources may be avoided by the Updated Transmission Line Facilities. Cultural resource field surveys would be completed prior to any construction activity to reduce potential impacts from the Updated Transmission Line Facilities. Siting of the Updated Transmission Line Facilities would follow industry standard siting guidelines.

5.10.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative impacts to religious facilities from construction activities include:

Rel-1: Avoid known sites.

5.10.4 Conclusion

Because there are no known churches within the Updated Corona Gen-Tie System Corridor and given the Project's commitment to the protection measure detailed above, no impacts are anticipated to religious resources. It is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair religious resources.

5.11 Visual and Scenic Resources

This section is intended to support the Application for Location Approval of Transmission Line under NMAC Title 17 Chapter 9 Part 592. The power generation portion of the project, occurring within the Updated Corona Wind Project Area, would, as a whole, avoid or minimize impacts to environmental resources. Although studies have been conducted on the Updated Corona Wind Project Area, that portion of the project previously described in the Existing Conditions section is not required by NMAC 17.9.592.10 to be analyzed within this report.

Qualitative and quantitative variables of resource sensitivity, resource quantity, and estimated ground disturbance were considered in predicting the extent and magnitude of impacts. What constitutes an impact level on a resource varies by resource as well as the assumptions for analysis for each resource. Protection measures were identified and include action that will reduce potential impacts to a resource from the Updated Transmission Line Facilities.

Based on the compatibility of the Updated Transmission Line Facilities with the current land uses within the Updated Corona Gen-Tie System Corridor; impacts to land uses from location of the Updated Transmission Line Facilities would be largely temporary and limited in area during construction; and the large majority of the Updated Corona Gen-Tie System Corridor would remain in its pre-existing use, as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair land use resources. Based on no direct or indirect impacts to schools and no direct or indirect impacts on State or County recreation lands, local parks, trails, or hunting access lands would occur as a result of the construction, operation, and maintenance of the Updated Transmission Line Facilities, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair school or recreation resources.

5.11.1 Methods and Impact Types

Assessment of impacts to visual and scenic resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operation, maintenance of the Updated Transmission Line Facilities would introduce new features into the visual landscape of the Updated Corona Gen-Tie System Corridor. The Updated Transmission Line Facilities were evaluated to determine whether the following types of impacts would occur:

- Proximity of the Updated Transmission Line Facilities to residences and residential areas.
- Changes to the visual landscape with respect to scenic resources, such as scenic byways.
- Changes to the visual landscape within or near recreational areas such as state and national parks.

5.11.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

New transmission structures, conductors, substation components, and cleared ROW areas would change the visual characteristics in the vicinity and the viewshed of the Updated Transmission Line Facilities. However, the Updated Transmission Line Facilities would not differ from other transmission lines and substations in the vicinity. For residences located near the Updated Transmission Line Facilities and residents traveling area roads in the Updated Corona Gen-Tie System Corridor, a new man-made feature

would be present in the landscape. Residents of homes along the line would be most prone to changes in the visual environment around their homes. Impacts would likely be low based on the low population density. However, the visual sensitivity to the line would be highly dependent on the orientation of the line to the home (in front, behind, alongside), any screening between the home and the line (trees, topography), distance, other visual components (existing lines, radio towers), and the general sensitivity of the occupants to the Updated Transmission Line Facilities.

Visual impacts resulting from the construction and operation of the proposed substations are anticipated to have similar impacts associated with the construction and operation of the proposed Supplemental Transmission Line Facilities. Each new substation would be an added visual element in the existing landscape.

No designated federal or state scenic routes or byways are in the vicinity of the Updated Corona Gen-Tie System Corridor (NMDOT, 2019; FHWA, 2019) (see Exhibit 15). The nearest scenic route is Historic Route 66, which is more than 20 miles north of the Updated Corona Gen-Tie System Corridor. Salt Missions trail is approximately 28 miles to the north end of the route. Therefore, the transmission line is sufficiently far from these routes that it would not be deemed to impact the scenic values of the routes.

Additionally, no national parks or state parks are in the vicinity of the Updated Corona Gen-Tie System Corridor. The closest national park is Salinas Pueblo Missions National Monument, which is approximately 28 miles west of the Updated Corona Gen-Tie System Corridor. The closest state parks are the Santa Rosa Lake State Park, Sumner Lake State Park, and Manzano Mountains State Park, all located more than 40 miles from the Updated Corona Gen-Tie System Corridor. Manzano Mountains State Park is the closest at 40 miles away. No known visually sensitive, cultural resource sites are in the vicinity of the Updated Corona Gen-Tie System Corridor. No known organized tourism activities are in or near the Updated Corona Gen-Tie System Corridor.

5.11.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative visual impacts from construction activities include:

Vis-1: Leave (where possible) plants smaller than 8 ft in height within the 180-foot-wide ROW to help reduce the effect of the ROW of visual and aesthetic resources.

Vis-2: Keep the ROW free of construction debris and other litter during construction to further reduce visual intrusion to the surrounding landscape.

Vis-3: The design of the buildings and related structures shall, to the extent reasonably possible, use materials, colors, textures, screening and landscaping that will blend the facility into the natural setting and existing environment.

Vis-4: No individual tower facility shall be installed at any location that would substantially detract from or block the view of the major portion of a recognized scenic vista, as viewed from any public road ROW or publicly accessible parkland or open space within the County.

Vis-5: As a condition of approval of a special use district for a Wind Energy Facility, within one year of the termination or abandonment of leases, easements or operations of a Wind Energy Facility, the permittee shall cause, at its own expense, the restoration of the land to its pre-facility condition.

5.11.4 Conclusion

Based on low visual impacts due to low population and long distances to sensitive visual areas such as scenic byways and parks, as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair visual resources.

5.12 Land Use, Including Farm, Range, and Recreational Resources

5.12.1 Impact Assessment Methods

Assessment of impacts to land uses from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in in Chapter 5.1 above and is discussed below. A land use impact is one that restricts the future use of land or conflicts with an existing use. The Updated Transmission Line Facilities tend to restrict certain activities but may or may not change the land use. Construction, operation, and maintenance of the Updated Transmission Line Facilities would result in both direct and indirect impacts to land use. For schools and recreational resources, impacts are generally low, short term, and temporary in nature. The Updated Transmission Line Facilities were evaluated to determine whether the following types of impacts would occur:

- Temporary and permanent land use changes.
- Restrictions on activities within the ROW.
- Inconsistency with local land use plans and zoning.
- Removal of land from future development.
- Potential use restrictions or conflicts on public lands.

5.12.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

5.12.2.1 Agricultural Land Use Impacts

The lands crossed by the Updated Transmission Line Facilities are used for agricultural purposes. Long-term land use impacts to grassland, cropland, and pasture primarily would be the result of structure placement, ROW maintenance, and access roads. Current agricultural practices would be maintained for most of the ROW. Areas of cropland within the ROW could continue to be farmed, and grazing could continue within the ROW. The only land that would be unavailable for agriculture would be the area occupied by actual transmission structures. Structures would be approximately 3 to 5 ft in diameter at ground level depending on the type of structure. The permanent footprint of transmission line structures would be removed from production, and structures would present obstacles that would need to be avoided. Pattern Development would work with landowners to reduce impacts to irrigation facilities. However, overall, the Updated Transmission Line Facilities would result in minimal reduction in agricultural production or land available for agricultural activities.

Easements or ROWs have been or would be obtained from landowners along the Updated Transmission Line Facilities for constructing and maintaining the line. The landowner would maintain ownership of the property and continue to pay taxes on the property, but Pattern Development would acquire rights allowing construction, operation, and maintenance of the Updated Transmission Line Facilities in exchange for a monetary payment to the landowner. The agreement between the landowner and Pattern Development would outline any use restrictions applying to the agreement. The agreement would include certain restrictions on the continued use of the property, such as prohibiting permanent structures and establishment of certain types of vegetation within the ROW that could affect access to the line or safe and reliable operation.

During construction and maintenance activities, agricultural lands would be subject to temporary impacts. Depending on the time of year, access for construction would result in damage to crops, compaction and rutting of soil, restrictions on access to the ROW, and restrictions on general agricultural practices in and around the ROW (such as prescribed burning of grassland pasture). Landowners would be compensated for crop and forage loss, and damaged soils would be restored to arable condition. Cattle may need to be re-located or confined away from the ROW areas of pasture during construction. Following completion of construction, disturbance and disruption to agricultural activities would largely cease. Periodic maintenance activities and emergency repairs would result in impacts similar to those for construction. However, these activities would be infrequent over the life of the Project. Landowners would be compensated for any damage, and the ROW would be restored to previous conditions.

In addition to the ROW for the Updated Transmission Line Facilities, approximately four temporary laydown areas for construction material and equipment would be necessary for the duration of construction. These laydown areas each would be up to 20 acres in size each. Where feasible, construction laydown areas are typically located at previously disturbed or developed locations such as vacant lots, existing utility yards, or parking lots to reduce impacts to sensitive resources. If existing yard locations are not available, preferred locations for yards would be undeveloped areas, such as grazing or cropland, that are cleared, flat, have all-weather access, and do not contain streams, wetlands, or other environmentally sensitive resources. Laydown yards would typically consist of flat or gently sloping lands where much of the construction material would be placed on pallets or cribbing. No topsoil would be removed, and minimal, if any, re-grading is expected to take place at these facilities. Laydown areas generally would be returned to a pre-construction condition upon completion of the Updated Transmission Line Facilities.

Three step-up substations and an adjacent switchyard would also be constructed. Construction would take place on up to approximately 20 acres of land per substation/switchyard and would result in the permanent conversion of this area from agricultural land to utility land use.

5.12.2.2 Land Use Plans and Regulations

As part of Torrance County's Goals and Objectives in the Torrance County Comprehensive Land Use Plan, the potential for wind and solar generated power is encouraged in order to improve and expand Torrance County-wide infrastructure to enhance the quality of life and support economic development. The Torrance County Zoning Ordinance encourages the development of businesses that harness wind energy (The Board of County Commissioners of Torrance County, 2016). Special Use Districts for Wind Energy Facilities are to foster the development of the county's wind power resources while preserving traditional land uses.

5.12.2.3 Public Lands

The Updated Transmission Line Facilities may cross state trust lands, depending on the final route. An easement to cross these state lands would be needed from the New Mexico SLO for these portions of the Updated Transmission Line Facilities. If an easement is needed across state trust lands, Pattern Development would coordinate with the SLO to develop an agreement that is consistent with the SLO's development of state trust lands, per its planning requirements. Applications have or will be submitted for all of the Updated Corona Wind Project Area (including the Updated Corona Gen-Tie System Corridor) to SLO.

5.12.2.4 Schools

No direct or indirect impacts to schools would occur as a result of the construction, operation, and maintenance of the Updated Transmission Line Facilities. The Corona Elementary/High School is located about 10 miles southwest of the Updated Corona Gen-Tie System Corridor boundary. Siting of the Updated Transmission Line Facilities would follow industry standard siting guidelines.

5.12.2.5 Recreation

No direct or indirect impacts on state or county recreation lands, local parks, trails, or hunting access lands would occur as a result of the construction, operation, and maintenance of the Updated Transmission Line Facilities. There are no parks and recreational areas in close proximity to the Updated Corona Gen-Tie System Corridor. Existing recreational opportunities would continue as they currently exist with minor, temporary disturbances possible during construction.

5.12.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative land use impacts include:

Land-1: Coordinate with landowners for potential measures, including routing, to reduce Project impacts on uses on specific properties.

Land-2: Coordinate with appropriate state land management agencies to obtain appropriate permits and easements for portions of the transmission line traversing public lands.

Land-3: Plan and conduct construction activities to reduce temporary disturbance, displacement of crops, and interference with agricultural activities.

Land-4: Restore compacted cropland soils as close as possible to pre-construction conditions using tillage.

Land-5: Compensate landowners for any new land rights required for ROW or access road easements.

Rec-1: Plan and conduct construction activities to reduce temporary disturbance, displacement of recreationists, and interference with recreation activities.

5.12.4 Conclusion

Based on the compatibility of the Updated Transmission Line Facilities with the current land uses within the Updated Corona Gen-Tie System Corridor, impacts to land uses from location of the Updated Transmission Line Facilities would be largely temporary and limited in area during construction. The large majority of the Updated Corona Gen-Tie System Corridor would remain in its pre-existing use. With inclusion of the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair land use resources.

Based on no direct or indirect impacts to schools and no direct or indirect impacts on state or county recreation lands, local parks, trails, or hunting access lands as a result of the construction, operation, and maintenance of the transmission line, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair school or recreation resources.

5.13 Socioeconomics

5.13.1 Impact Assessment Methods

Assessment of impacts to socioeconomic resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Socioeconomic resources include elements of the human environment, such as population characteristics, employment and other economic factors, public services, and housing. Construction and operation of the Updated Corona Gen-Tie System and Corona Wind Update would result in both direct and indirect socioeconomic impacts, most of which are positive impacts. Potential socioeconomic impacts include:

- Generation of economic activity from jobs, earnings, and economic output.
- Temporary increase in demand and spending for local goods, services, and construction materials from construction of the Updated Corona Gen-Tie System and Corona Wind Update.
- Temporary increase in population from the influx of construction workers.
- Temporary increase in demand for temporary lodging facilities from the influx of construction workers.
- Temporary disruptions (such as temporary traffic changes or noise) to nearby residents during construction.

5.13.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

The economic and fiscal impacts of the Corona Wind Projects would make a significant contribution to the economic base of Torrance County with both short-term development activities, and long-term contributions to the regional economy.

Over 30 years of operations, the overall 2018 Approved Projects would produce an estimated $2.6 billion in direct economic impacts, and taking account of economic multiplier impacts, approximately $3.8 billion in direct, indirect and induced economic benefit to the local economy (Tysseling, 2017). Discounting this stream of benefits at a 5 percent annual rate (appropriate for public benefits analysis), and noting that the undiscounted economic impacts are stated in terms of 2018 dollars (i.e., unadjusted for inflation), the present value of the direct economic benefits from the 2018 Approved Projects are estimated to be nearly $1.4 billion, and the direct, indirect, and induced economic benefits of the 2018 Approved Projects are estimated to produce a present value of $2.0 billion (Tysseling, 2017). This equates to an estimated $1.44 billion, and the direct, indirect, and induced economic benefits of the 2018 Approved Projects are estimated to produce a present value of $2.1 billion scaled at a 3-percent increase to account for the updated wind and transmission areas.

The 2018 Approved Projects align directly with several of the specific goals of the New Mexico State Energy Plan. A significant attribute of the 2018 Approved Projects is the development of the SunZia Transmission Project transmission facilities. Moreover, several other objectives of the State Energy Plan are achieved by the 2018 Approved Projects and related developments, including:

- Supporting regional energy policy, infrastructure, and development pathways and solutions.
- Ensuring that sound science and economics, as well as the availability of energy resources drive state energy policy decisions.
- Focus on economic growth, diversification, and private sector job creation.
- Consider appropriate incentives that would increase market potential and competitiveness with other states in the West.
- Accelerate reduction of freshwater consumption in the energy sector.
- Establish the energy foundation of new and improved infrastructure in electric power transmission.

Development of electric generation facilities comprising the Updated Corona Gen-Tie System and Corona Wind Update to be included in the 2018 Approved Projects, offers New Mexico highly desirable economic development investments. Investments in these wind generation and transmission facilities

stimulate substantial growth in the renewable energy sector and foster an economic development climate that broadens the state's long-standing role as a sustainable participant in the energy marketplace. The Updated Corona Gen-Tie System and Corona Wind Updates' facilities would not displace or capture existing commercial energy market activities. Instead, these investments would create new economic development in its exportation of environmentally preferred New Mexico energy resources.

Once operational, the economic benefits and revenue streams would be a stable foundation of economic activity anticipated for at least the 30-year life of the 2018 Approved Projects and the Updated Corona Wind Projects' financing and would likely continue beyond that time. Additionally, the 2018 Approved Project and Updated Corona Wind Project establish a new economic infrastructure that would likely foster further developments of a similar nature.

The short-term impacts during the development period would flow from the $2.4 billion capital investment for the 2018 Approved Projects and Updated Corona Wind Projects' facilities (Tysseling, 2017). These developments would occur over approximately 350,000 acres across the three counties and would introduce significant new economic activities for decades to come.

The 2018 Approved Projects and Updated Corona Wind Projects are estimated to create 1,186 total full-time equivalent jobs during construction, with an estimated 356 of those jobs sourced from local labor sources (Tysseling, 2017). This equates to an estimated 1,225 total full-time equivalent jobs during construction, with an estimated 370 of those jobs sourced from local labor sources at a 3-percent increase to account for the updated wind and transmission areas. Payroll during the development phase would add approximately $60 million in income to the local labor force for the Project construction alone. The bulk of these short-term impacts would occur in 2020 to 2022.

Pattern Development estimates that of the total capital expenditures during construction of the 2018 Approved Projects and Updated Corona Wind Projects, it is likely that $120 million in contracts would flow to local construction service providers (Tysseling, 2017).

Once construction is completed and operations commence, the 2018 Approved Projects and Updated Corona Wind Projects are expected to employ approximately 94 permanent jobs with a payroll estimated to be approximately $4.5 million and total operating costs of approximately $1.7 million per year (Tysseling, 2017).

The land lease and easement agreements with the private landowners on which the 2018 Approved Projects and Updated Corona Wind Projects would be sited would provide direct new revenues to

landowners within the footprint of development. These landowners are expected to realize approximately $12.5 million of new revenues during the development period, and a minimum of approximately $9.3 to $10.5 million per year during the operations period (Tysseling, 2017).

GRT revenues will increase as a result of the construction projects by an estimated $22.4 million for 2018 Approved Projects' and Updated Corona Wind Projects' development. Fiscal impacts associated with property taxes are muted as a result of the financing through Industrial Revenue Bonds (IRBs), but provision has been made by the developers to provide payments in-lieu of taxes (PILOTs) to several of the municipal and school district beneficiaries of these tax revenues in an amount estimated at approximately $3.6 million per year (Tysseling, 2017).

The direct economic impacts of the 2018 Approved Projects and Updated Corona Wind Projects during the development period are anticipated to be $128.8 million, with direct, indirect and induced (multiplier) impacts suggesting a $211.4 million impact from the development of the 2018 Approved Projects and Updated Corona Wind Projects (Tysseling, 2017). This equates to an estimated $132.7 million, with direct, indirect and induced (multiplier) impacts suggesting a $217.7 million impact from the development at a 3-percent increase to account for the updated wind and transmission areas. Once operational, the 2018 Projects and Updated Corona Wind Projects should generate an annual direct economic impact of approximately $82.7 million, and, when economic multipliers are considered, the annual impact from the 2018 Approved Projects and Updated Corona Wind Projects operation can be estimated to be approximately $118.0 million (Tysseling, 2017).

5.13.3 Protection Measures

Protection measures that would be implemented to reduce potential negative socioeconomic impacts from construction activities include:

Socio-1: Work with individual landowners to coordinate the timing of construction to minimize short-term impacts on agriculture.

5.13.4 Conclusion

The Updated Corona Gen-Tie System and Corona Wind Update would develop a relatively new and under-developed economic resource in the state of New Mexico—wind energy—that would be directly exported from the state along with the 2018 Approved Projects. Aside from the technology, innovation and capital investments developed in conjunction with the 2018 Approved Projects and Updated Corona Wind Project, this development creates new economic activity, value, and opportunity within New Mexico, which would be exported from the state. This is a highly valuable attribute of the 2018 Approved

Projects and Updated Corona Wind Projects, as it would not displace or capture existing commercial activities, but, instead, would create the most desirable form of economic development in its exportation of environmentally preferred New Mexico energy resources. In short, the 2018 Approved Projects and Updated Corona Wind Project would create new economic value from economic activities that are not currently a part of the New Mexico economy.

5.14 Communication Signals

5.14.1 Impact Assessment Methods

Assessment of impacts to communication signal resources, from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally avoidable for communication signal resources.

5.14.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

The Updated Transmission Line Facilities are planned to avoid beam paths. Siting of the Updated Transmission Line Facilities would be completed outside of existing, known fresnel zones and would avoid inference with communication pathways. One (1) AM or FM station tower was identified within 35 miles of the Updated Corona Gen-Tie System Corridor. The Updated Transmission Line Facilities would avoid AM and FM station towers to the extent practicable if new tower facilities are developed.

5.14.3 Protection Measures

Protection measures that would be implemented to reduce potential negative communication signal impacts from construction activities or operation include:

Comm-1: Pattern Development shall minimize or mitigate any interference with electromagnetic communications, such as radio, telephone or television signals caused by any wind energy facility.

Comm-2: No individual tower facility shall be installed in any location where its proximity with fixed broadcast, retransmission or reception antenna for radio, television or wireless phone or other personal communications systems would produce electromagnetic interference with signal transmission or reception.

5.14.4 Conclusion

Microwave path and AM and FM station towers would be avoided by the Updated Transmission Line Facilities to the extent practicable; therefore, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair communication signals.

5.15 Radioactive Waste and Radiation Hazards

Electric transmission line and substation infrastructure do not generate or contain radioactive waste or radiation hazards. The Updated Transmission Line Facilities would not generate radioactive waste or radiation hazards, and, therefore are not addressed further in this ER.

5.16 Hazardous Materials

5.16.1 Impact Assessment Methods

Assessment of impacts from hazardous materials, from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Accidental spill of hazardous materials could occur with the construction, operation, and maintenance of the Updated Transmission Line Facilities. These hazards are described in more detail below.

5.16.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

During construction, use of trucks, heavy equipment, or stored supplies could result in accidental discharge of fuel, lubricants, and automotive fluids. Although the potential exists, any spills would be accidental, occasional, and of limited extent, and would be considered minor to negligible and temporary in duration. A SPCC Plan would be prepared by Pattern Development and would contain information regarding training, equipment inspections, maintenance and repair, spill prevention kits, and refueling operations for construction vehicles, with an emphasis on preventing spills. Hazardous materials would not be drained onto the ground or into streams or drainage areas. All construction waste including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials would be removed to a disposal facility authorized to accept such materials weekly.

5.16.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative hazardous materials impacts include:

Haz-1: Prepare a SPCC Plan.

Haz-2: Hazardous materials will not be drained onto the ground or into streams or drainage areas.

Haz-3: Construction waste including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials will be removed to a disposal facility authorized to accept such materials weekly.

5.16.4 Conclusion

Impacts from hazardous materials would be avoided through the implementation of proper construction practices, development and implementation of a SPCC Plan, as well as the protection measures detailed above; therefore, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair important environmental resources from hazardous materials.

5.17 Safety

5.17.1 Impact Assessment Methods

Assessment of impacts to safety, from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Safety concerns can arise from the Updated Transmission Line Facilities construction, operation, and maintenance. These concerns are described in more detail below.

5.17.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Pattern Development would develop a safety plan prior to construction to manage and reduce safety risk. Speed limits would be posted and followed to reduce traffic safety concerns on roadways. Proper construction practices would be followed to reduce injury to personnel and damage to property. In the unforeseen event that a safety issue arises, Pattern Development's safety plan would have procedures in place to address most safety situations. Pattern Development will comply with all manufacturer specifications and relevant Occupation Safety and Health Administration requirements to ensure the safety of residents, employees, contractors, livestock, the public, and other users of the land.

Construction of the Updated Transmission Line Facilities could cause wildfire ignition. O&M activities (e.g., welding, vehicle ignition), and the presence of energized transmission line facilities (e.g., arc ignition) could also cause wildfire ignition. Pattern Development and/or its contractors would notify federal, state, and local agencies of any fires and comply with all rules and regulations administered by the federal, state, and local land management agencies concerning the use, prevention, and suppression of fires, including any fire prevention orders that may be in effect at the time of the construction, operation,

or maintenance activity. Additionally, Torrance County emergency responders and fire districts will be contacted to ensure appropriate plans are in place at the Corona Wind Projects to quickly respond to any emergencies. Pattern Development will work with the departments to ensure the safety of the firefighters, Corona Wind Projects' employees, landowners, neighbors, livestock, and other users of the land. The Corona Wind Projects will have emergency response plans in place to respond to various natural disasters, even though the Updated Corona Gen-Tie System Corridor generally is not considered to be a high-risk site. An annual emergency response drill, in which local responders will be invited to participate, will be completed onsite to test the Corona Wind Projects' emergency response

Within the Updated Corona Gen-Tie System Corridor and Corona Wind Update, safety risks will be reduced as electrical substations and transformers will be located inside locked fences or enclosures and will be clearly marked to show that energized electrical equipment is located inside. In addition, Pattern Development will man a 24/7 monitoring center to monitor the substation and turbines. There will be signage on the substation fences with the monitoring center's phone number. Modern wind turbines are inherently unclimbable by the general public since there are no exterior ladders or lattice work and interior ladders are secured behind locked doors located at the bases of the turbine towers.

5.17.3 Protection Measures

Protection measures that would be implemented to reduce any potential safety impacts include:

Safe-1: Pattern Development and its contractors, as appropriate, will initiate discussions with local fire districts and regional fire prevention staff prior to construction to discuss emergency procedures and to provide transmission line safety training, including safety procedures for conducting fire suppression activities near a power line.

Safe-2: All vehicles will be equipped with appropriate fire suppression tools and equipment. Fire suppression equipment will include, but not be limited to, shovels, buckets, and fire extinguishers.

Safe-3: Smoking and equipment parking will be restricted to designated areas.

Safe-4: Pattern Development and/or its contractors will fuel all highway-authorized vehicles offsite to minimize the risk of fire. Fueling of construction equipment that is transported to the site via truck and is not highway authorized will be done in accordance with regulated construction practices and federal, state, and local laws.

Safe-5: Pattern Development will develop a safety plan prior to construction. The plan will include items such as medical emergency facilities and procedures, wildlife agency contacts and procedures, and inclement weather procedures.

Safe-6: Appropriate warning signage shall be placed on wind turbine towers, electrical equipment, and wind energy facility entrances.

Safe-7: To the extent practicable, the facility shall connect to existing substations, or if new substations are needed, minimize the number of new substations.

Safe-8: Electrical controls and control wiring and power lines shall be wireless or underground, except where wind farm collector wiring is brought together for connection to the transmission or distribution network, adjacent to that network.

5.17.4 Conclusion

Impacts from unsafe events would be reduced through the implementation of proper construction practices, as well as the protection measures detailed above; therefore, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair important environmental resources because of safety concerns.

5.18 Geographic Resources

5.18.1 Impact Assessment Methods

Assessment of impacts to geographic resources from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. The Project is in the Great Plains region of New Mexico. Geographic resources identified in the region include state and national parks and monuments. The Updated Transmission Line Facilities were evaluated to determine whether the following types of impacts would occur:

- Diminishment of scenic resources within and from state or national parks and monuments by the addition of man-made elements to the natural landscape.
- Introduction of noise/air pollution to state or national parks and monuments.

5.18.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

As discussed in Section 5.11, there are no national parks or state parks in the vicinity of the Updated Corona Gen-Tie System Corridor. The closest national park is Salinas Pueblo Missions National Monument, which is approximately 28 miles west of the Updated Corona Gen-Tie System Corridor. The closest state parks are the Santa Rosa Lake State Park, Sumner Lake State Park, and Manzano Mountains State Park, all located more than 40 miles from the Updated Corona Gen-Tie System Corridor. Manzano Mountains State Park is the closest at 40 miles away. The Updated Transmission Line Facilities would result in minor emissions from construction vehicles and activities but would not impact the overall air quality in the region, including the national and state parks. Noise impacts (such as from construction activities) would be highly localized and would not impact noise level at the national or state parks.

As discussed in Section 5.9, two historic archaeological resources are reported with the Updated Corona Gen-Tie System Corridor. One site is associated with the railroad and the second is a small prehistoric lithic scatter. Impacts to known locations of cultural resources would be low because the Updated Transmission Line Facilities are intended to be designed around these areas. Cultural resource field surveys would be completed prior to any construction activity to reduce potential impacts from the Updated Transmission Line Facilities to unlocated sites. Any discoveries which may occur during construction would be managed through a UDP.

5.18.3 Protection Measures

Due to no anticipated impacts to geographic resources, no protection measures are proposed.

5.18.4 Conclusion

Impacts to geographic resources would be avoided by the Updated Transmission Line Facilities to the extent practicable; therefore, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair geographic resources.

5.19 Military Activities and Aviation

5.19.1 Impact Assessment Methods

Assessment of impacts to military and aviation activities from the Updated Transmission Line Facilities construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally avoidable in nature for military activities and aviation.

5.19.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Three military training routes cross the Updated Corona Gen-Tie System Corridor. Pattern Development would work with FAA to request DNH for the Updated Transmission Line Facilities. Based on the height of the Updated Transmission Line Facilities and the location of military and aviation resources, the transmission line facility construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor would not impact military activities and aviation.

5.19.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative military or aviation impacts from construction activities include:

Mil-1: Coordinate with military bases and aviation facilities as needed.

Mil-2: Use FAA approved lighting as required.

5.19.4 Conclusion

Impacts to military activities and aviation resources would be avoided by the Updated Transmission Line Facilities to the extent practicable; therefore, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair military activities and aviation resources.

5.20 Roads

5.20.1 Impact Assessment Methods

Assessment of impacts to roads from the Updated Transmission Line Facilities from construction, operation, and maintenance within the Updated Corona Gen-Tie System Corridor follows the impact assessment methodology described in Chapter 5.1 above and is discussed below. Construction, operations, and maintenance impacts are generally low, short term, and temporary in nature for roads.

5.20.2 Impacts Specific to the Updated Corona Gen-Tie System Corridor

Potential impacts for roads would be greatest during construction of the Updated Transmission Line Facilities. Construction equipment and increased traffic have the potential to degrade existing road conditions. Pattern Development would document pre-construction road conditions and return roads used for construction access to pre-construction condition or better once construction is completed. Increased road traffic from construction would be localized and short term based on where the Updated Transmission Line Facilities construction is occurring that day or week. Low impacts to roads in the

Updated Corona Gen-Tie System Corridor are anticipated based on localized, short term impacts, and Pattern Development's commitments to return roads used for construction to pre-construction conditions.

5.20.3 Protection Measures

Protection measures that would be implemented to reduce any potential negative road impacts from construction activities include:

Road-1: Pre-construction conditions will be documented, and Pattern Development will develop a road use agreement with NMDOT and Lincoln and Torrance County Road Maintenance Departments, as necessary.

Road-2: Construction speed limits will be established.

5.20.4 Conclusion

Based on localized, low, short term impacts, and Pattern Development's commitments to return roads used for construction to pre-construction conditions, as well as the protection measures detailed above, it is not expected that the proposed location of the Updated Transmission Line Facilities would unduly impair roads.

6.0 CONSULTATION AND COORDINATION

The following individuals and materials have contributed to the preparation of the Corona Wind Companies' ER for the Updated Corona Wind Project Area.

6.1 List of Preparers and Reviewers

6.1.1 Pattern Development

- Adam Cernea Clark, Manager Environmental and Natural Resources
- Crystal Coffman, Director Business Development
- Jared Garrand, Analyst Business Development
- Carla Najjar, Special Counsel
- Dan Najjar, Special Counsel

6.1.2 Burns & McDonnell Engineering Company, Inc.

- Paul Callahan, Project Principal
- Chris Knopp, Project Manager
- David Dean, Project Manager
- Bob Rowe, Senior Archeologist
- Crystal Bravo-Cogar, Senior Environmental Scientist
- Gregory Buck, Assistant Environmental Scientist
- Kyle Boatright, Geographic Integration Systems Specialist

6.2 Technical Reports Contributing to the Environmental Report

- *Critical Issues Analysis for the Proposed Ancho Wind Project* (Report, WEST Inc., March 2017a).
- *Critical Issues Analysis for the Proposed Cowboy Mesa Wind Project* (Report, WEST Inc., March 2017b).
- *Critical Issues Analysis for the Proposed Viento Loco Wind Project* (Report, WEST Inc., March 2017c).
- *Raptor Nest Survey, Pattern Wind Energy Project* (Report, WEST Inc., August 2017d).
- *Site Characterization Study, Pattern Wind Energy Project* (Report, WEST Inc., August 2017e).
- *The Economic and Fiscal Impact of the Corona Wind Project in New Mexico* (John C. Tysseling PhD, 2017).

- *Waters of the U.S. and Biological Resources Assessment for 10 Proposed Wind Turbine Locations and Access Roads at the Ancho Wind Proj*ect, Lincoln County, New Mexico (Report, Blanton & Associates, Inc., 2017a).
- *Waters of the U.S. and Biological Resources Assessment for 11 Proposed Wind Turbine Locations and Access Roads at the Viento Loco Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017b).
- *Waters of the U.S. and Biological Resources Assessment for 15 Proposed Wind Turbine Locations and Access Roads at the Duran Mesa Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017c).
- *Waters of the U.S. and Biological Resources Assessment for 16 Proposed Wind Turbine Locations and Access Roads at the Tecolote Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017d).
- *Waters of the U.S. and Biological Resources Assessment for 21 Proposed Wind Turbine Locations and Access Roads at the Red Cloud Wind Project*, Torrance County, New Mexico (Report, Blanton & Associates, Inc., 2017e).

6.3 Recipients of the Environmental Report

- Lincoln/Torrance County Board of County Commissioners
- Lincoln/Torrance County Manager
- Lincoln/Torrance County Road Superintendent
- City of Corona City Council
- Mayor, Corona
- Corona City Manager
- City of Duran City Council
- Mayor, Duran
- Duran City Manager
- Corona Elementary/High School
- Estancia Elementary/Middle/High School
- Vaughn Elementary/High School
- New Mexico Environment Department
- New Mexico State Engineer
- New Mexico Attorney General
- New Mexico SLO

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APPENDIX 1 - EXHIBITS

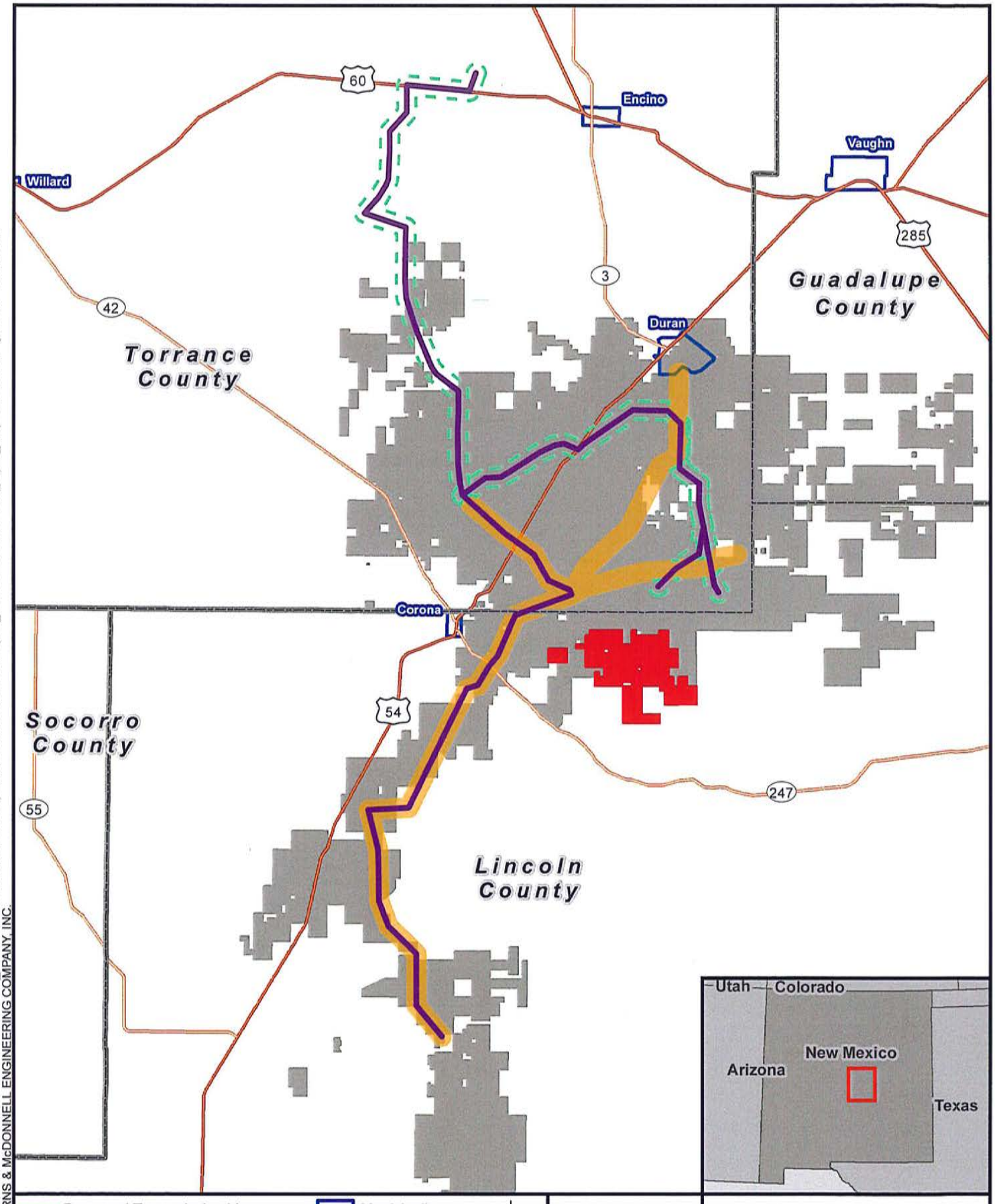

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Exhibit 1
Project Area
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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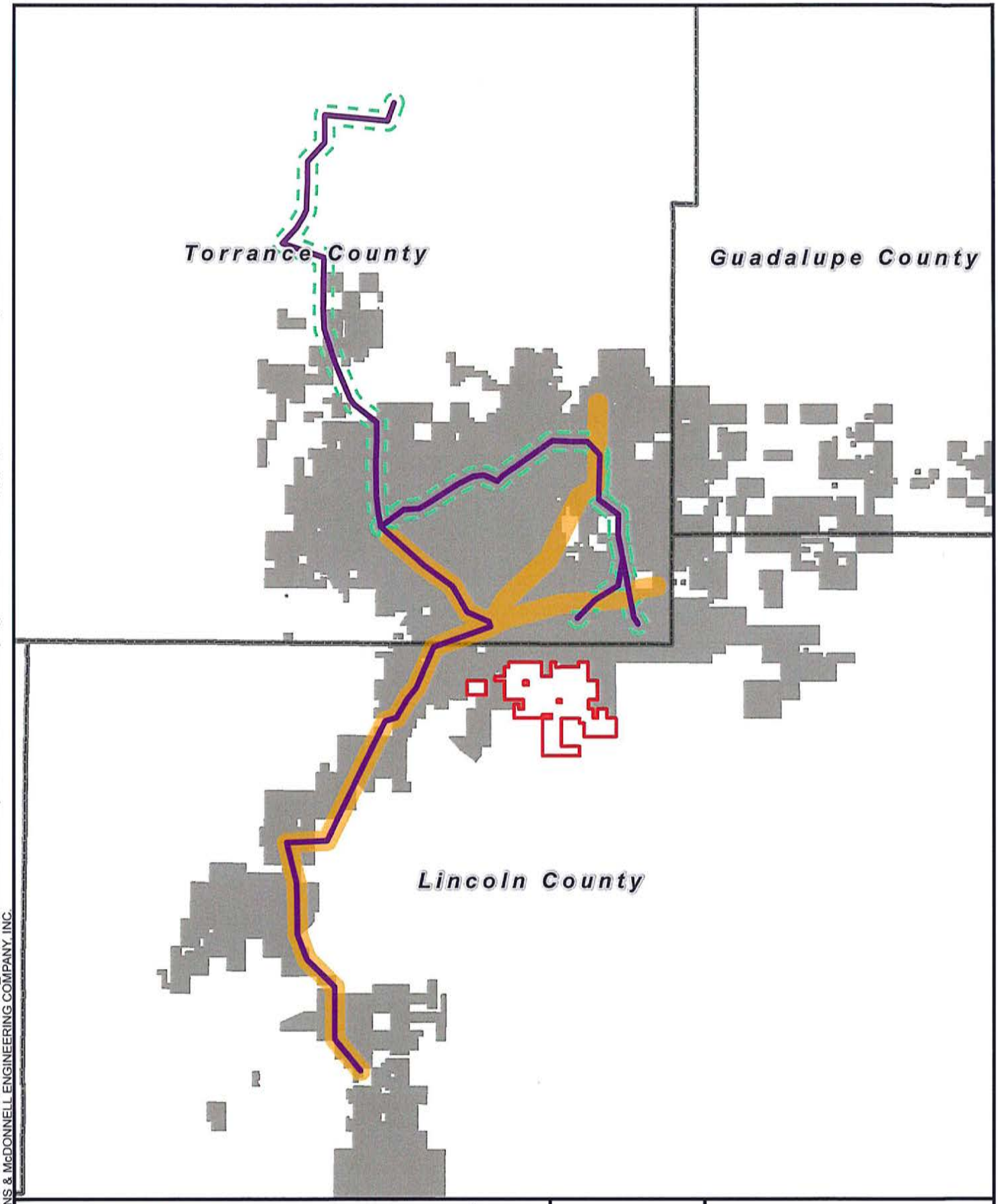

Proposed Transmission Line
One-Mile Transmission Line Buffer
Corona Wind Update
Approved Wind Project Area
Approved Transmission Line Buffer

NORTH

0 3.5 7
Scale in Miles

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Exhibit 2
Assessment Area
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

Issued: 12/13/2019

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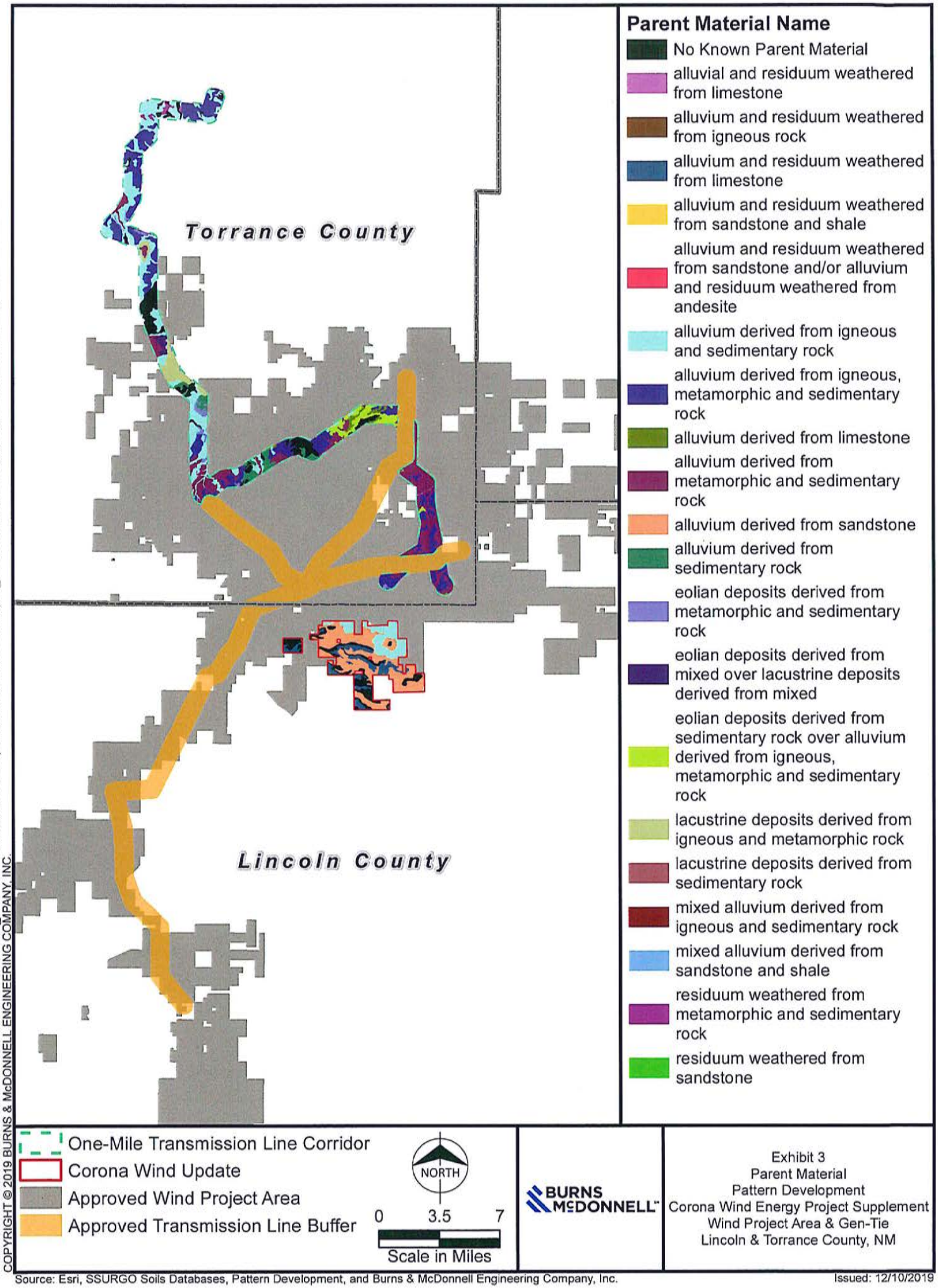

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Exhibit 3
Parent Material
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, SSURGO Soils Databases, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

Issued: 12/10/2019

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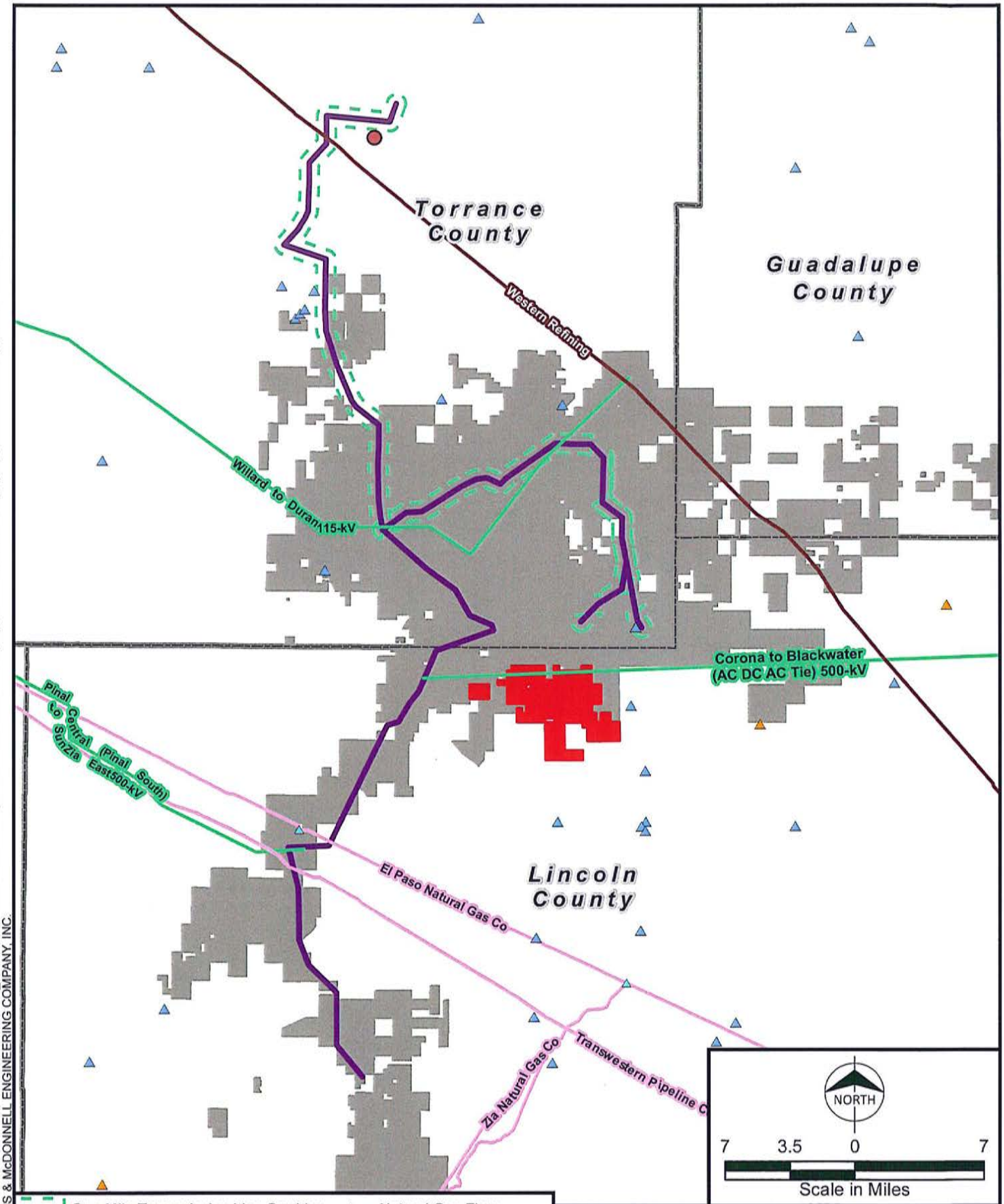

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Exhibit 4
Oil & Gas Well Summary
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Oil Conservation Division (OCD), Ventyx/Energy Velocity, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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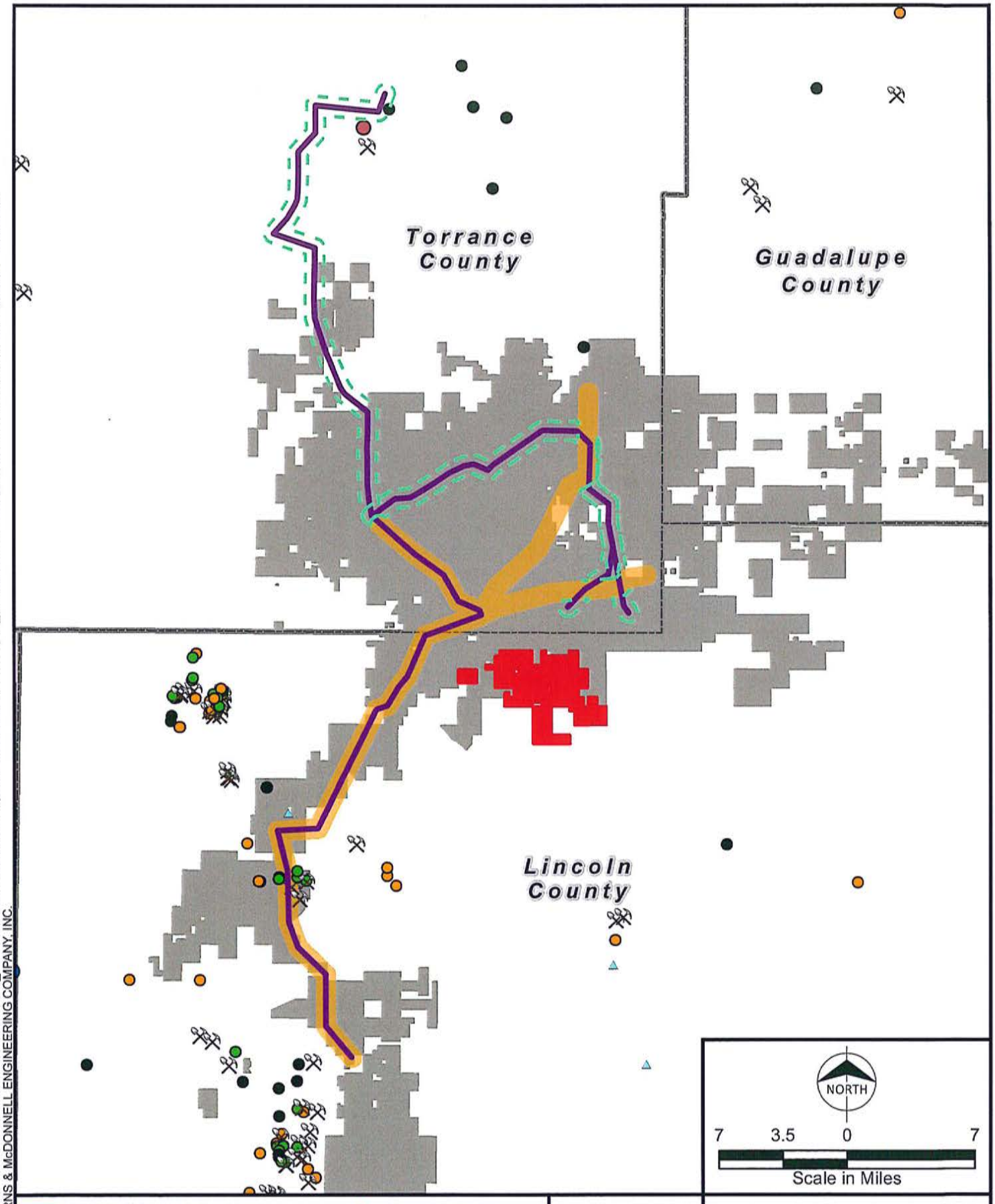

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Exhibit 5
Mineral Resources Map
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, USGS-Mineral Resources Data System (MRDS), Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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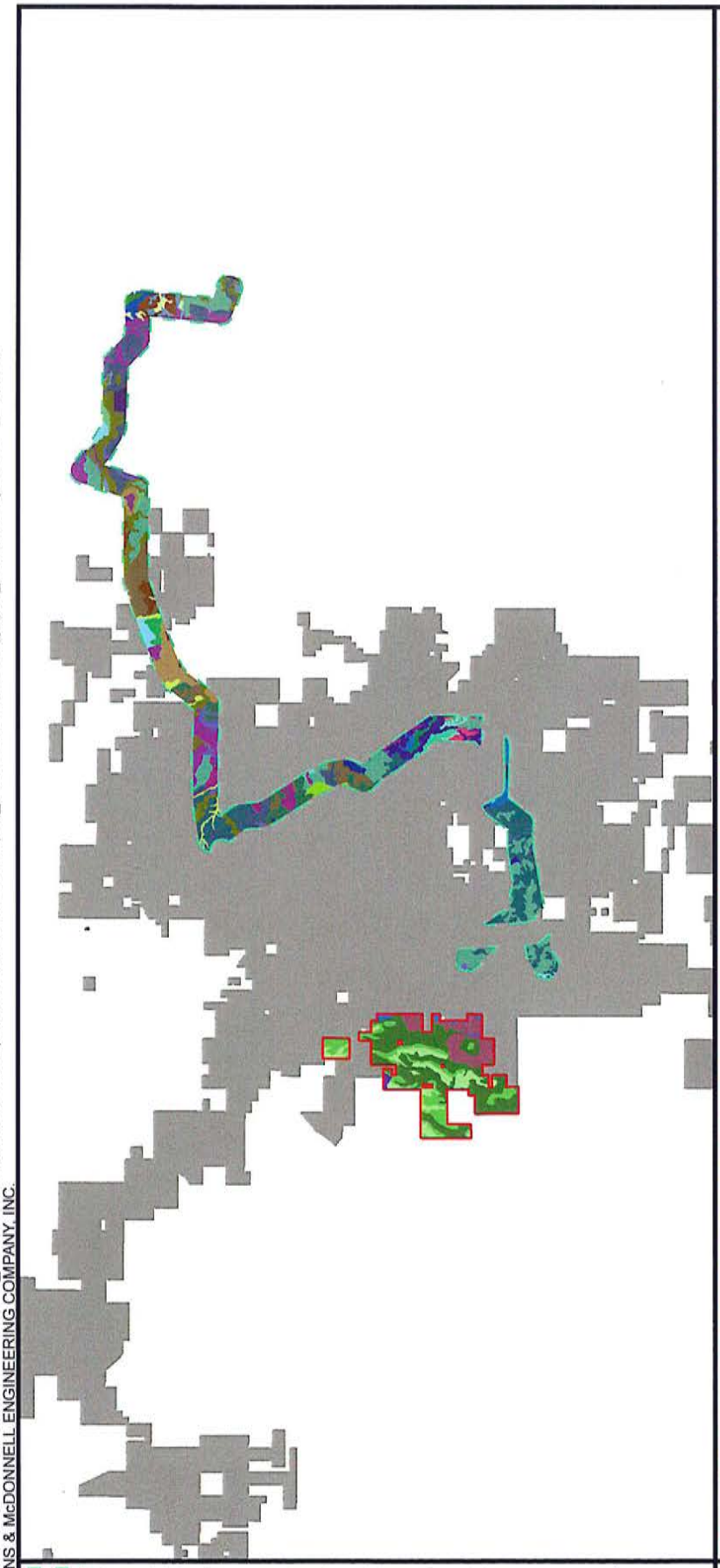

Map Unit Name

- Bernal-Travessilla fine sandy loams
- Caliche pit
- Chilton-La Fonda complex, 1 to 9 percent slopes
- Clovis loam, 0 to 5 percent slopes
- Clovis soils, 0 to 5 percent slopes, eroded
- Clovis-Dean loams, 0 to 5 percent slopes
- Clovis-Harvey association, loam surface, gently sloping
- Clovis-Pastura association, gently sloping
- Darvey-Asparas association, gently sloping
- Darvey-Pastura association, gently sloping
- Deama very cobbly loam, moderately sloping
- Deama-Pastura association*
- Deama-Rock outcrop association, very steep
- Dean loam, 1 to 9 percent slopes
- Hagerman fine sandy loam, 1 to 5 percent slopes
- Harvey loam, 1 to 9 percent slopes
- Harvey-Dean loams, 1 to 9 percent slopes
- Hightower-Oro Grande complex, moderately steep
- Hogadero-Pena association, moderately undulating
- Ildefonso fine sandy loam, 0 to 5 percent slopes
- Karde loam, saline
- Karde-Willard loams, saline
- Kech gravelly loam, 1 to 9 percent slopes
- Kim-Otero-Pastura complex
- Kim-Pastura-Tapia loams
- La Fonda loam, 1 to 9 percent slopes
- La Fonda-Rock outcrop complex
- Laporte-Rock outcrop complex
- Lava flows-Lithic Ustic Haplocambids complex, 0 to 45 percent slopes
- Manzano loam
- Mokiak-Stroupe-Rock outcrop association, very steep
- Otero and Palma soils
- Pastura loam*
- Pastura-Harvey association, moderately rolling
- Pedrick loamy fine sand
- Pena-Hogadero association, hilly
- Penistaja fine sandy loam, 1 to 6 percent slopes
- Penistaja loamy fine sand, hummocky, 1 to 8 percent slopes
- Penistaja-Dean fine sandy loams, 1 to 5 percent slopes
- Penistaja-Travessilla association, gently sloping
- Pinon channery loam, 3 to 20 percent slopes
- Plack-Dioxice association, gently sloping
- Plack-Dioxice loams, 0 to 8 percent slopes
- Plack-Penistaja association, gently sloping
- Playas
- Prewitt and Manzano soils
- Rance-Gypsum land complex
- Reventon-Sampson association, gently sloping
- Rock land
- Rock outcrop-Pinon-La Fonda complex
- Rock outcrop-Stroupe-Deama association, extremely steep
- Sampson loam, 0 to 5 percent slopes
- Steep rock land
- Stroupe-Witt association, moderately steep
- Tapia and Dean soils, eroded
- Tapia loam, 0 to 5 percent slopes
- Tapia-Dean loams, 0 to 5 percent slopes
- Tortugas-Asparas-Rock outcrop association, moderately sloping
- Tortugas-Rock outcrop association, moderately sloping
- Willard loam, strongly saline
- Witt-Penistaja association, gently sloping

One-Mile Transmission Line Corridor

Corona Wind Update

Approved Wind Project Area

*Names shortened for generalization.

NORTH

0 3.5 7

Scale in Miles

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Exhibit 6
Soils Summary
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

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Source: Esri, SSURGO Soils Databases, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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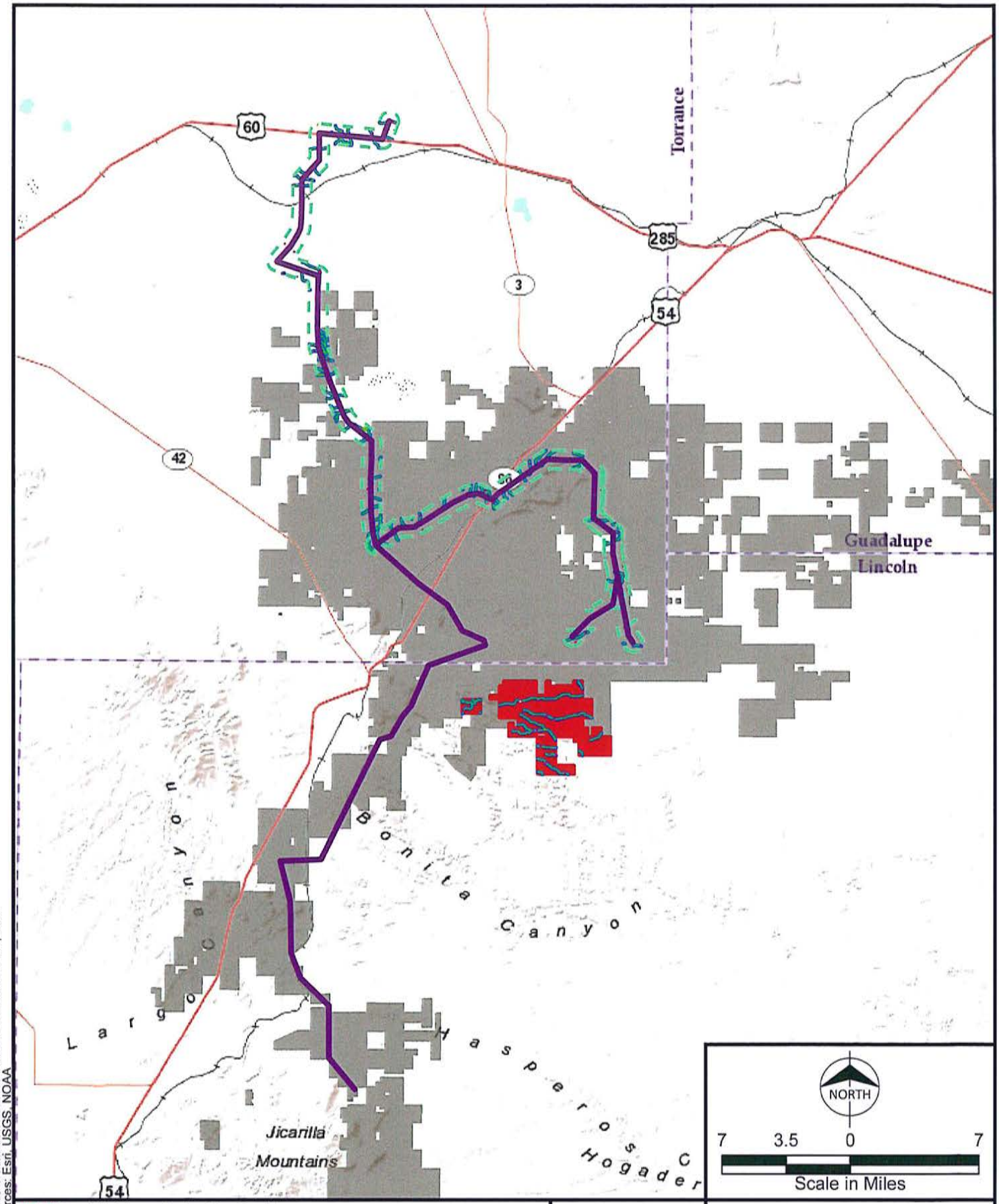

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Exhibit 7
Surface Waters
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, USGS-National Hydrography Dataset (NHD), USFWS-National Wetland Inventory (NWI), Pattern Development, Ventyx/Energy Velocity, and Burns & McDonnell Engineering Company, Inc.

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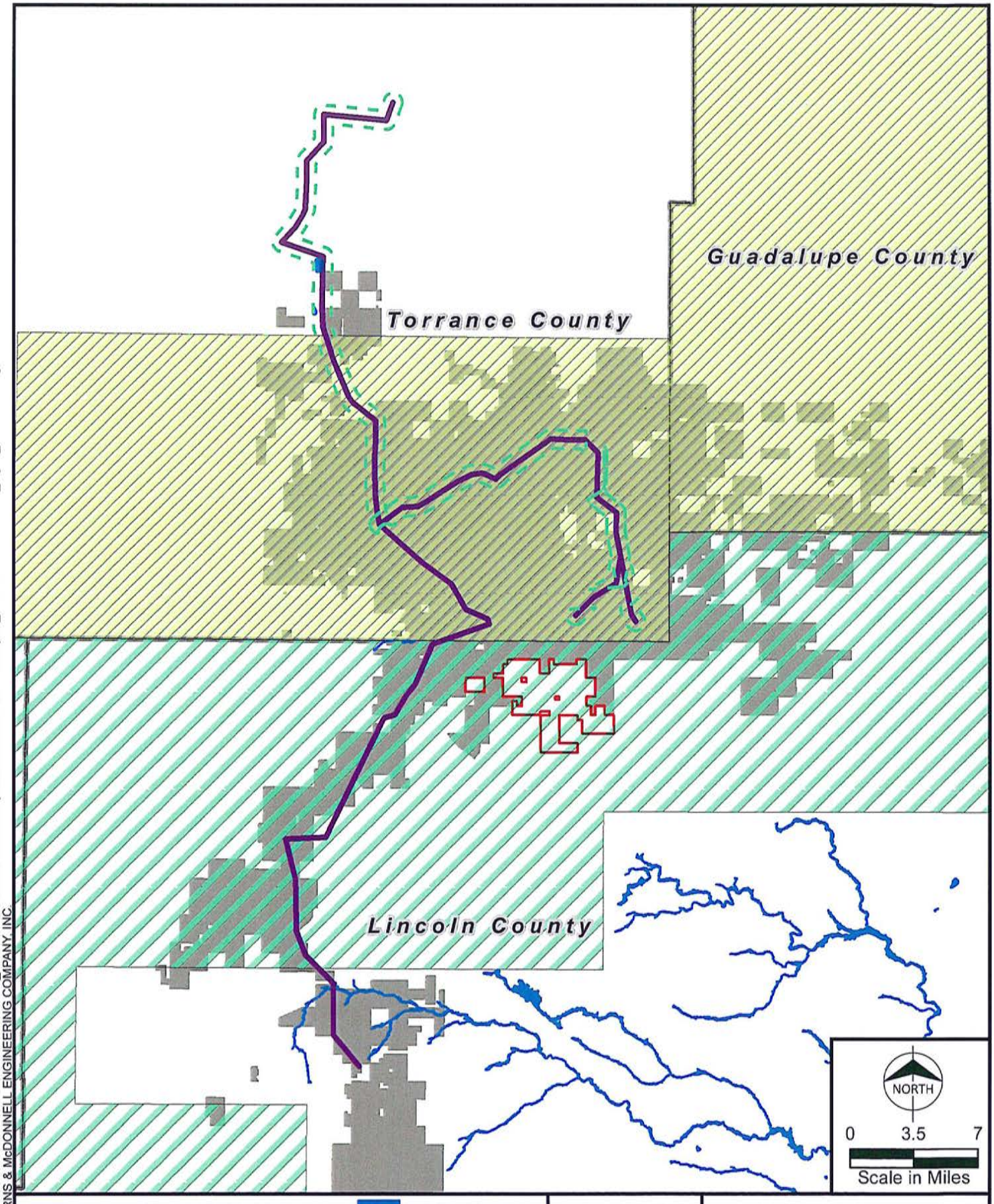

Proposed Transmission Line
One-Mile Transmisison Line Corridor
Corona Wind Update
Approved Wind Project Area
FEMA Designated Zone D
FEMA - Zone A
Unmapped Area

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Exhibit 9
Floodplain Summary
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, FEMA, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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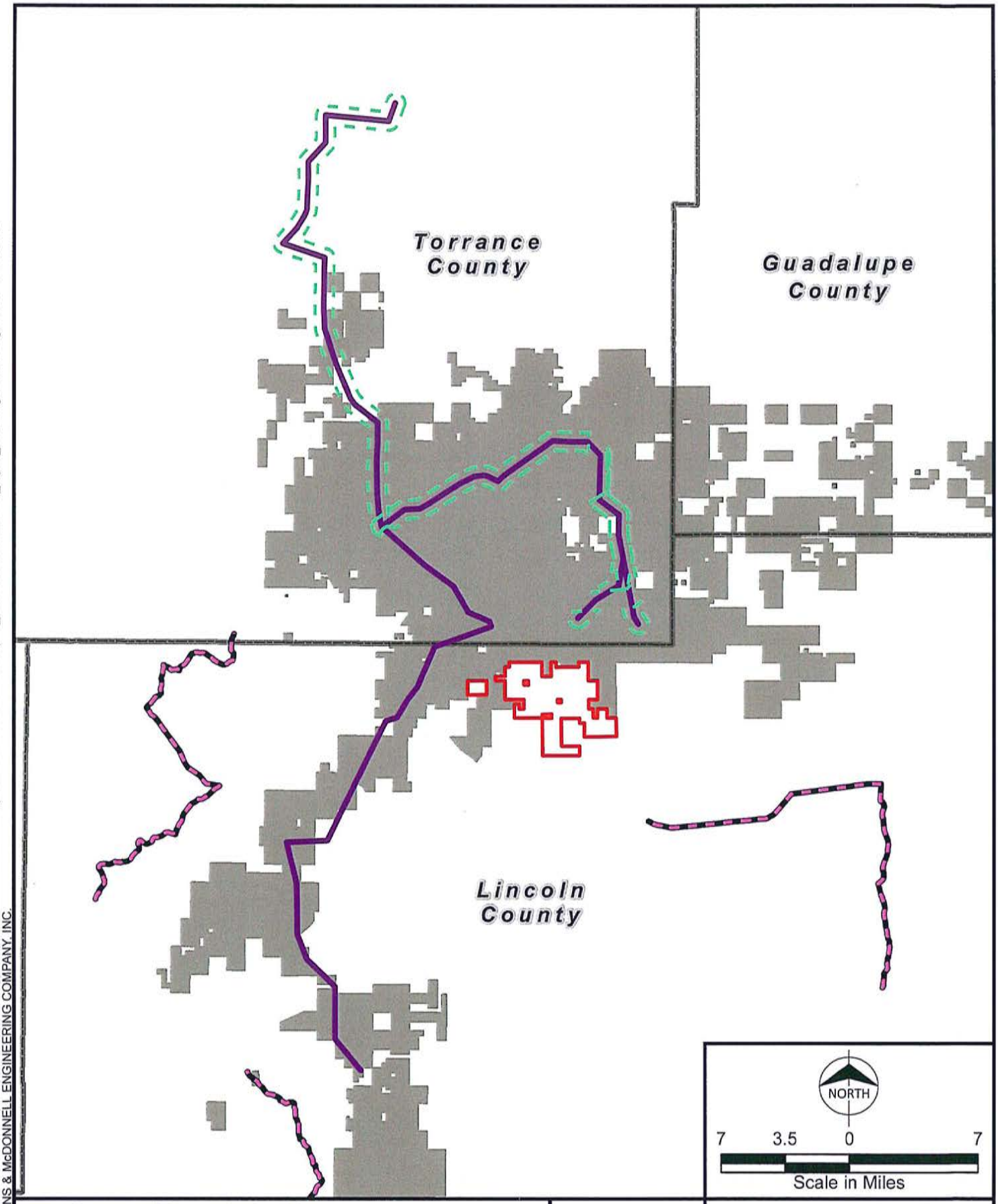

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Exhibit 10
Breeding Bird Survey Routes
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Breeding Bird Survey, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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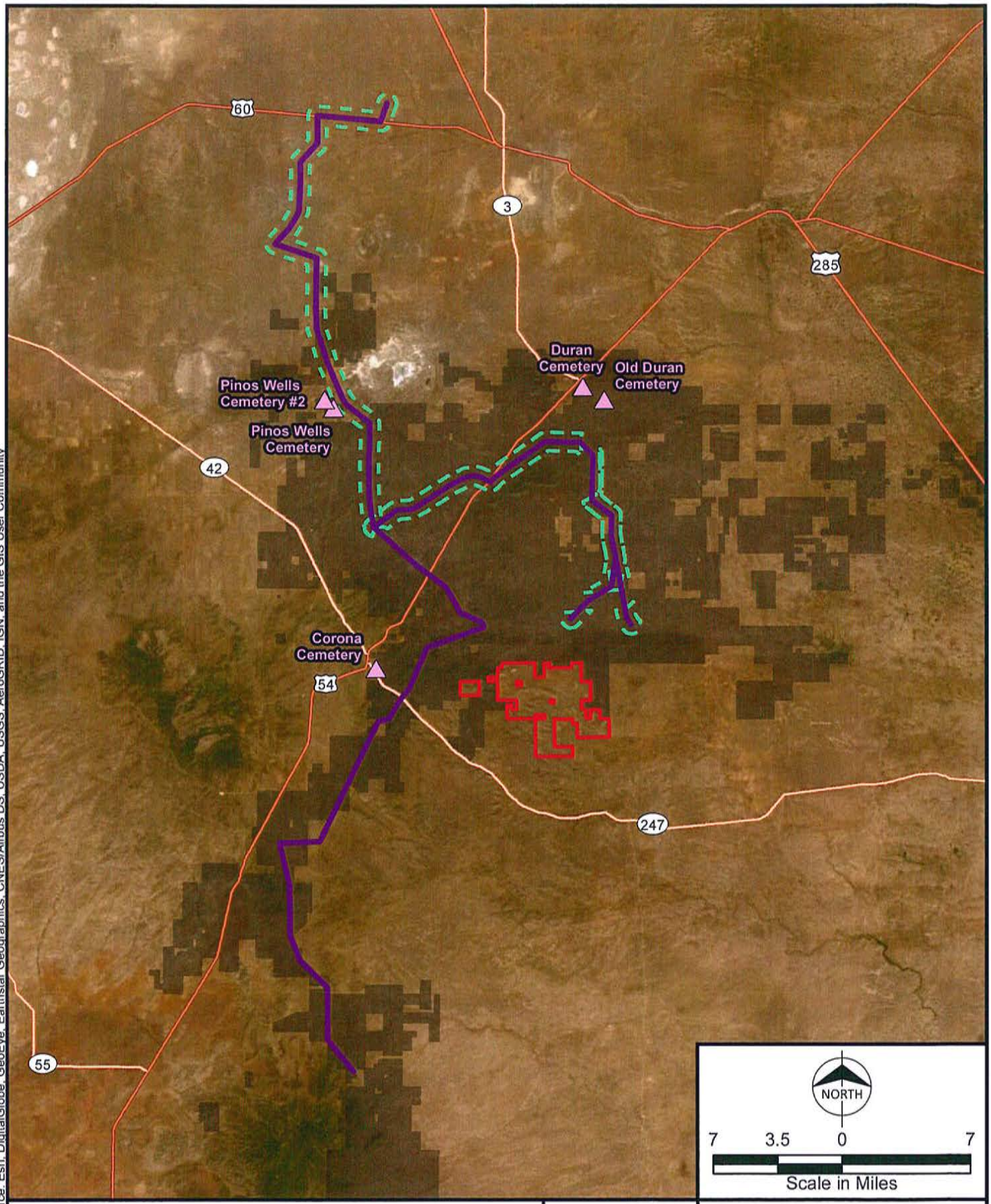

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Exhibit 11
Cemeteries
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

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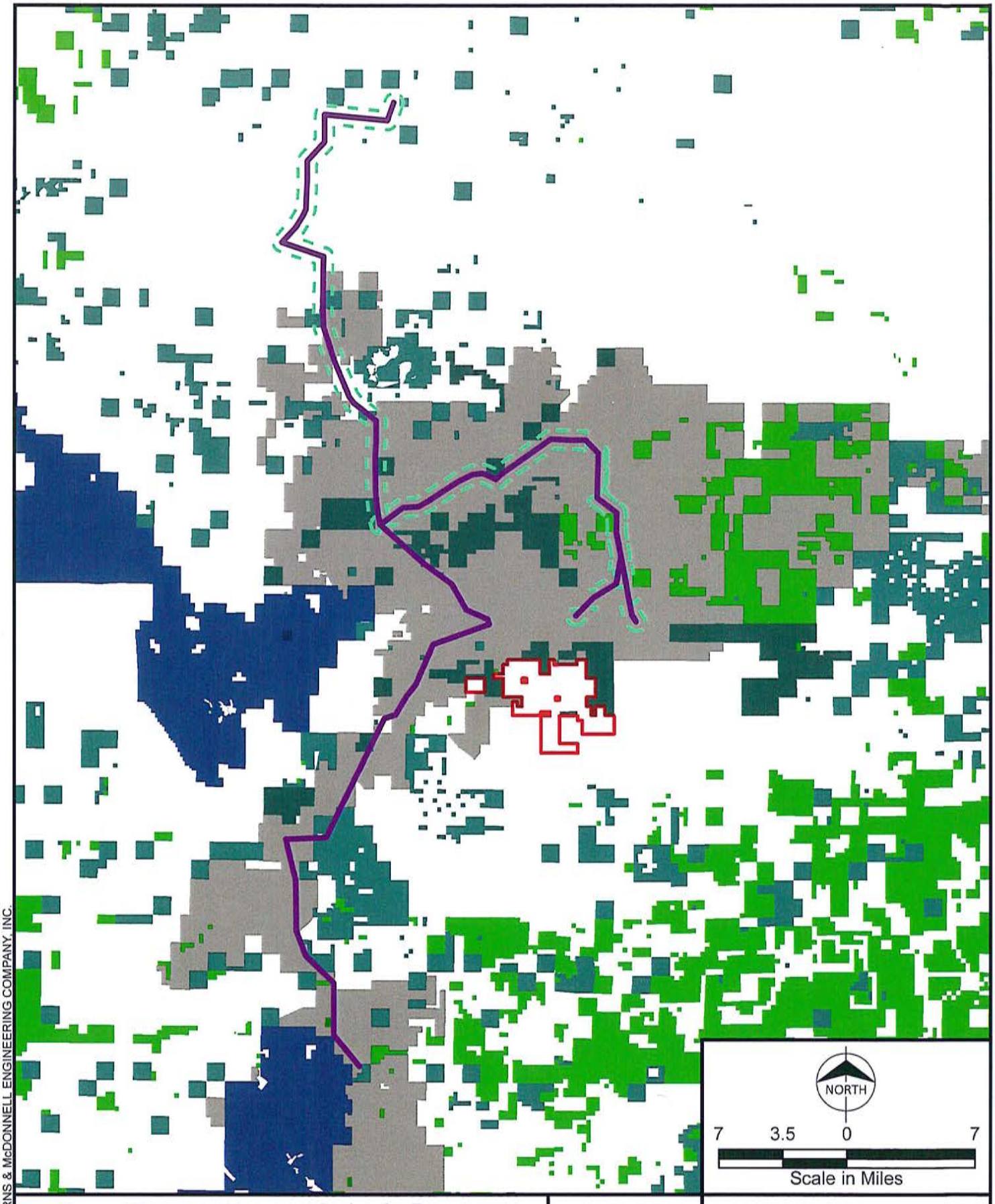

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Exhibit 12
Easement Map
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, PADUS V1.4, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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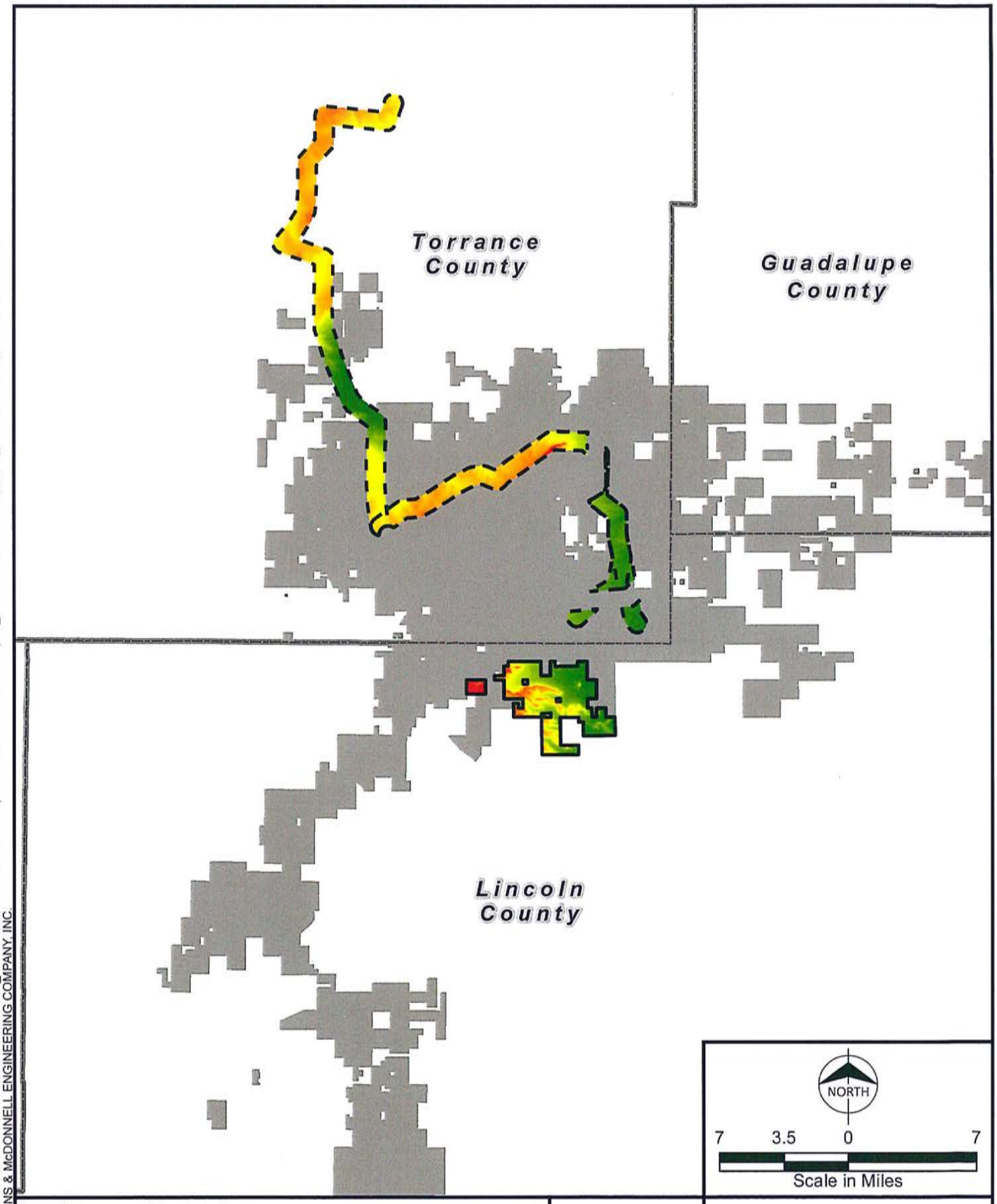

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Exhibit 13
Elevation Map
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, USGS, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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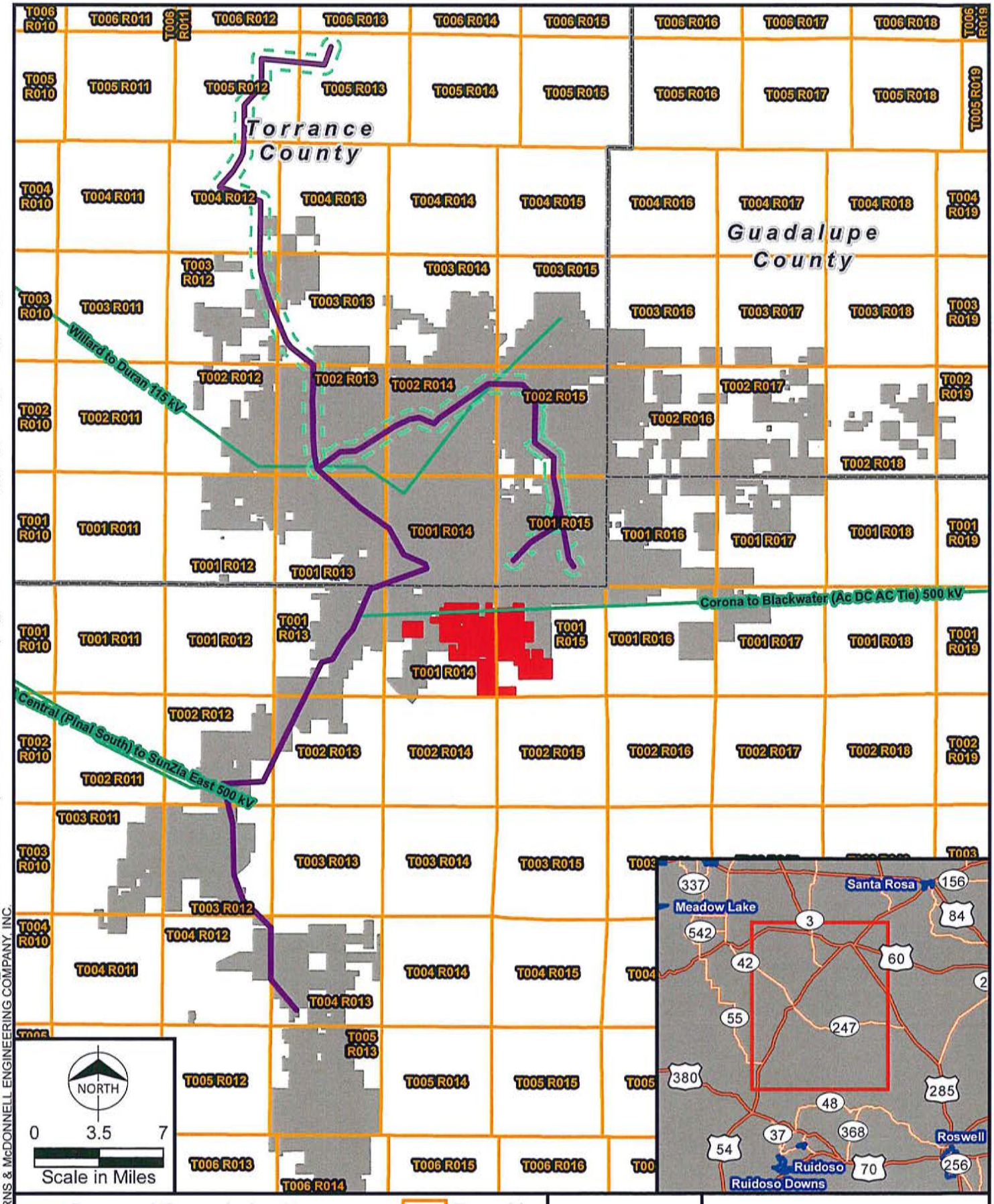

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Exhibit 14
Boundary Summary
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Census, Pattern Development, Ventyx/Energy Velocity, and Burns & McDonnell Engineering Company, Inc.

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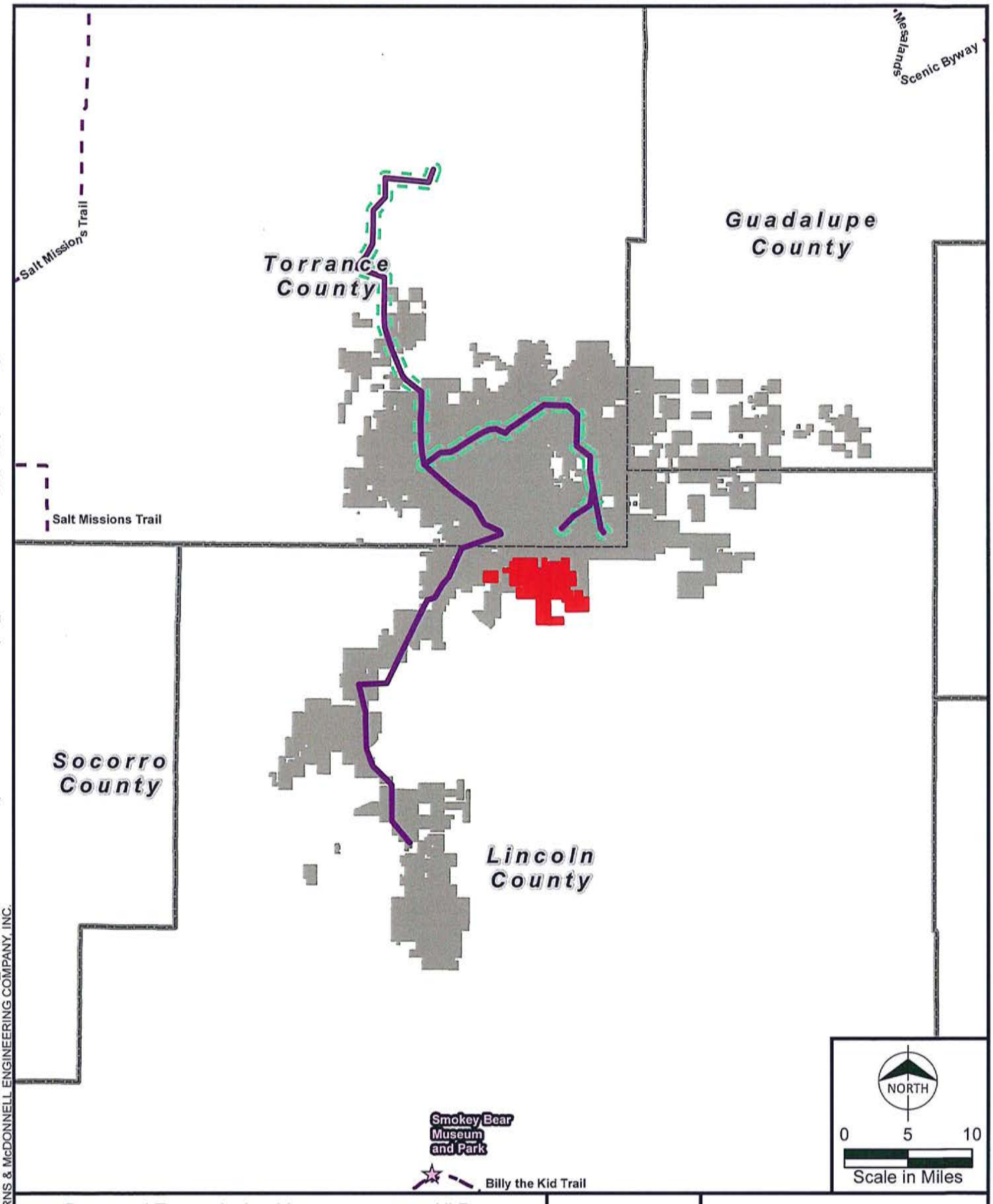

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Exhibit 15
Byways & Trails
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Federal Highway Administration, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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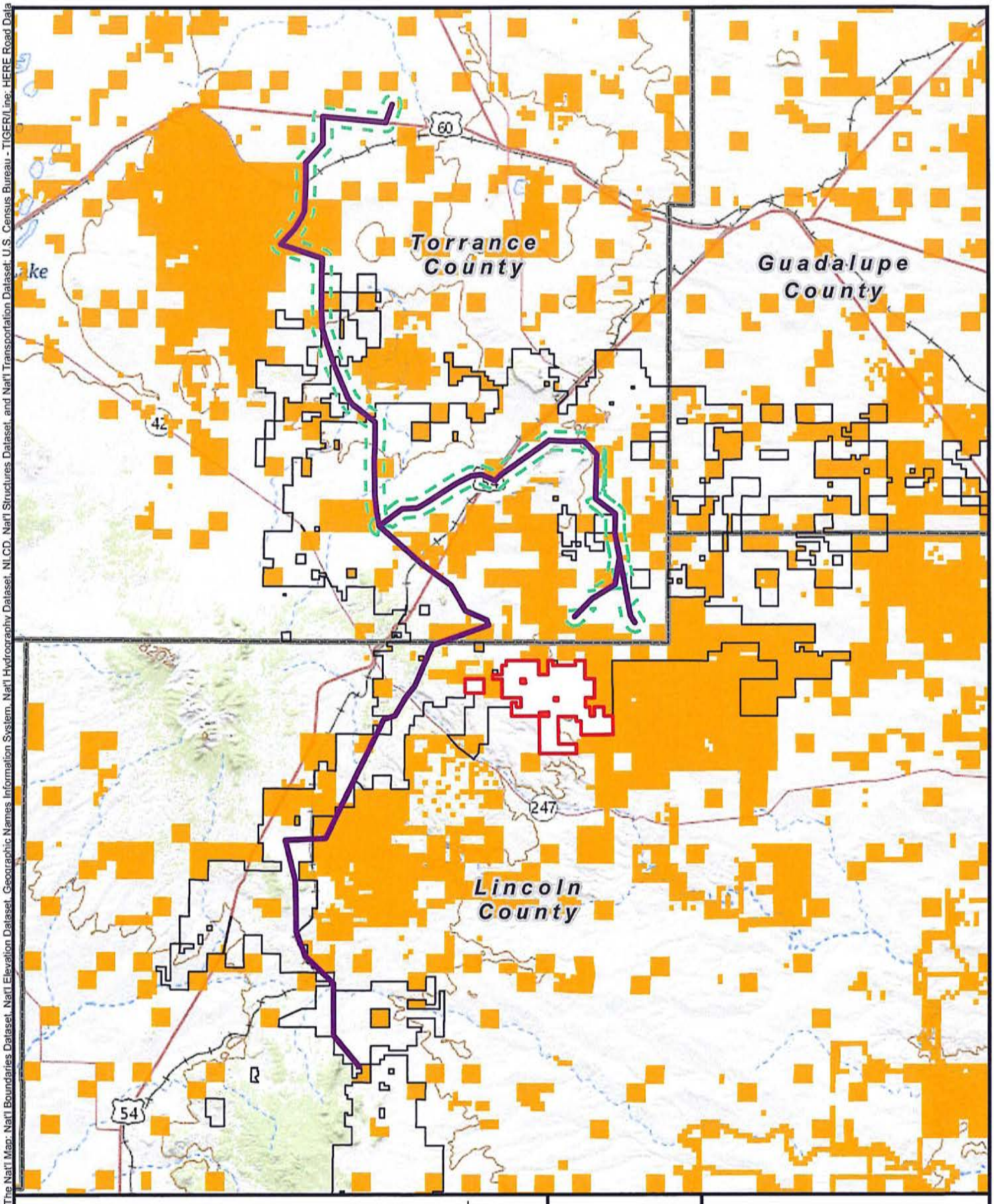

Proposed Transmission Line
One-Mile Transmission Line Corridor
Corona Wind Update
Approved Wind Project Area
State Land

NORTH

0 3.5 7
Scale in Miles

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Exhibit 16
State Lands
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Earth Data Analysis Center (EDAC), Playa Lakes Venture, State Land Office, Pattern Development, and Burns & McDonnell Engineering Company, Inc. Issued: 12/13/2019

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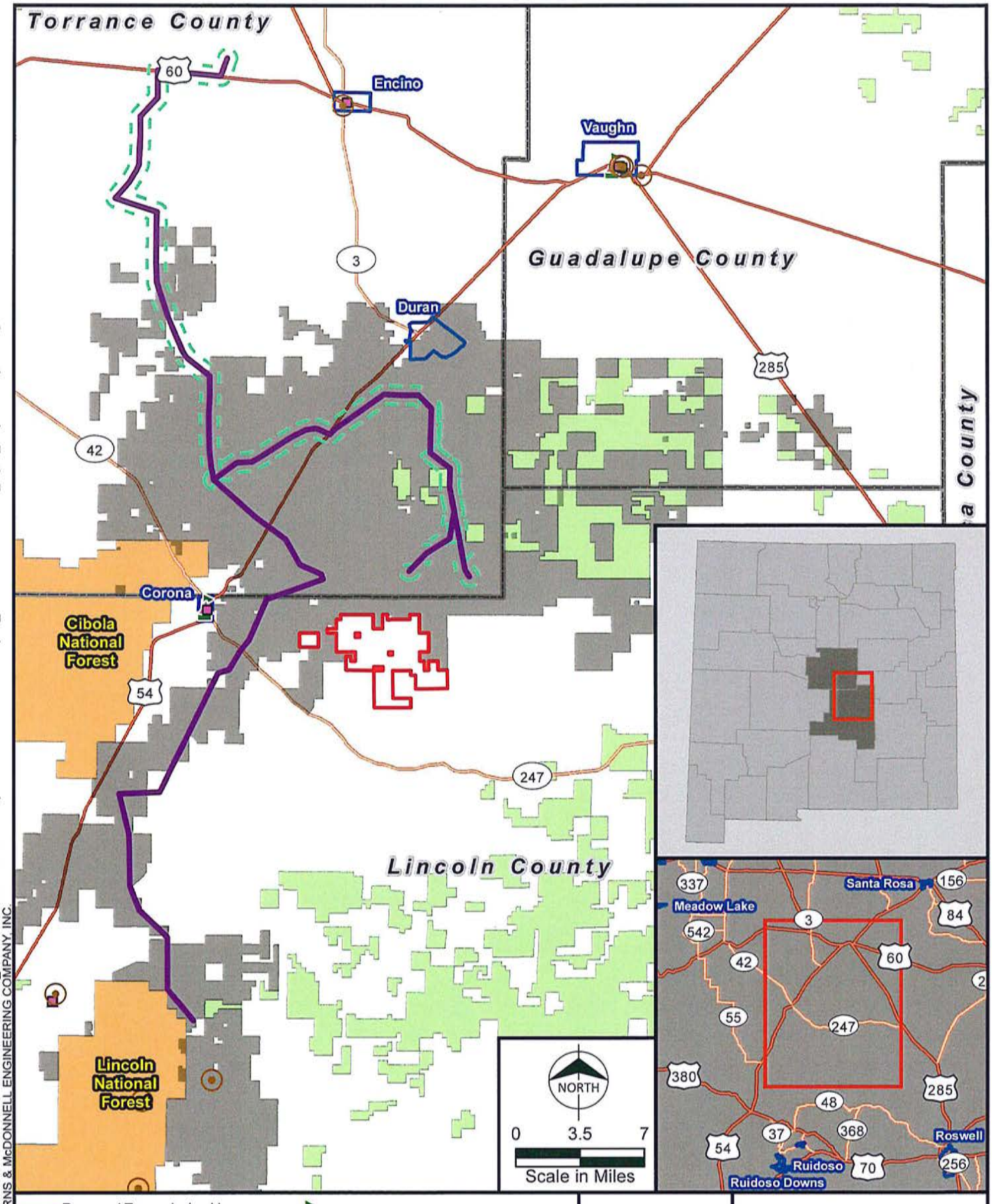

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Exhibit 17
Project Vicinity
Pattern Development
Corona Wind Energy
Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Census, Pattern Development, and Burns & McDonnell Engineering Company, Inc.

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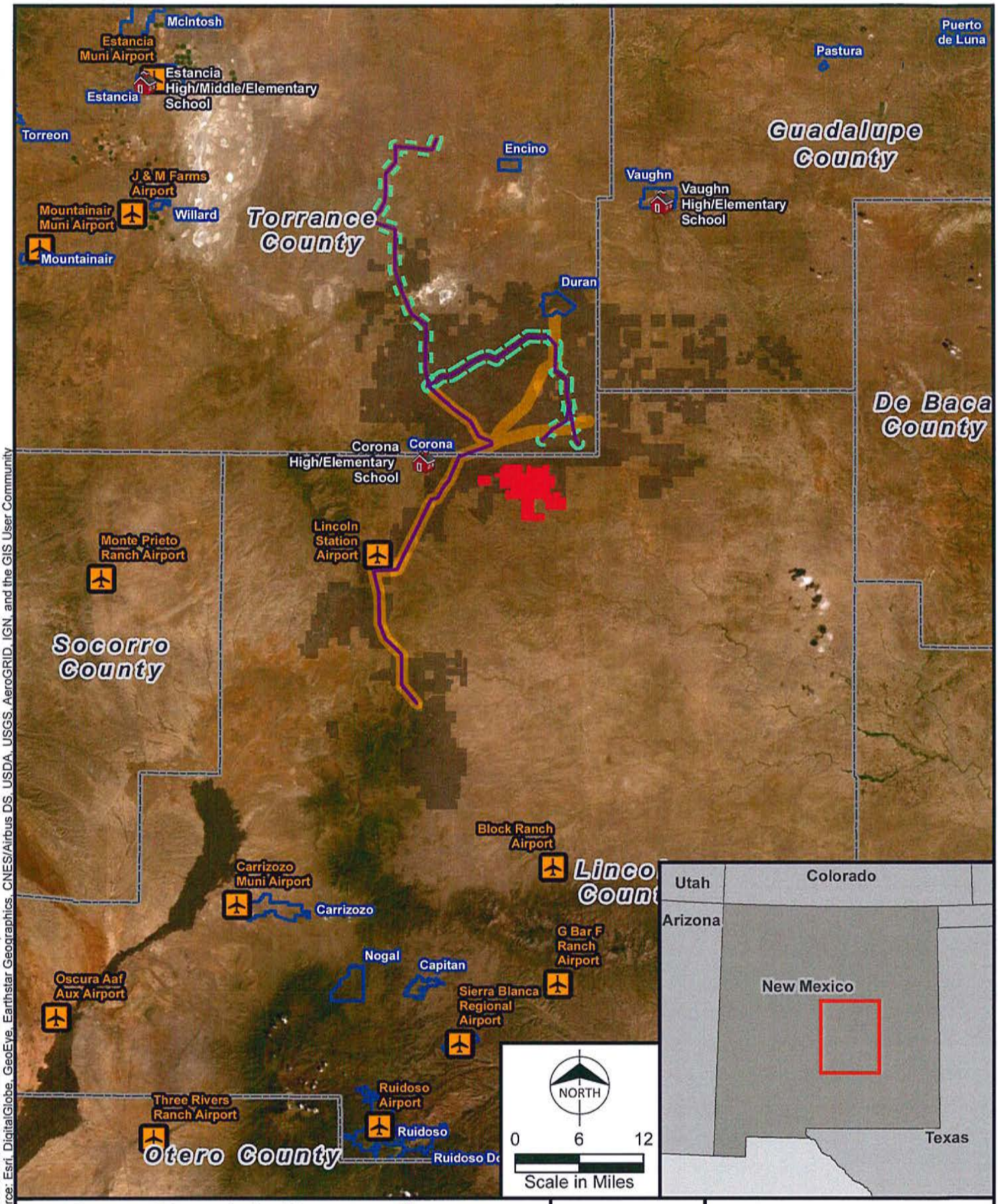

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Exhibit 18
General Vicinity Map
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Pattern Development, Ventyx/Energy Velocity, and Burns & McDonnell Engineering Company, Inc.

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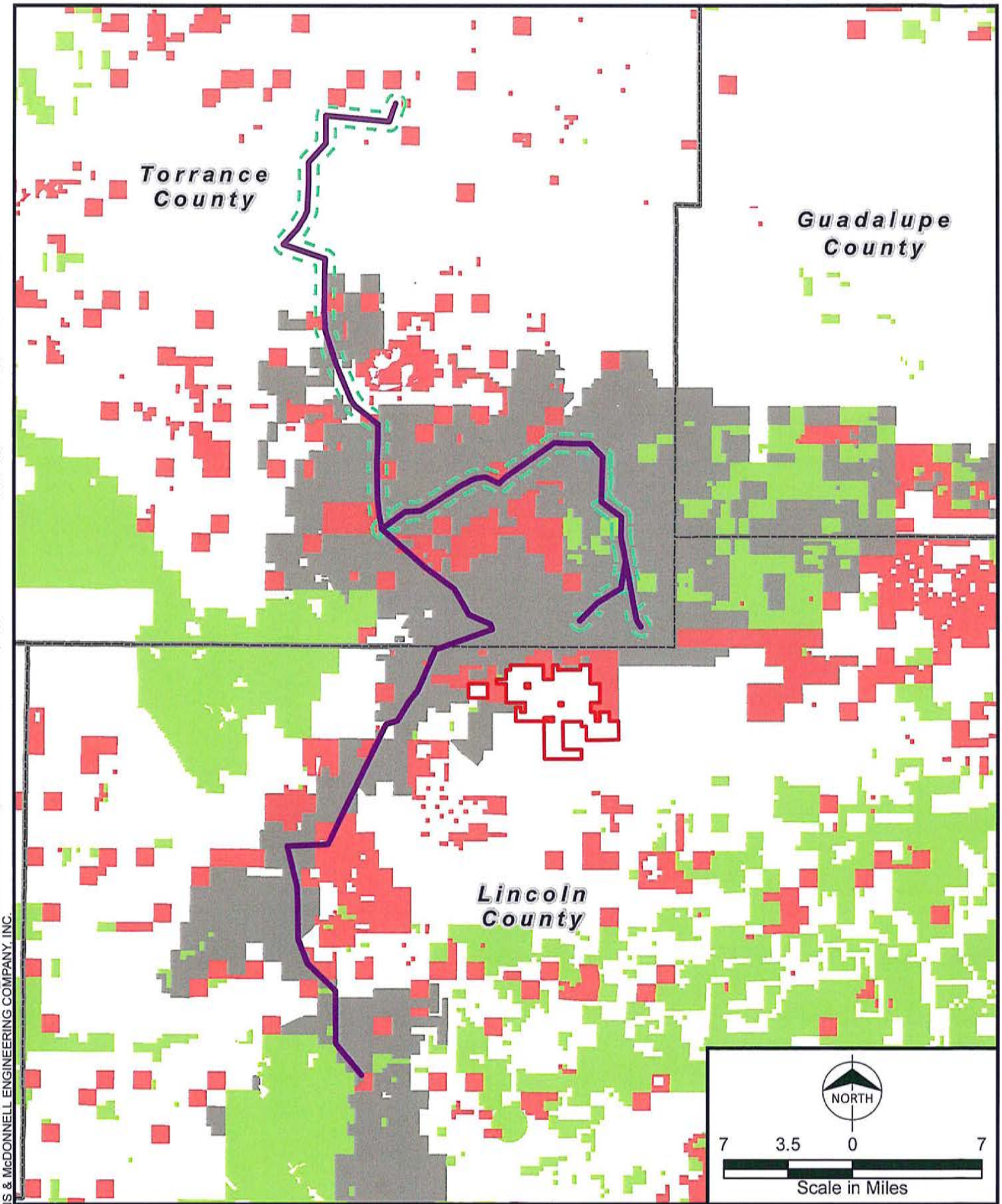

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Exhibit 19
GAP Analysis Program
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

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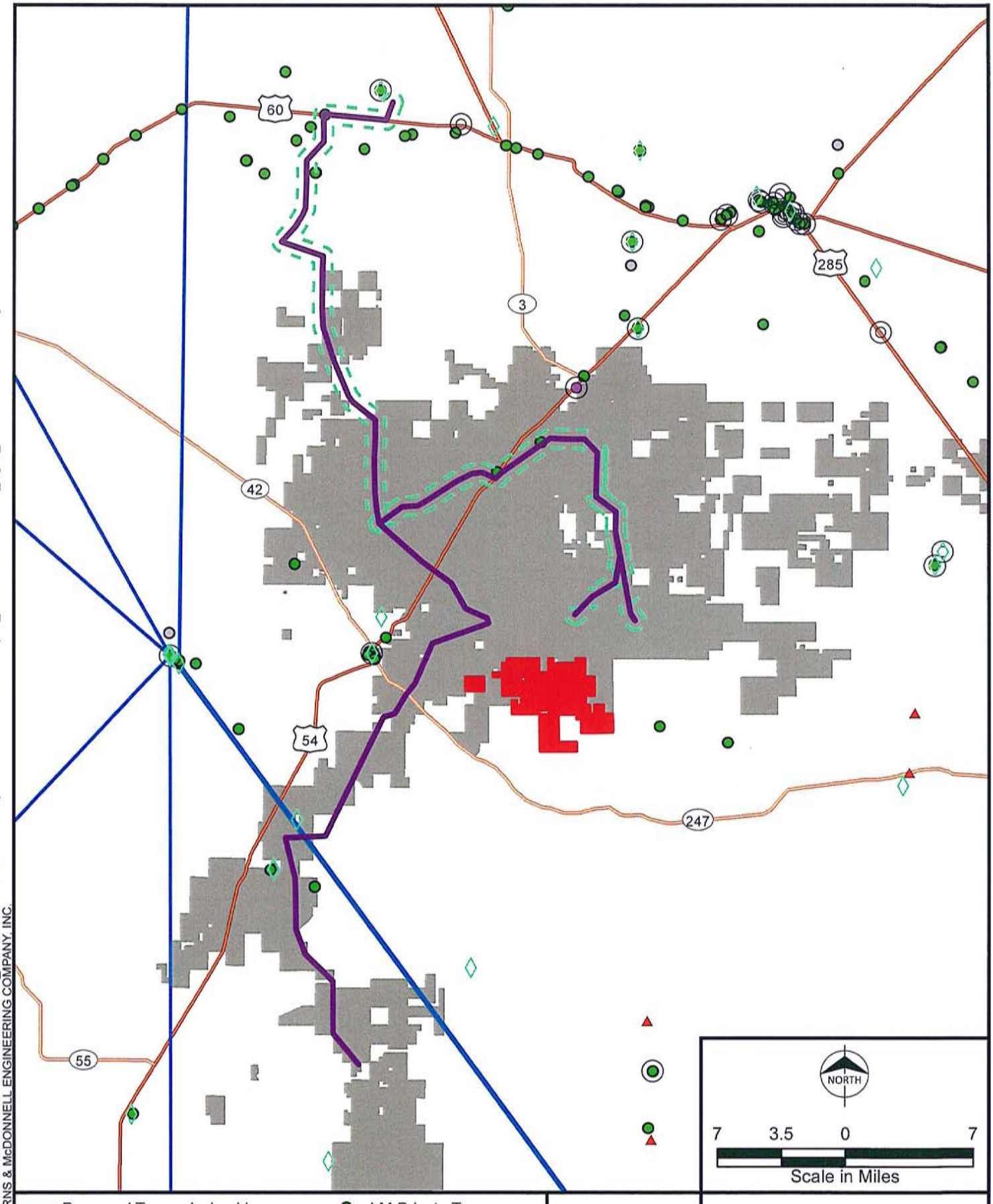

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Exhibit 20
Communications Map
Pattern Development
Corona Wind Energy Project Supplement
Wind Project Area & Gen-Tie
Lincoln & Torrance County, NM

Source: Esri, Census, Pattern Development, FCC, and Burns & McDonnell Engineering Company, Inc.

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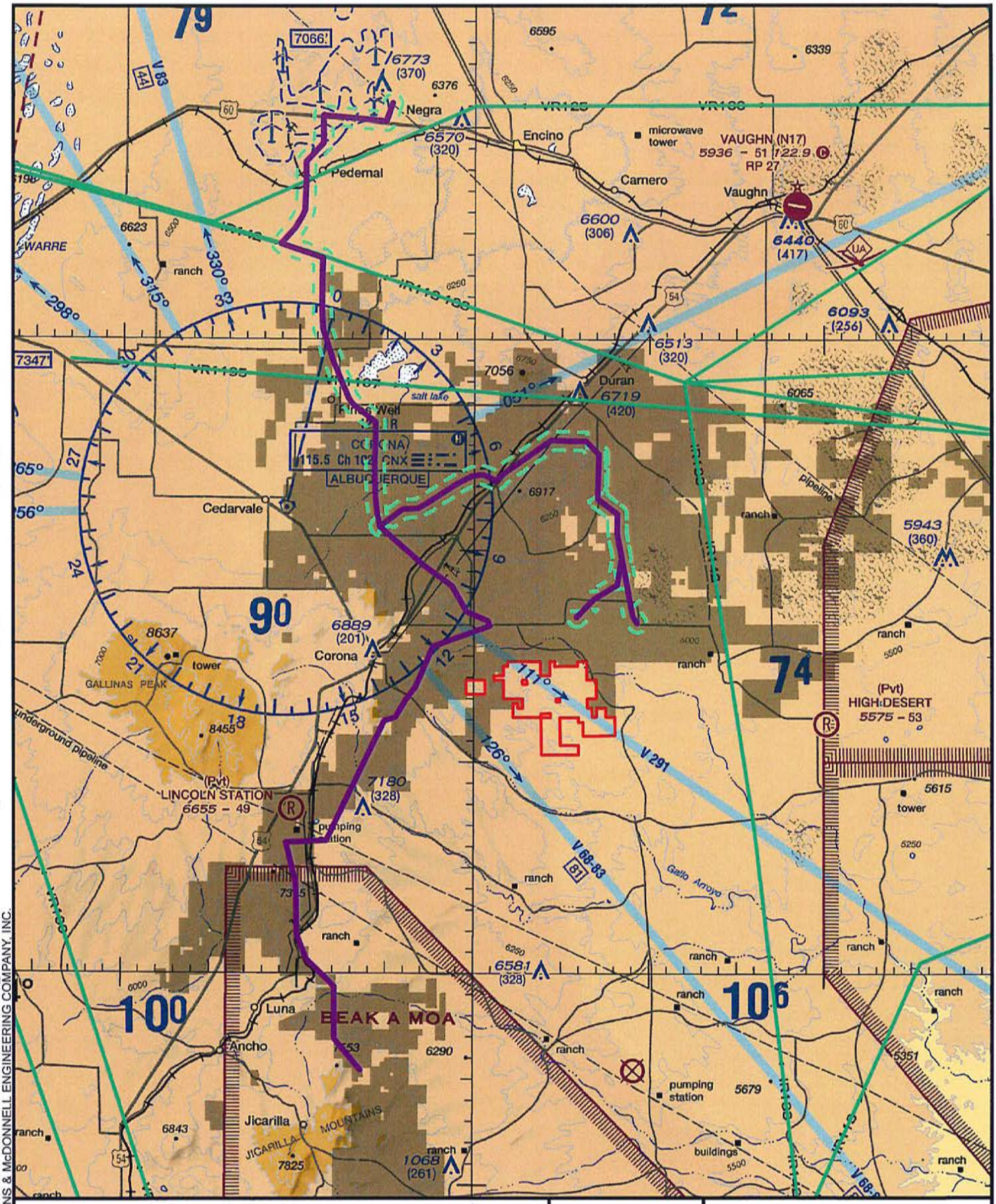

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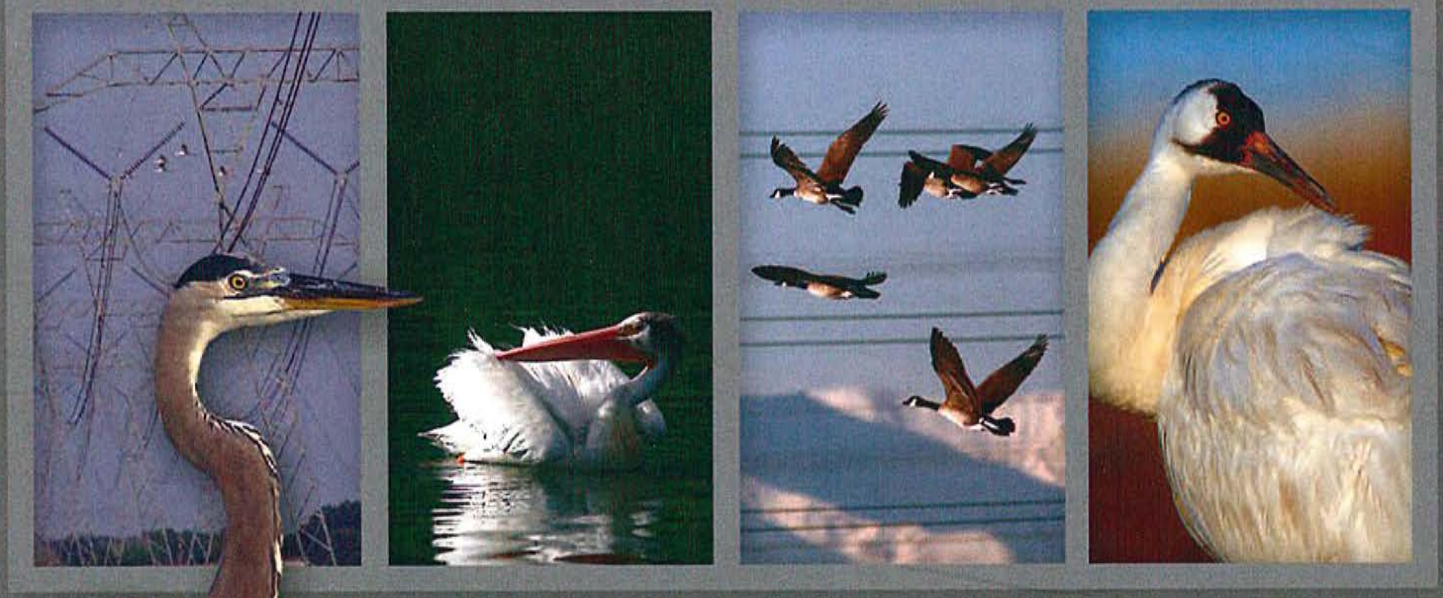
BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit ACC-2

Reducing Avian Collisions with Power Lines



The State of the Art in 2012

Edison Electric Institute
Power by Association

Avian Power Line Interaction Committee

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SAMPLE

Reducing Avian Collisions with Power Lines

The State of the Art in 2012

SAMP

Prepared by:

Avian Power Line Interaction Committee

October 2012



PREVIOUS VIEW

Additional copies of this book may be obtained through:

the Avian Power Line Interaction Committee (www.aplic.org) and the Edison Electric Institute (www.eei.org).

This book should be cited as follows:

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SAMPLE

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SAMPLE

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ABSTRACT

PURPOSE AND SCOPE OF THIS MANUAL

Reducing Avian Collisions with Power Lines (Collision Manual) was first published by the Avian Power Line Interaction Committee (APLIC) and Edison Electric Institute (EEI) in 1994 under the title *Mitigating Bird Collisions with Power Lines*. The 2012 edition of this manual provides electric utilities, wildlife agencies, and other stakeholders with guidance for reducing bird collisions with power lines based on the most current information. This is especially important given the need to reduce bird injury and mortality from collisions, comply with bird protection laws, and enhance the reliability of electrical energy delivery.

PROGRESS IN DEALING WITH COLLISION ISSUES

In the United States, most studies of bird collisions have occurred since the late 1970s. These studies described the problem and led to a growing awareness among stakeholders. In 1989, APLIC was founded to address whooping crane (*Grus americana*) collisions with power lines. APLIC published its first *Collision Manual* in 1994 to summarize the knowledge of bird collisions with power lines at that time. National and international collaboration on bird/power line interactions has since grown. Research today includes studies on collision reduction, monitoring systems, and standardization of collision mortality data collection. Future priorities include improving the comparability of studies, testing and documenting line marker efficacy, and refining remote collision detection devices.

As power line infrastructure expands to meet the growing demand for electricity, the collision risk to avian species also seems likely to increase. Yet, this risk may be reduced by assessing potential avian impacts during line siting and routing, improving line marking devices, standardizing study methods, and increasing awareness.

AVIAN REGULATIONS AND COMPLIANCE

In the United States, three federal laws protect almost all native avian species and prohibit *taking* (killing or injuring) them even if the act was unintended and occurred as a result of otherwise legal activities. The Migratory Bird Treaty Act (16 U.S.C. 703-712) protects 1,007 (2012) North American migratory bird species (50 CFR 10.13). The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c) provides additional protection for these two species. The Endangered Species Act (16 U.S.C. 1531-1555) provides protection to federally listed species (designated as threatened or endangered) and to their critical habitat. Utilities in the United States should work with both the U.S. Fish and Wildlife Service (USFWS) and state wildlife agencies to identify permits and procedures that may be required.

In Canada, two laws protect avian species by prohibiting *take*. The Migratory Birds Convention Act protects most species of migratory birds in Canada. The Canadian Species at Risk Act provides for the protection and recovery of threatened and endangered species. Additional protection for species at risk has been developed by the provincial governments, such as the Alberta Wildlife Act. Utilities in Canada should work with the Canadian Wildlife Service and provincial wildlife agencies to identify permits and procedures that may be required.

UNDERSTANDING BIRD COLLISIONS

Understanding the nature of bird collisions is essential for minimizing them. Bird collisions with power lines result from a complex mixture of biological, environmental, and engineering factors. Biological characteristics include body size, weight, maneuverability, flight behavior, vision, age, sex, health, time of day, season, habitat, and habitat use. Environmental conditions include land uses, weather, visibility, lighting, and sudden disturbances.

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Engineering aspects include size of lines, line placement, line orientation, line configuration, structure type, and sometimes obstruction lighting under Federal Aviation Administration rules.

It is difficult to extrapolate collision risk from one power line study and apply or compare it with other studies because of site-specific conditions and the lack of standard study methods, which result in variability of reported mortality rates. Species of birds reported to be susceptible to collisions generally have a large body size, long wing span, heavy body, and poor maneuverability. Examples include species of loons, storks, grebes, waterfowl, and some species of hawks and eagles. Flight behavior and other biological attributes contribute to species risk. Individual losses from collision mortality are unlikely to affect large and robust populations. However, for species that are rare or endangered, the loss of a few or even one individual may impact a local population or the overall population's viability.

MINIMIZING COLLISION RISKS

Engineers and biologists can work together to identify and address collision issues when modifying existing lines or planning new lines. Early consideration of risk factors may reduce the need for costly modifications later. In addition, while a utility is taking steps to minimize collision risk, a proactive public participation program can address social issues by building positive relationships, increasing public knowledge, identifying and responding to public concerns early, and promoting responsible behavior (e.g., discouraging vandalism of line marking devices).

When modifying existing lines, study options include collision monitoring, line modification studies, and avian risk assessment. Line modifications must be carefully evaluated to identify, quantify, and balance the existing risks with the potential effectiveness and risks posed by the alternatives. Risk reduction options include line marking, managing surrounding lands, removing the shield wire, changing the size or configuration of wires, rerouting the line, and burying lines. Typically, the first options are line marking and managing surrounding lands because the remaining options are seldom feasible.

When planning new lines, three study options can be used to identify the optimal route: spatial analysis using GIS, field assessment, and avian risk assessment. Risk reduction options could include line placement, orientation, and configuration relative to biological and environmental factors.

LINE MARKING DEVICES

Studies suggest that most bird collisions occur with the shield wire, which is the smallest diameter and highest wire on a transmission line. Many studies of lines with high collision rates indicate that collision risk can be lowered by 50% to 80% when these lines are marked, though the most recent study published at this writing demonstrated only a 9.6% reduction (Barrientos 2012). However, recommendations for which device is the most effective and standard spacing are not possible due to differences in study designs and site-specific conditions. As a result of these differences, reduction rates may not be replicable from one line or study to another.

Since 1994, line marking devices have been further developed in North America, Europe, and South Africa. Advances in aerial marker spheres, spirals, and suspended devices include changes to design, colors, attachments, and materials in an effort to improve effectiveness and durability and to reduce possible damage to lines.

AVIAN PROTECTION PLANS

In 2005, APLIC and the USFWS announced their jointly developed *Avian Protection Plan Guidelines (Guidelines)*. An Avian Protection

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Plan (APP) is a voluntary, utility-specific plan for reducing the risks to birds and system reliability that result from avian interactions with electric utility facilities. An APP provides the framework necessary for implementing a program to reduce bird mortalities, document utility actions, improve service reliability, and comply with bird protection laws. The *Guidelines* are intended to help utilities craft their own APPs for managing avian/power line issues that are particular to their location and operations.

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FOREWORD

Avian interactions with power lines, including collisions, electrocutions, and nesting have been documented since the early 1900s. Collisions with telegraph lines were first reported in 1876. However, it was not until the 1970s that biologists, engineers, resource agencies, and conservationists began to realize the extent of these interactions. It was then that they began investigating and addressing collision issues. We commend this early professional leadership in tackling a complex issue and building a foundation of credibility and cooperation that characterizes the relationship between the U.S. Fish and Wildlife Service (USFWS) and the Avian Power Line Interaction Committee (APLIC) today.

In December 1983, an ad hoc group began to address whooping crane *(Grus americana)* collisions with power lines in the San Luis Valley, Colorado. This work led to the 1989 founding of APLIC and the publication of *Mitigating Bird Collisions with Power Lines: State of the Art in 1994 (Collision Manual)*, which became the companion of *Suggested Practices for Raptor Protection on Power Lines: State of the Art in 1981 (Electrocution Manual)*. The 1994 *Collision Manual* brought together what was known about collision mitigation and presented research protocols for studying problem lines. It focused on standardizing these protocols so that data from various studies might be comparable and applicable to the issues experienced by electric utilities nationwide. This theme is carried forth and expanded upon in this 2012 revision.

Today electric utilities across North America recognize that bird/power line interactions may create operational risks, health and safety concerns, and avian injuries or mortalities, all of which reduce electrical reliability and increase a utility's liability. The USFWS is responsible for conserving and protecting United States trust resources covered by the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and Endangered Species Act. It is within this potentially adversarial framework that the longstanding collaborative partnership between industry and agency has emerged.

With this edition of the *Collision Manual* (now titled *Reducing Avian Collisions with Power Lines*) along with the 2006 *Electrocution Manual*, the 2005 *Avian Protection Plan Guidelines*, and Edison Electric Institute's 2001 *Introduction to Public Participation*, utilities have a toolbox of the latest technology, science, expertise, and field experience. APLIC and the USFWS hope you will use this edition of the *Collision Manual*, along with its companion documents, to help implement avian protection plans, conserve protected birds, and improve electrical system reliability.

Jerome Ford
USFWS, Assistant Director Migratory Bird Program

Dave Bouchard
APLIC, Immediate Past Chair

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THIS PUBLICATION IS DEDICATED TO THE MEMORY OF

Richard "Dick" S. Thorsell

(April 11, 1927 – April 15, 2012)



Dick Thorsell had a lifetime devotion to birds and was one of the founders of APLIC. He brought electric utilities, government agencies, and environmental groups together to work in cooperation to study and mitigate bird deaths from power line collisions and electrocutions. Dick came to the Edison Electric Institute (EEI) in 1970 after serving as the Executive Director of the Stony Brook–Millstone Watershed Association in New Jersey. Dick was the producer of films on utility/natural resource issues, including *Silver Wires, Golden Wings.* The film featured Morley Nelson's work on understanding and reducing raptor electrocutions. It brought awareness of electrocution issues to electric utilities and credibility to the industry for its efforts to address the problem.

Dick was a WWII Navy veteran, and in 1953 he graduated from Lehigh University with a B.A. in Conservation. During the summer of 1950, he took a job as a Ranger Naturalist for the U.S. National Park Service. In 1954, as a graduate student, he travelled to Bermuda to help determine what was destroying nests of the Bermuda petrel, or cahow *(Petrodroma cahow)*, a bird that until 1951 was thought to have been extinct for more than 300 years. During 47 days of field observations he conceived a way to reduce nest predation of the cahow by the more aggressive white-tailed tropic bird *(Phaethon lepturus)*, known in the islands as the longtail. His solution was credited as one of the most critical developments in the cahow's recovery and conservation.

In 1988, Dick was honored by the Raptor Research Foundation for his pioneering efforts in raptor protection: *"All who appreciate the flight, spirit, and symbolism of the golden eagle are in your debt; and those who know you well enough understand that having hundreds, if not thousands of living eagles to your credit, is sufficient personal award for your accomplishments."*

Dick received APLIC's Morley Nelson Award in 2009 to acknowledge his efforts in pioneering avian/power line conservation and his dedication to developing and maintaining positive partnerships among the key interests in avian/power line issues.

Dick retired from EEI in1991 and pursued his personal interests while remaining ever ready to advise the industry on developing issues and to keep us on track.

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CHAPTER 1

Introduction

IN THIS CHAPTER

- Purpose and Scope of the Manual
- Reader Guide to the Manual
- Overview of Power Lines
- Perspectives for Dealing with Bird Collisions

Some birds flying in the vicinity of power lines may be susceptible to collision. While power lines are only one of numerous causes of bird injury and mortality, collisions with power lines can be reduced. This chapter introduces the problem of bird collisions, defines the categories and configurations of power lines, and presents the biological, engineering, economic, and social and cultural perspectives on bird/power line collisions.

PURPOSE AND SCOPE OF THE MANUAL

Reducing Avian Collisions with Power Lines (Collision Manual) was first published by the Avian Power Line Interaction Committee (APLIC) and the Edison Electric Institute (EEI) in 1994, under the title *Mitigating Bird Collisions with Power Lines*, as a comprehensive review of avian collisions with power lines (collisions) and recommendations for minimizing them. Since 1994, the understanding of bird collisions and the methods for reducing them has grown (e.g., Bevanger 1994, 1998; Janss 2000; Rubolini et al. 2005; and Jenkins et al. 2010). Collisions with power lines cannot be eliminated, but they can be reduced. This edition of the manual builds upon the foundation of the 1994 *Collision Manual* using the research and experience gained through the years since its original publication.

Power lines are an integral part of the modern landscape. Estimates of the number of miles of transmission lines in the United States range from 862,000 kilometers (km) (535,622 miles [mi]) (J. Goodrich-Mahoney, EPRI, pers. comm.) to 1,024,534 km (636,616 mi) (EEI 2010) based on 2009 and 2010 data from the Federal Energy Regulatory Commission, North American Electric Reliability Corporation, and other sources. For distribution lines, the number of miles is less certain, but it is about five to six times that of transmission lines based on two large company systems (D. Bouchard, pers. comm.).

Some bird species that are active in the vicinity of power lines are more susceptible to collision and electrocution risk than others. The risks and reduction measures for bird electrocutions are addressed in the publication *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (APLIC 2006).

Power lines are only one of numerous anthropogenic causes of bird collision mor-

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tality. Others include tall buildings, windows, vehicles, communication towers, airplanes, and wind turbines (Avery et al. 1980; Erickson et al. 2005). Estimates of bird collision mortality vary widely because of differences in mortality monitoring and extrapolations of those data. Based on reviews, Erickson et al. (2005) estimated that buildings and windows account for most bird collision mortality in the United States, followed by power lines, automobiles, communication towers, and wind turbines. This manual only addresses bird collisions with power lines.

Interactions between birds and power lines are a complex mixture of biological, environmental, and engineering factors. Electric utility stakeholders need to understand the nature of bird interactions with power lines when siting, routing, and designing power lines and determining mortality reduction measures. This is especially true given the need to reduce bird collisions, comply with bird protection laws, and enhance reliable electrical energy delivery.

This manual was developed for electric utilities, wildlife agencies, and other stakeholders and is based on what is known to date about collisions. It is intended to provide this audience with:

- An overview of power lines and perspectives on dealing with avian/power line collisions (Chapter 1)
- A summary of current knowledge, literature, and field experience related to avian collisions with power lines and the factors that influence them (Chapters 2 and 4)
- A discussion of the laws, regulations, and the operational implications of avian collisions (Chapter 3)
- A review and discussion of current practices for planning, management options, study design, and devices used to minimize avian collisions with power lines (Chapter 5, Chapter 6 and Appendix B)
- An overview for developing an Avian Protection Plan (Chapter 7)
- A compilation of collision literature spanning several decades (Appendix A)
- A glossary of collision terms and resources for further information (Appendices C and E)

WIP

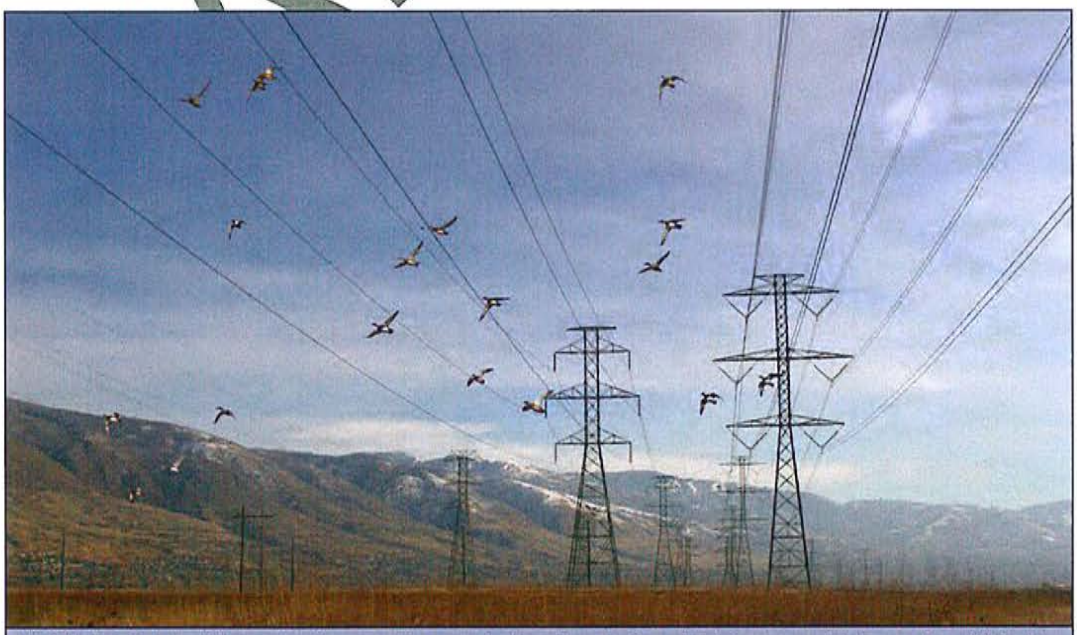

FIGURE 1.1: The highest wire on a transmission line is the shield wire, which can be difficult for birds, especially flocking birds such as waterfowl, to see.

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READER GUIDE TO THE MANUAL

Table I.I provides a quick guide to common collision topics in this manual. Readers can also search the electronic version (a CD is included) for specific keywords. This manual consists of the following chapters and appendices.

TABLE 1.1: Quick guide to the Collision Manual.

Subject	Chapter(s)
Power lines, voltage, and the electric power system	1
Perspective of power line engineers	1, 4, 5, 6
Perspective of biologists	1, 4, 5, Appendix B
Perspective of the public and other stakeholders	1, 5, 6, 7
Advantages and disadvantages of underground power lines	1, 5
History of bird collisions and mitigation	2, 6, Appendix A
Current state of knowledge related to bird collisions	2, 4, 5, Appendix A
Funding organizations for collision research	2, Appendix E
Study methods and options	2, 4, 5, Appendix B
Strategies and approaches to address bird collisions	2, 4, 5, 6, 7
Laws and policies governing birds and bird mortality	3
Permits related to bird laws and policies	3
Factors that contribute to collisions	4
Variability in reported collision mortality rates	4
Significance of mortality for bird populations	4
Scientific methods to assess risk and impacts	4, 5, Appendix B
Methods for reducing bird collisions on an existing power line	5, 6
Methods for routing and designing a new power line while minimizing bird collisions	5, 6
Benefits of public participation	5, 7
Legal issues and other considerations for line marking	6
Effectiveness of line marking devices	6
How to develop a voluntary, utility-specific Avian Protection Plan	7

- Chapter 1. Introduction
- Chapter 2. Progress in Dealing with Collision Issues
- Chapter 3. Avian Regulations and Compliance
- Chapter 4. Understanding Bird Collisions
- Chapter 5. Minimizing Collision Risks
- Chapter 6. Line Marking to Reduce Collisions
- Chapter 7. Avian Protection Plans
- Appendix A. Literature Cited and Bibliography
- Appendix B. Designing Site-Specific Studies for Collision Monitoring
- Appendix C. Glossary
- Appendix D. Acronyms
- Appendix E. Resources

SAMPLE

OVERVIEW OF POWER LINES

TRANSMISSION VERSUS DISTRIBUTION LINES

Power lines are rated and categorized, in part, by the level of electrical voltage they carry. Because the amount of electricity is large, voltage is usually specified as kilovolts (kV) where 1 kV is equal to 1,000 volts (V). In a power system, from the power generation facility to the customer (Figure 1.2), four voltage classifications are used: power source, transmission, distribution, and utilization (Table 1.2). Although there are exceptions to these voltage classifications, they hold in general and will be used this way in this manual.

Voltage classification also depends on the purpose a power line serves. Transmission lines (≥60 to 765 kV) are used to transmit large blocks of electricity from the power generation facility to the load centers (communities). Within load centers, the high voltage of transmission lines is reduced at substations and then delivered via distribution lines (2.4 to 60 kV) for residential, commercial, and industrial uses. The distribution voltages are again stepped down to the lower voltages for the end user (120 to 600 V) usually by pole- and pad-mounted transformers. Both transmission and distribution lines are power lines, a term used throughout this manual (Figure 1.3).

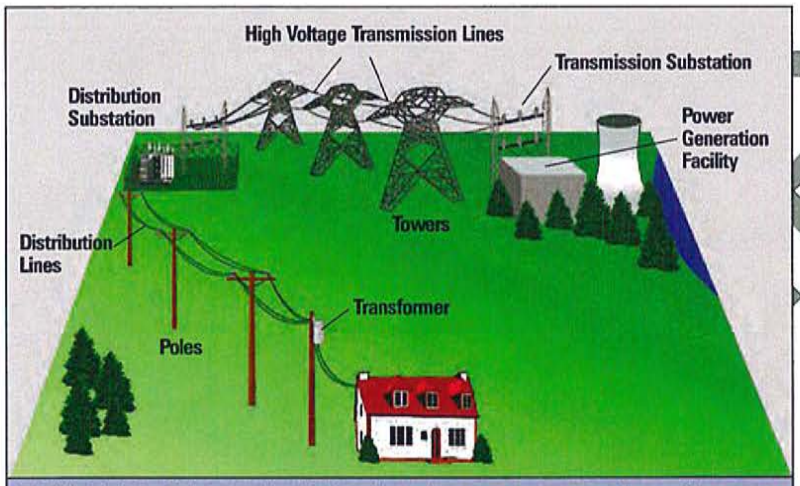

FIGURE 1.2: Schematic of the electric power system from the generation facility to the customer (modified from Rural Utilities Service).

TABLE 1.2: Voltage classifications in North America.

Classification	Voltage
Power Generation Facility	12 V to 22 kV
Transmission	60 to 765 kV*
Distribution	2.4 to 60 kV
Utilization	120 to 600 V

* This is the typical range for transmission; however, there are exceptions.



FIGURE 1.3: Transmission lines (left) and distribution lines (right).

© JERRY LIGUORI (LEFT) AND DAVE BOUCHARD, AEP (RIGHT)

PREVIEW

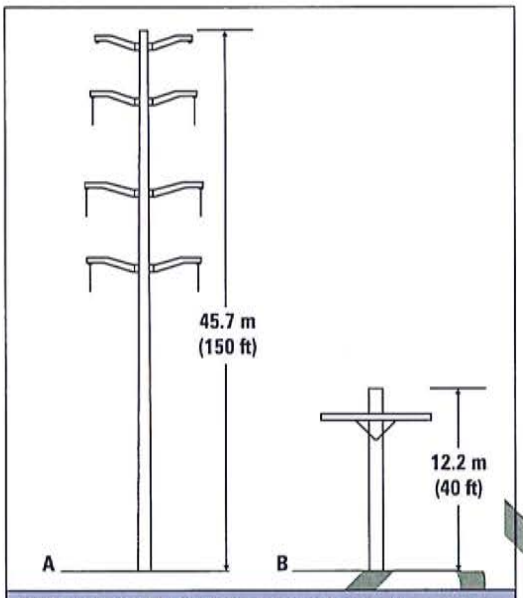

FIGURE 1.4: Height comparison of transmission (typically 18.3 to 58 m [60 to 190 ft] tall) (A) and distribution structures (typically 6.4 to 14.6 m [21 to 48 ft] tall) (B).

POWER LINE CONFIGURATION

Power lines may be energized (carrying electricity) or non-energized (grounded). Energized lines are called phase conductors. Distribution lines may have one, two, or three phase conductors per circuit. Alternating current (AC) transmission lines always have three phases per circuit, and structures may carry multiple circuits. For example, a three-phase, double-circuit line would have six phase conductors. Phase conductors may be configured horizontally or vertically on the tower or pole (Figure 1.5). High voltage transmission lines may be bundled, which means two to six lines per phase are placed in close proximity to each other instead of using only one line per phase (Figure 1.6). Distribution lines may also be installed on transmission structures below the transmission lines; this is referred to as a distribution underbuild (Figure 1.7).

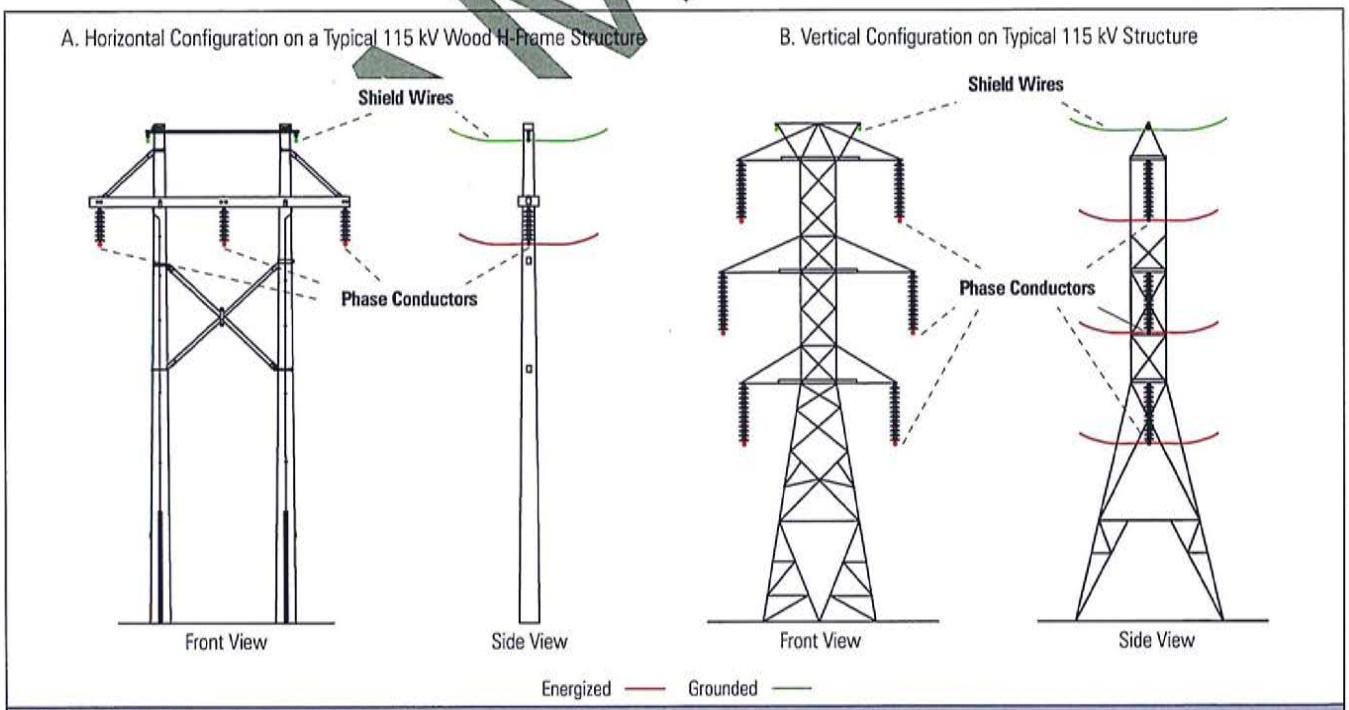

FIGURE 1.5: Horizontal (A) and vertical (B) transmission line configurations.

NOT

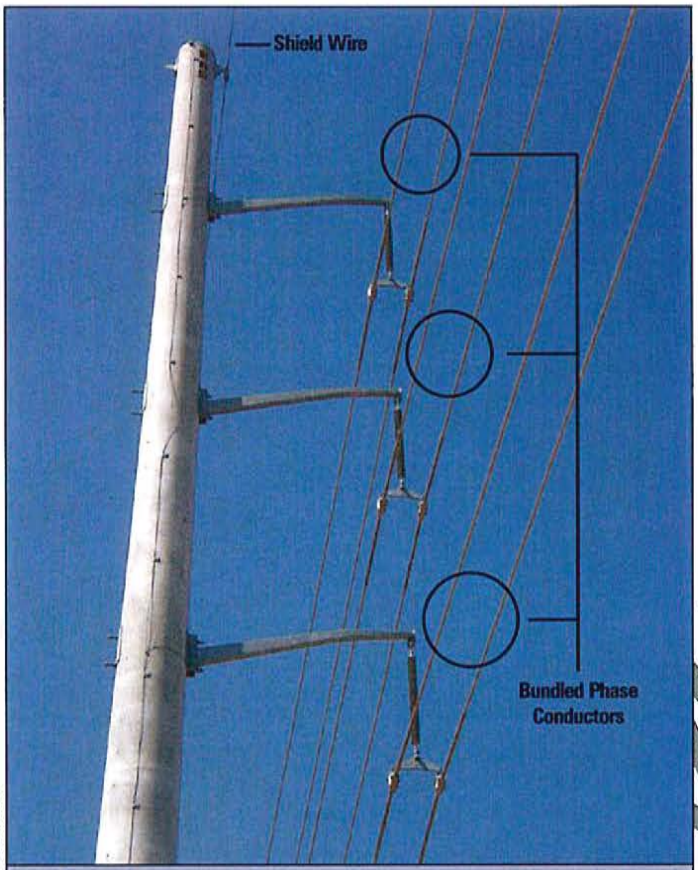

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FIGURE 1.6: Bundled phase conductors on a three-phase, single-circuit, 138-kV transmission line.

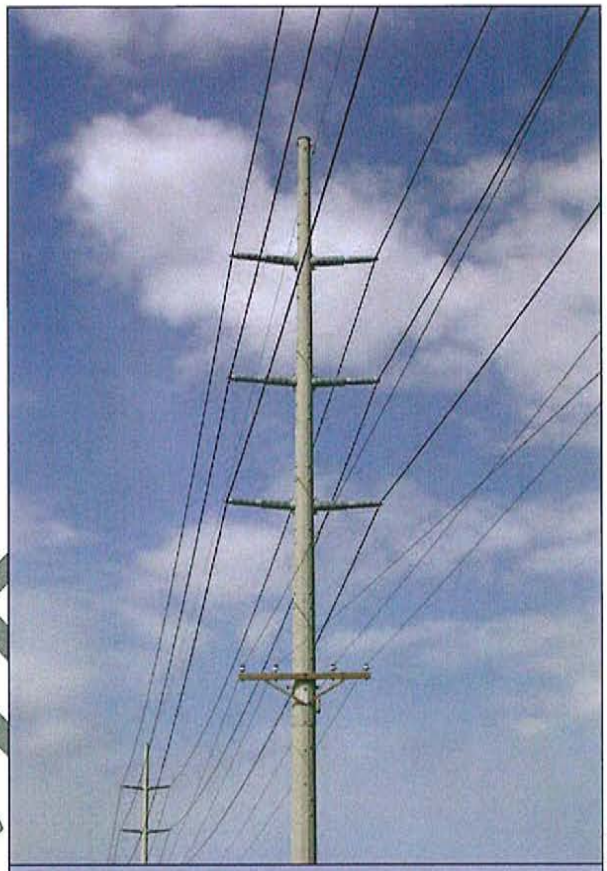

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FIGURE 1.7: Distribution underbuild on a double-circuit transmission line.

Non-energized conductors are at ground potential or zero voltage potential. There are two kinds of non-energized conductors: shield wire (also called static wire or overhead ground wire) and neutral wire.

Shield wires are installed above the phase conductors on transmission lines to protect them from lightning (Figure 1.8). Static electricity from the shield wire is taken to earth (ground) by grounding conductors. In a low lightning area, some transmission lines with lower voltages (e.g., 69 kV) may not have a shield wire. Shield wires are the lines most associated with bird collisions on transmission lines because they are the highest wire and are smaller in diameter (1 to 1.3 centimeters [cm]; 0.4 to 0.5 inches [in])[1] than phase conductors (2.5 to 5 cm [1 to 2 in]; bundled lines are multiples of these), making them more difficult to see (e.g., Savereno et al. 1996). When birds are flying at the elevation of shield wires or gaining altitude to avoid the more visible phase conductors, the potential for collision with the shield wire increases. For more information on how power line configuration affects collision risk, see Chapters 4 and 5.

[1] Measurements are provided first in metric, then in English form.

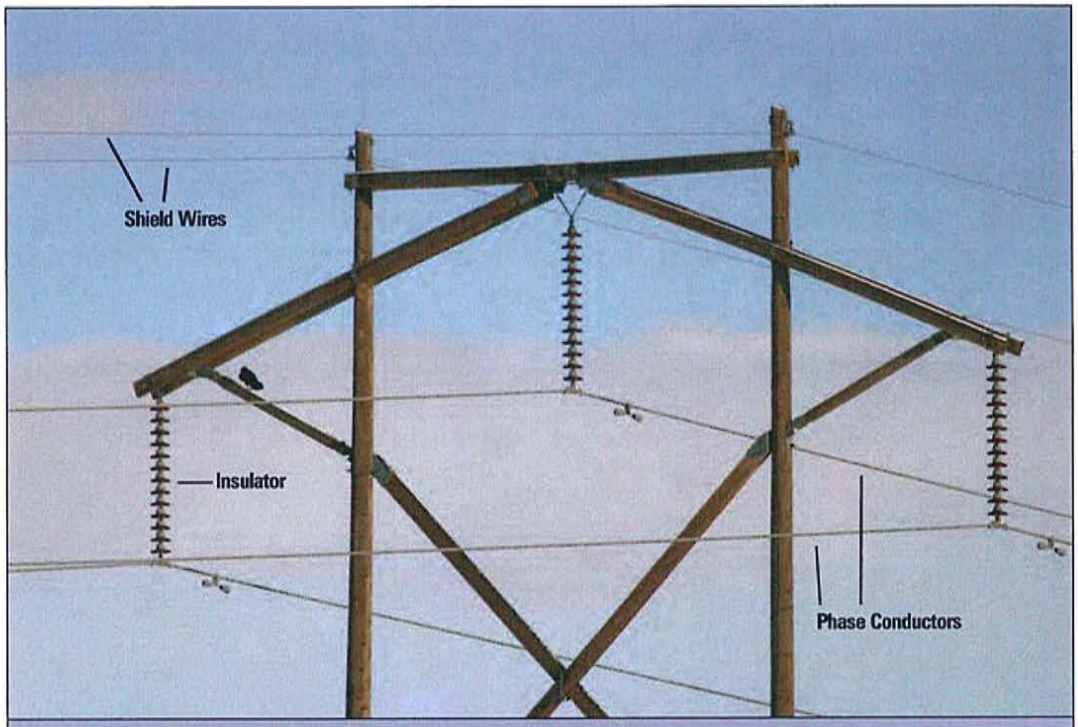

FIGURE 1.8: Shield wires are the highest wires on a transmission line.

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The neutral wire, with regional exceptions, is installed below or parallel to the phase conductors on a distribution line (Figure 1.9) and carries return current, which is taken safely to ground via grounding conductors. In high lightning areas there are exceptions where the neutral is also used as a shield wire on a distribution line.

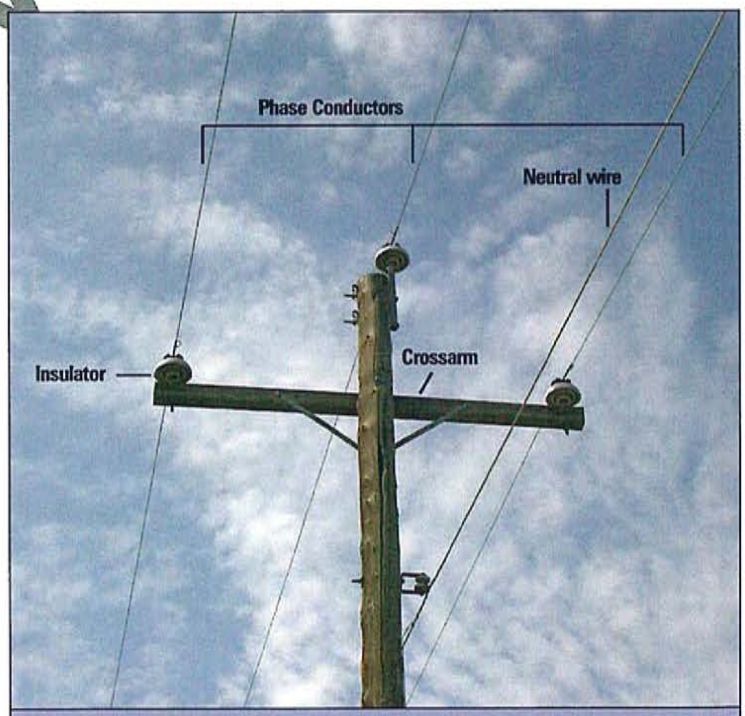

FIGURE 1.9: The neutral wire is usually positioned below the phase conductors on a distribution line.

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SAMPLE

High Voltage: Alternating Current versus Direct Current

Alternating current (AC) transmission and distribution systems are the world's most prevalent type of line. AC transmission systems consist of three phases, each phase consists of 1 to 6 wires (two or more is a bundle). Three phases make a circuit, and a line may have more than one circuit. AC phases may be arranged either horizontally or vertically. As voltage increases, loss over distance decreases, but at some distance high voltage direct current (HVDC) becomes more efficient than high voltage alternating current (HVAC). HVDC transmission systems have a growing presence in the United States and the world. They are most effective in transmitting electricity long distances at high voltages (400 to 600 kV in North America and up to 800 kV in other countries). HVDC structure design is similar to HVAC designs, but with two poles instead of three phases (Figure 1.10). HVDC is transmitted on two bundled conductors known as positive and negative poles. The poles are spaced at least 9.1 meters (m) (30 feet [ft]) apart and are always arranged horizontally. Both systems require shield wires for lightning protection. Most importantly, both systems have the same cautions for attaching collision-preventive devices, i.e., these devices may be applied to shield wires, but are not always compatible with energized lines ≥150 kV or as manufacturers have otherwise demonstrated.

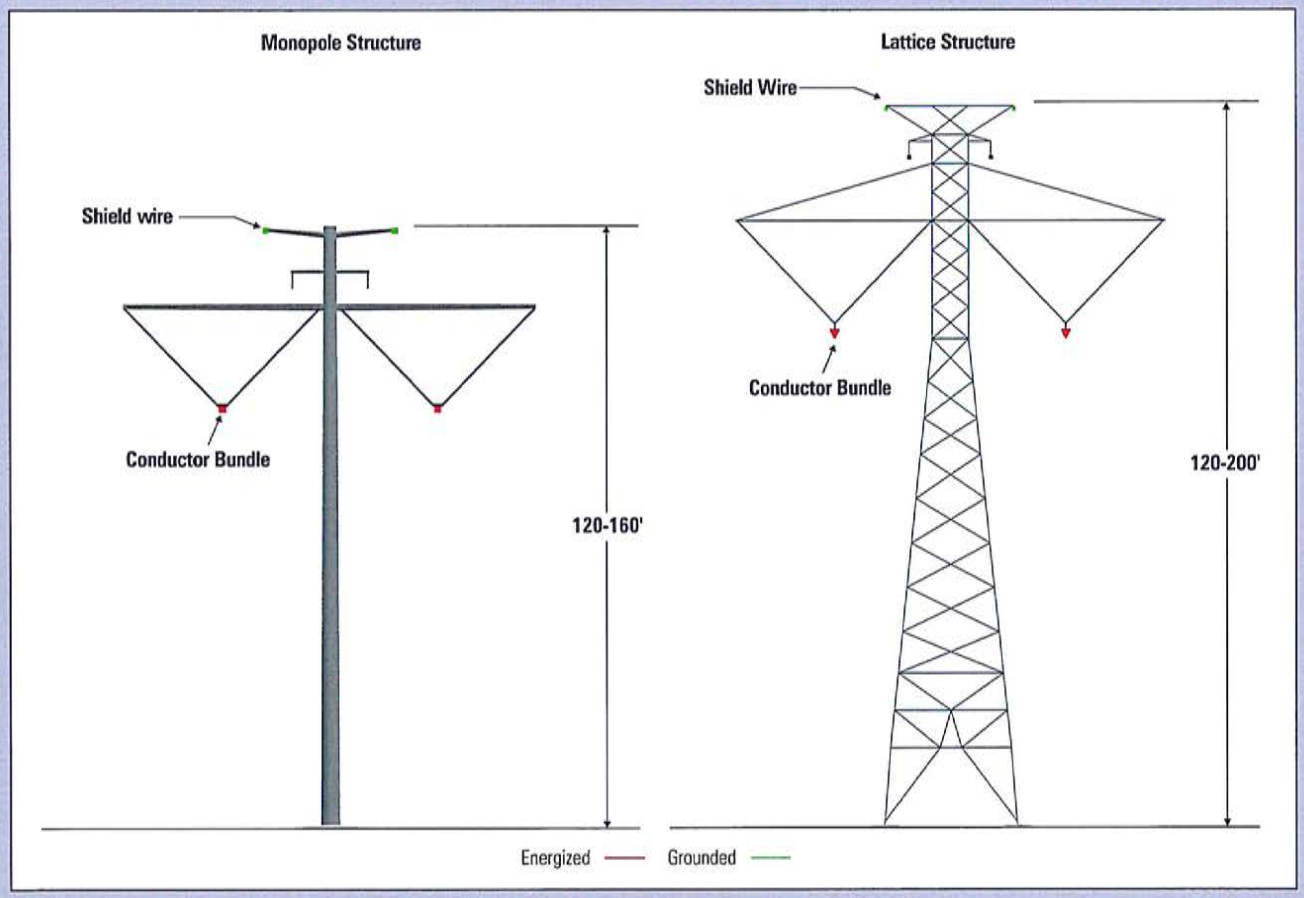

FIGURE 1.10: Typical high voltage direct current transmission line structures.

MEETING ELECTRICAL POWER DEMANDS (LOAD REQUIREMENTS)

A power line's voltage, configuration, conductor spacing, location, and structure type are determined by the present and anticipated power demands or load requirements the line will serve. Because electric utilities are required by law to provide reliable electrical service, they plan, fund, and build new power lines. If enough power is available in an area, then building new distribution lines can sometimes meet the increasing demand. Alternatively or additionally, transmission lines can be built to bring power to the load center from distant power generation facilities.

Transmission line corridors are determined by the location of power generation facilities and substations in relation to load centers. Within the corridor, the preferred and alternative routes are determined, among other things, by rights-of-way (ROWs) availability, land use patterns, potential environmental impacts, terrain, archeological sites, proximity to habitable dwellings, and crossings over water, highways, and other power lines (see *Planning New Power Lines* in Chapter 5 for a discussion and illustration of the planning process).

Different ROW widths are required for different transmission line voltage ratings; these are generally determined by state statutes and the National Electrical Safety Code. ROW widths are also a function of structure height, span length, the conductor height above ground, and the low point of the conductor. ROW widths for transmission lines will vary from 15.2 m (50 ft) to more than 60.9 m (200 ft). Because ROWs are becoming increasingly difficult to obtain,

Transmission Lines and Renewable Energy

Current renewable energy mandates are leading to the development of wind, solar, and other renewable sources. Because these renewable energy sources are typically remote, new transmission lines are often needed to connect them to the grid and carry electricity to load centers.

Overhead versus Underground Power Lines

Electric utilities install power lines either overhead or underground depending upon numerous considerations. Some key factors include customer needs, costs, code requirements, terrain, voltage, and technological and environmental restrictions. Cost is a major concern as electric utilities have mandates to serve customers with high quality, reliable electric service at the lowest cost possible.

Power lines, particularly residential distribution lines, are installed underground in many areas throughout the country where it has been found technically and financially feasible to do so. However, at transmission voltages, there are many more areas where installing lines underground is not feasible (see *Burying Power Lines* on page 62). It becomes more practical to build them overhead as the voltage of the line increases. Therefore, the focus of this manual is to provide guidance for addressing issues associated with reducing collision risks on overhead power lines.

CAUTION

it is a common practice to increase the voltage levels of lines in existing ROWs when statutes and safety allow. As voltages increase, the amount of power that can be transmitted increases by a greater multiple.[2] Transmission voltages for carrying electricity long distances are generally in the range of 115 to 765 kV in the United States.

PERSPECTIVES FOR DEALING WITH BIRD COLLISIONS

A single approach is rarely successful in solving a complicated, multi-faceted issue such as bird collisions with power lines. An integrated approach that considers the biological, environmental, engineering, economic, and social and cultural perspectives of collisions is needed.

BIOLOGICAL AND ENVIRONMENTAL PERSPECTIVES

Biologists generally focus on gathering data to better understand the problem and creating solutions to minimize collision risk. Utility biologists and/or their consultants may be responsible for site evaluation studies and collision studies (see Chapters 5 and 6 and Appendix B). Site evaluation studies determine baseline avian and habitat conditions and assess the possible collision risks to birds following power line construction. Collision studies can help determine reliable mortality rates and quantify the effectiveness of measures taken to minimize collisions.

Collecting high quality data is critical for collision studies. Utilities should plan their studies carefully, using methods and metrics that can be replicated to gather and analyze data. The data should be sufficient for use in estimating the likelihood of collisions and for measuring the effectiveness of collision reduction efforts. In addition, methods must be sufficiently flexible to accommodate the species and site-specific conditions being studied and applied consistently throughout a study and between studies (Bevanger 1999; Barrientos et al. 2011).

In most cases, the approach to these studies is based on type of information needed to make management decisions, determine if line modifications are effective, and/or identify areas of bird activity and high collision risk. In some cases, wildlife agencies may recommend specific studies or protocols, and it is advisable to obtain their comments on a study design. Utilities and their consultants should also consider peer review by independent scientists for the study findings, since the results may undergo rigorous legal cross-examination if the issue is litigated. Publication in a refereed scientific journal is encouraged because it makes the data more widely available and contributes to a greater resource pool for the development of study design methods.

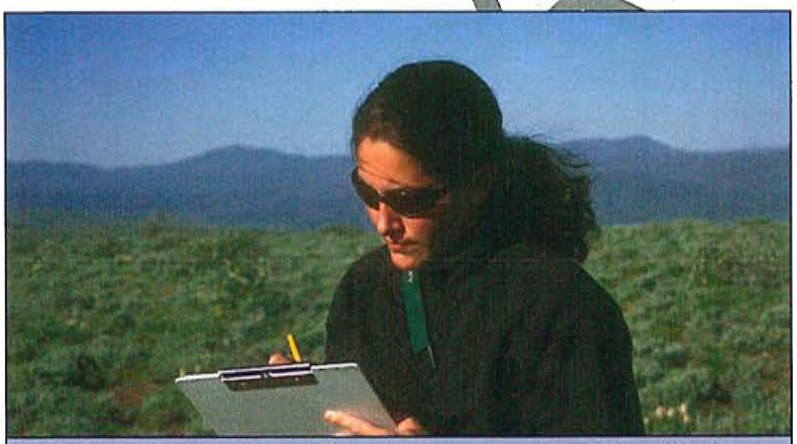

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FIGURE 1.11: Biologists gather data to assess the risk of bird collisions.

[2] The carrying capacity of a line increases at a greater rate than the increase in voltage, i.e., one 765-kV circuit = three 500-kV circuits = six 345-kV circuits. Another advantage of higher voltage is that the voltage drop or loss over distance decreases as the voltage increases.

AMPLE

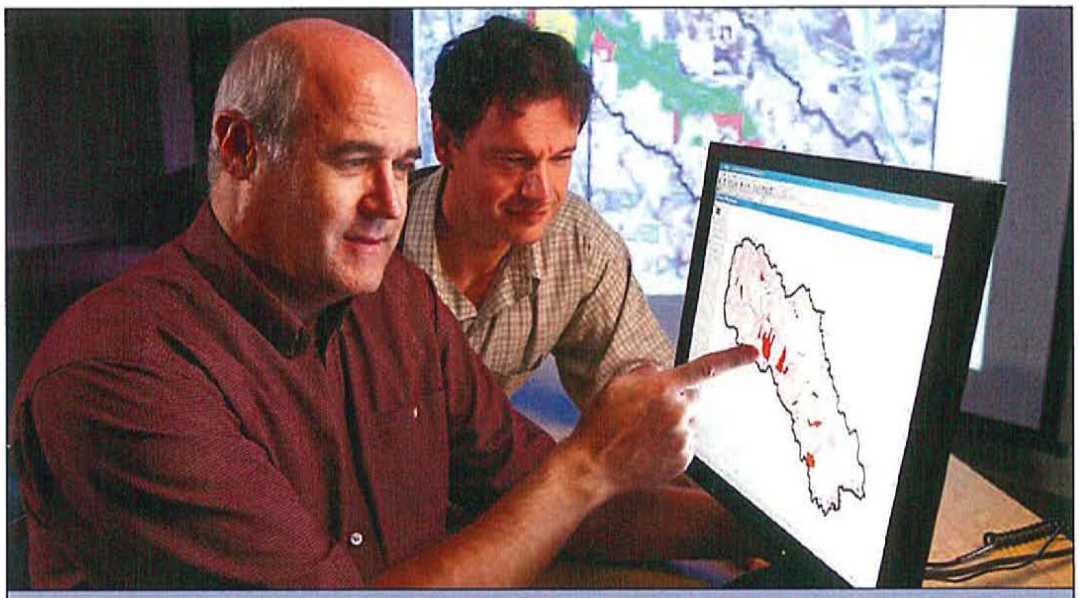

FIGURE 1.12: Engineers work with biologists to reduce risk through appropriate design and routing of power facilities.

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SAMPLE

ENGINEERING PERSPECTIVE

Engineering research, development, and design are essential in the integrated approach to preventing or minimizing bird/power line collisions. Utility engineers should work with biologists early in the design and routing process to identify the key collision issues (see Chapter 4) and to develop feasible collision reduction strategies when modifying existing lines and planning new lines (see Chapters 5 and 6). Early science-based site evaluations and avian risk assessments can be part of improving route selection and line configurations to minimize collision problems. This can reduce or eliminate the need for costly modifications after construction. Design decisions also include other factors such as cost, routing through public or private land, crew availability, and material availability; as a result, a less favorable design for avian interactions may need to be used.

ECONOMIC PERSPECTIVE

No integrated approach would be complete without considering the economics of construction, operation, and maintenance of a power line. The cost for bird friendly power lines and configurations needs to be included during the design phase and route selection. A cost benefit analysis of appropriate collision minimization designs and mitigation can be performed. The later in the process that a biological or engineering solution is initiated, the more difficult, time-consuming, and costly it can become. Since electrical reliability is mandated by utility commissions, avoiding power outages, including those caused by birds, is a priority for electric utilities. Early planning can help meet requirements for reliability, regulatory compliance, efficiency, public acceptance, and cost-effectiveness.



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FIGURE 1.13: Engaging the public may help a utility meet requirements for electrical reliability and reduce collision risk to birds.

SOCIAL AND CULTURAL PERSPECTIVES

In addition to cost and power reliability, the public may have concerns about power line design and placement, including esthetics, environmental effects, wildlife, and safety. Vandalism is also a persistent problem. Electrical components and line marking devices on power lines can become targets. Engaging the public may make it easier for a utility to meet the requirements of providing reliable electricity while reducing risks to birds. It can also reduce delays and costs associated with controversy and litigation (EEI 2001).

Utilities and their consultants can use a variety of public participation tools to engage the public (see Chapter 5 and Appendix E). Used effectively, these tools can build positive relationships, increase public knowledge, identify and respond to public concerns early, and promote responsible behavior (e.g., discouraging vandalism of line marking devices).

PREVIOUS VIEW



CHAPTER 2

Progress in Dealing with Collision Issues

IN THIS CHAPTER

- North America
- International
- Future Research Priorities

Much progress has been made since the 1970s in understanding and addressing bird collisions with power lines. This chapter recalls the conferences and studies that have occurred in North America and internationally. The major avian power line research organizations are introduced, along with future research priorities.

NORTH AMERICA

UNITED STATES

The first reported bird collision with overhead lines in the United States was documented in 1876 (Coues 1876); numerous bird carcasses, mostly horned larks (*Eremophilia alpestris*), were reported during one week in a 5.8-kilometer (km) (3-mile [mi]) section of an overhead telegraph line between Cheyenne, Wyoming, and Denver, Colorado. Coues indicated that such collisions had already been reported in Europe, although no references were given. Another early report of collisions with electric wires in the United States was documented in 1904 (Emerson 1904). Emerson reported that shorebirds, as well as a black rail (*Lateralllus jamaicensis*), collided with electrical wires over a salt marsh and evaporation ponds in the San Francisco Bay area. Avery et al. (1980) provides an annotated bibliography of other early power line collision literature.

Most collision studies have been published since the late 1970s and have led to a growing awareness among stakeholders. During the 1970s, Bonneville Power Administration conducted studies on reducing collisions with power lines (Lee and Meyer 1977; James and Haak 1980; and Beaulaurier 1981). Lee and Meyer (1977) proposed using devices such as image intensifiers for nocturnal observation and collision detectors that would measure the number of bird strikes on wires. They also suggested using thermal imaging, a relatively new technique at the time, to view birds and bats flying near power lines and wind turbines. Lee and his colleagues set a new scientific standard for studies of the interaction between birds in flight and power lines.

In 1978 bird/power line issues were addressed at a national conference sponsored by the U.S. Fish and Wildlife Service (USFWS),

SAMPLE



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FIGURE 2.1: APLIC has helped fund studies on the effectiveness of different types of line marking devices in reducing bird collisions with power lines.

SAMPLE

the Environmental Protection Agency, and the Oak Ridge Associated Universities (Avery 1978).[3] This conference was followed by a 1978 meeting at the Edison Electric Institute (EEI) in Washington, D.C. There, EEI and the Electric Power Research Institute (EPRI) discussed a research program on bird/power line interactions. EPRI funded an assessment of completed, ongoing, and planned research; an analysis of future research needs regarding the impact of power lines on birds in flight; and a series of studies aimed at developing different methods for measuring the impact of power lines on birds in flight.

In 1989, a group of biologists representing a wide range of utility interests, together with representatives from the USFWS and the National Audubon Society, formed the Avian Power Line Interaction Committee (APLIC).[4] APLIC, in cooperation with the USFWS, funded a study on the effectiveness of different types of line markers in the San Luis Valley of Colorado. Such a study was needed because aerial marker spheres were commonly recommended for power lines where bird collision potential existed, although there were no data that established their effectiveness. Further details can be found in Brown and Drewien (1995).

APLIC and EPRI were also instrumental in developing and providing funding for an international conference on bird interactions with utility structures (Miami, September 1992). The proceedings of that workshop included papers and case studies by researchers from various utilities and universities in the United States, Canada, South Africa, and India, and other organizations and agencies including the USFWS, Bureau of Land Management, and U.S. Navy.

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[3] Avery 1978 is the citation for the USFWS version of the proceedings; the original proceedings were documented by Oak Ridge Associated Universities. This reference will be noted as Avery 1978 in this document.

[4] Founding APLIC utility members included Bonneville Power Administration, Edison Electric Institute, Central and South West Services (currently American Electric Power), Florida Power & Light Company, Houston Lighting and Power Company (currently CenterPoint), Nebraska Public Power District, Pacific Gas and Electric Company, Pacific Power & Light Company (currently PacifiCorp), Public Service Company of Colorado (currently Xcel Energy), San Luis Rural Electric Cooperatives, Southern California Edison Company, and Virginia Power (currently Dominion). A list of current APLIC members can be found at www.aplic.org.

In 1994, APLIC published *Mitigating Bird Collisions with Power Lines* (APLIC 1994) to compile the research on bird collision issues to date. Since then, research and reviews of this issue have continued. In 1999, EPRI held a workshop sponsored by APLIC and EEI entitled Avian Interactions with Utility and Communication Structures, which included papers and discussions on the bird collision issues these two industries face (see EPRI 2001). Every three to four years since 1976, electric utilities and utility organizations including EEI, EPRI, and APLIC help sponsor the International Symposium on Environmental Concerns in Rights-of-Way Management. This symposium often includes papers on bird collisions. APLIC also conducts avian protection workshops at its semi-annual business meetings and at other times through the year upon request (see www.aplic.org for information on upcoming workshops).

Since the early 2000s, the California Energy Commission (CEC) has sponsored a large number of research projects including identification of research needs on avian collisions with power lines in California: *A Roadmap for PIER Research on Avian Collisions with Power Lines in California* (Hunting 2002). CEC also has a searchable database on avian collision literature, *An Annotated Bibliography of Avian Interactions with Utility Structures* (CEC 2011).

Other CEC, APLIC, and EPRI sponsored studies include:

- *Human-related Causes of Raptor Mortality in Western Montana: Things are not Always as They Seem* (Olson 2001)
- *Bird Strike Indicator/Bird Activity Monitor and Field Assessment of Avian Fatalities* (EPRI 2003)
- *Raptor and Raven Electrocutions in Northwestern Mexico* (Cartron et al. 2004)
- *Corona Testing Devices Used to Mitigate Bird Collisions* (EDM 2004).
- *Assessment of Avian Mortality from Collisions and Electrocutions* (Dorin and Spiegel 2005)
- *Preventing Raptor Electrocutions in an Urban Environment* (Dwyer and Mannan 2007)
- *Evaluating and Reducing Avian Collisions with Distribution Power Lines at Cosumnes River Preserve* (Yee 2007)
- *Bird Strike Indicator Field Deployment at the Audubon National Wildlife Refuge in North Dakota* (Pandey et al. 2008)
- *Raptor and Corvid Response to Power Distribution Line Perch Deterrents in Utah* (Prather and Messmer 2010)
- *Evaluating Diverter Effectiveness in Reducing Avian Collisions with Distribution Lines at San Luis National Wildlife Refuge Complex, Merced County, California* (Ventana Wildlife Society 2009)
- *Contemporary Knowledge and Research Needs Regarding the Potential Effects of Tall Structures on Sage-grouse* (UWIN Cooperative 2010)
- *Protocol for Investigating the Effects of Tall Structures on Sage-grouse (Centrocercus spp.) Within Designated or Proposed Energy Corridors* (UWIN 2011)
- *Line Marking Study near Coleharbor, ND, 2006-2008* (WAPA 2011)

Bibliographies of Collision Literature

Appendix A of this manual includes the literature cited and a bibliography of collision literature. An annotated bibliography of early collision literature was provided by Avery et al. (1980). In addition, the California Energy Commission hosts a searchable database on collisions: *On-Line Annotated Bibliography of Avian Interactions with Utility Structures* (CEC 2011).

SAMPLE



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FIGURE 2.2: In Canada, the first reported collision victims were snow geese.

SAMPLE

CANADA

The first reported bird collision in Canada was published by Blokpoel and Hatch (1976) after several thousand snow geese (*Chen caerulescens*) were flushed by an aircraft into a transmission line. The geese had been feeding on a stubble field near Winnipeg, Manitoba. Between 25 and 75 geese were reportedly injured or killed after striking the wires.

Since then, there have been few published accounts of bird collisions in Canada. In 1997, the *Blue Jay* published a discussion on birds and power line risk (Curtis 1997). Other accounts can be found in proceedings from the Canadian hosted 5th and 7th International Symposium on Environmental Concerns in Rights-of-Way Management in Quebec (1993) and Alberta (2000). In 2007, a study on using a landscape-scale model to predict the risk of collisions in Alberta was completed (Heck 2007; Quinn et al. 2011). It examined the practicality of using GIS spatial modeling to predict areas with elevated collision frequency across large, existing electric service territories.

Bird/power line interaction knowledge is growing in Canada and more emphasis is being placed on identifying the root cause in relation to a utility's reliability issues. The cause of many outages has been identified as a direct result of wildlife interactions, including birds. Many utilities are also installing line marking devices in areas where collisions have been reported or suspected.

Depending on the species, collisions with power lines may be violations of federal and provincial wildlife laws (see Chapter 3) and can result in penalties. Most bird species present in Canada are migratory and are very often the same species present in the United States and subject to many of the same collision risks, which stem from the same biological, environmental, and engineering factors outlined in Chapter 4.

Although Canada has wildlife laws in place, as of 2011 there is not a Canadian organization addressing the management of bird interactions with power lines; so Canadian companies have turned to American utilities for support by joining APLIC. In 2012, the first APLIC workshop in Canada was held in Banff. Electric utility representatives, consultants, contractors, and government regulators from across the country attended.

In addition to legal requirements and due diligence, Canadian companies have recognized that bird collisions need to be minimized for environmental, public relations, and public health reasons. Through increased management of avian collision issues, companies have been better able to demonstrate to utility staff, regulators, and the public, their commitment to reducing utility impacts on birds.

MEXICO

In Mexico, the USFWS has been working with officials of the Mexican government through the Trilateral Committee of the North American Free Trade Agreement, the

Migratory Bird Treaty with Mexico, Partners in Flight, and the National Wind Coordinating Collaborative to help Mexico better address avian collision and electrocution issues. These efforts are also tied to Mexico's land-based wind energy development, which includes power line issues (R. Villegas-Patraca, pers. comm.; A. Manville, pers. comm.; Mexico Institute of Ecology and USFWS, unpubl. reports, respectively).

INTERNATIONAL

Important collision research has been conducted in Europe, Asia, and Africa. In 2003, BirdLife International prepared the guide *Protecting Birds from Power Lines: A practical guide on the risks to birds from electricity transmission facilities and how to minimize any such adverse effect* (BirdLife International 2003). It reviewed the risks from power lines, including collisions, and recommended standards to protect birds, siting considerations, use of underground power lines, hiding or obscuring power lines against more prominent landscape features, and the use of line marking devices. In 2007, BirdLife International developed a policy position statement on the risks to birds from transmission lines (BirdLife International 2007). In 2009, the Council of Europe issued *Follow-up Recommendation No 110, 2004* (Schuerenberg et al. 2009) on minimizing adverse effects of power lines on birds. It reviews standards and retrofitting methods and provides an exhaustive list of actions taken by 26 European countries.

In 2011, the United Nations Environment Programme (UNEP) for the African-Eurasian Waterbird Agreement (AEWA) and the Convention on Migratory Species (CMS) released a *Review of the Conflict between Migratory Birds and Electricity Power Grids in the African-Eurasian Region* (CMS 2011a) and the *Guidelines for Mitigating Conflict between Migratory Birds and Electricity Power Grids* (CMS 2011b). CMS (2011a) provides a summary of collision issues and hot spots in Europe, Asia, and Africa. Also in 2011, the *Budapest Declaration on Bird Protection and Power Lines* (MME 2011) was adopted by the participants of the Budapest Conference, Power Lines and Bird Mortality in Europe. The declaration aims for all new construction of power poles to be bird-safe by 2016 and all dangerous poles to be retrofitted by 2020. The conference was attended by 123 participants from 29 European and Central Asian countries, the European Commission, UNEP AWEA, six energy and utility companies, experts, businesses, and non-government organizations.

In Asia, the risk of bird collisions with power lines is being recognized as more studies are conducted on bird electrocutions associated with new power line structures. For example, in Mongolia, while performing a review of raptor electrocutions on new concrete poles with metal crossarms, researchers found that Pallas' sandgrouse (*Syrrhaptes paradoxus*) were killed after colliding with power lines during an unusual seasonal relocation (Gombobaatar et al. 2010).

In Uzbekistan, systematic collision monitoring using standard protocols has not been conducted and therefore reported mortalities can only be considered anecdotal. However, these observations have shown that certain species are more susceptible to collisions and/or electrocutions. It is known that during spring and autumn migration, medium and large size birds collide with or are electrocuted on the power lines, which include rare and declining species like the steppe eagle (*Aquila nipalensis*), golden eagle (*Aquila chrysaetos*), imperial eagle (*Aquila heliaca*), osprey (*Pandion haliaetus*), short-toed eagle (*Circaetus gallicus*), and Saker falcon (*Falco cherrug*) (Abdunazarov 1987; Shernazarov and Lanovenko 1994).

SAMPLE

In Kazakhstan, researchers found 409 bird carcasses of 34 different species during a 2006 survey of power line mortality. Many deaths were due to electrocutions and 44% were raptors. Deaths due to collisions were also noted (Lasch et al. 2010).

The great bustard (*Otis tarda*), which once ranged from Manchuria to Portugal, is now extirpated or endangered across much of the continent because of habitat loss, disease, and mortality from power line collisions (Janss and Ferrer 2000; Garcia-Montijanoi et al. 2002; Alonso and Martin 2005). It is one of the world's heaviest flying birds with a maximum weight of 21 kilograms (46 pounds). As a result, great bustards maneuver slowly in flight and are not able to avoid wires spotted at the last moment. Collisions have been observed by researchers in Mongolia (Kessler 2007). The research group notes that great bustard collisions with power lines are a common occurrence in developed Western Europe and are becoming more frequent in China.

In South Africa, The Endangered Wildlife Trust has a Wildlife & Energy Program that coordinates and sponsors research on bird/power line interactions (EWT 2011) (see Appendix E). This includes a study on the vision characteristics of the Ludwig's bustard (*Neotis ludwigii*) and blue crane (*Anthropoides paradiseus*) with respect to their ability to see power lines while in flight and how to reduce the collision risk for these species. It also includes a range-wide study of the collision rates of the Ludwig's bustard.[5]

In Kenya, a 2009 risk assessment of bird interactions with electrical infrastructure identified several sites of high collision risk to birds of conservation concern. These species included the grey-crowned crane (*Balearica regulorum*), lesser flamingo (*Phoeniconaias minor*), white stork (*Ciconia ciconia*), secretary-bird (*Sagittarius serpentarius*), and a number of vultures and raptors (Smallie and Virani 2010).



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FIGURE 2.3: Researchers have studied the effects of power line collisions on vulnerable species, such as the Ludwig's bustard of Europe, Asia, and Africa.

[5] The range of the Ludwig's bustard includes Angola, Botswana, Lesotho, Namibia, and South Africa.

SAMPLE

FUTURE RESEARCH PRIORITIES

As more power lines are built across the landscape, collision risk is anticipated to increase. Yet, this risk may be offset through assessment of potential avian impacts during siting and route selection, improved line marking devices and study methods, and increased awareness among stakeholders. With the continued growth in power line mileage, more collision research is needed. Because of the susceptibility of some endangered species, such as the whooping crane (*Grus americana*) and California condor (*Gymnogyps californianus*), power lines in these species' ranges will require careful evaluation and routing in addition to line marking devices and/or other collision reduction measures.

National and international collaboration on bird/utility interactions has increased markedly since the late 1990s. Guidelines for the development of Avian Protection Plans are a product of this collaboration (see Chapter 7). Electric utilities are increasingly adopting avian protection policies, plans, and conservation measures, and APLIC will continue to provide guidance on bird collision issues. Cooperation in addressing collision issues will continue between electric utilities and wildlife agencies. This relationship will advance the collision risk reduction measures discussed in this manual (see Chapters 5 and 6).

Regional and species-specific studies of collision mortality and methods for minimizing collisions would be especially helpful. At this time there is no organized attempt to understand the extent and magnitude of collision mortality from power lines. Current knowledge of collisions is geographically, regionally, and site biased because most studies have been conducted on lines with known collision problems. In addition, avian/power line collision risk is not uniformly distributed because it is highly dependent on species and habitat variables. Bevanger (1999) recommended several areas of investigation that combine well-planned observational studies with experimental studies rather than non-standardized collision records that cannot be scientifically or statistically compared. Recent studies on the effectiveness of line markers (e.g., Yee 2008 and Murphy et al. 2009) follow these recommendations. Standardized protocols for monitoring mortality at communication towers (e.g., Manville 2002, 2009b; Gehring et al. 2009) and wind turbines (e.g., CalWEA 2011) could also provide models that could be adapted for power line mortality assessments.

The effectiveness of line marking devices needs further study. In particular, more research is required to determine the device and spacing best suited to different environmental conditions and species. Except for studies sponsored by the CEC and APLIC (e.g., Ventana Wildlife Society 2009; Yee 2008; WAPA 2011) relatively few systematic studies have looked at the comparative effectiveness



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FIGURE 2.4: Because of the susceptibility of some endangered species, such as the whooping crane, power lines in these species' ranges require careful evaluation and routing.

APLIC

of different line marking devices. Barrientos et al. (2011) conducted a meta-analysis of line marking studies, discussed the limitations, and provided recommendations for more scientifically rigorous evaluations. In addition, no systematic comparison of the effectiveness of these devices with different species, in different habitats, or in different weather conditions has been conducted. As new styles of line markers continue to be developed and existing markers are modified, associated effectiveness testing will be needed.

Funding Organizations for Collision Research

APLIC, EPRI, and CEC are three organizations that provide some funding for research on avian/power line interactions (see Appendix E). The USFWS conducts limited primary research and funds state research through Section 6 Endangered Species Act grants.

APLIC funds research projects that further the knowledge of avian/power line interactions including:

- Assessments of collision and/or electrocution rates associated with power lines
- Risk assessments to identify factors contributing to collisions and electrocution mortality risks for different species
- Evaluations of impacts of power line construction on bird species

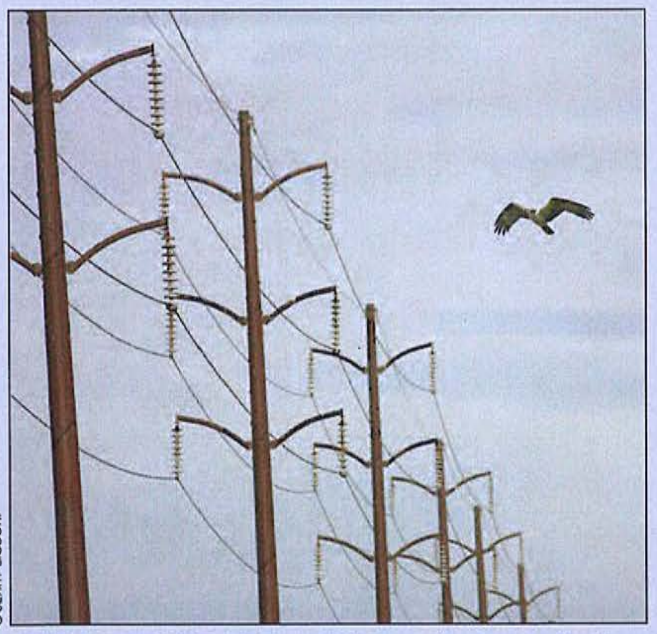

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FIGURE 2.5: APLIC, EPRI, and CEC are three organizations that provide some funding for research on avian/power line interactions.

EPRI's research priorities emphasize information and monitoring systems that will improve understanding of and mitigating for avian interactions with utility facilities. These include the Bird Activity Monitoring System and avian vision studies that may help develop more effective collision prevention devices.

The CEC (Hunting 2002) identified a number of research priorities that still apply today and need to be considered to better understand avian collisions with power lines. These include:

- Standardizing mortality estimation
- Testing and documenting the efficacy of line marking devices
- Testing and documenting the efficacy and limitations of remote collision detection devices
- Determining collision risk levels associated with potential high avian-use habitats
- Monitoring and reporting over the long term



CHAPTER 3

Avian Regulations and Compliance

IN THIS CHAPTER

- Overview of Existing Laws and Policies
- Permit Requirements

Most native North American birds are protected by the Migratory Bird Treaty Act. Additional statutes provide further protection for bald and golden eagles *(Haliaeetus leucocephalus* and *Aquila chrysaetos)* and birds that are threatened or endangered. This chapter describes United States' and Canada's federal regulations that protect these birds, their habitat, and the corresponding conservation and permitting measures.

OVERVIEW OF EXISTING LAWS AND POLICIES

UNITED STATES

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703–712) is the legal cornerstone of migratory bird conservation and protection in the United States. It is a strict liability statute, meaning that proof of intent is not required in the prosecution of a taking (injuring or killing) violation. Most actions that result in *taking* or possessing a protected species, its nest, parts, and/or eggs are violations.

The MBTA states: "Unless and except as permitted by regulations…it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, *take*, capture, kill… possess, offer for sale, sell…purchase…ship, export, import…transport or cause to be transported…any migratory bird, any part, nest, or eggs of any such bird, or any product …composed in whole or in part, of any such bird or any part, nest, or egg thereof…."

Generally speaking, the MBTA protects the majority of birds that nest in North America (50 CFR 10.13). As of 2012 there were 1,007 bird species on the list of migratory bird species protected under the MBTA. The list includes waterfowl, shorebirds, seabirds, wading birds, raptors, and songbirds. The 1972 MBTA amendment extended protection to birds of prey—eagles, hawks, falcons, and owls—and to corvids, such as crows and ravens. However, the MBTA does not protect non-migratory upland game birds (such as grouse and quail) or introduced species such as house (English) sparrows (*Passer domesticus*), European starlings (*Sturnus vulgaris*), rock pigeons (common/feral pigeons, *Columba livia*), monk parakeets (*Myiopsitta monachus*), and 121 other less commonly encountered species that have been excluded from protection by the MBTA (USFWS 2005a [70 Fed. Reg. 49, 15 March 2005]).

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FIGURE 3.1: The Migratory Bird Treaty Act of 1918 is the legal cornerstone of bird protection in the United States, protecting more than 1,000 North American bird species such as this cedar waxwing (*Bombycilla cedrorum*).

An individual, which can mean a corporation or other organization, who violates the MBTA may be fined up to $15,000 and/or imprisoned for up to six months for a misdemeanor conviction. An individual who knowingly *takes* any migratory bird with the intent to sell, offer to sell, barter, or offer to barter such bird or who knowingly sells, offers for sale, barters, or offers to barter any migratory bird is subject to a felony violation with fines of up to $250,000 and/or imprisonment for up to two years. The MBTA has no provision for permitting incidental or accidental take.

Federal agencies taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations are directed by Executive Order 13186 (3 CFR 2001; Office of the President 2001. [66 Fed. Reg. 11, 17 January 2001]) to develop and implement a memorandum of understanding (MOU) with the U.S. Fish and Wildlife Service (USFWS) that shall promote the conservation of migratory bird populations. This includes federal agencies' power line infrastructure-related collisions and electrocutions of protected birds. To date (2012), MOUs have been signed by the Department of Defense, Department of Energy, U.S. Forest Service, National Park Service, Bureau of Land Management, Minerals Management Service/Bureau of Ocean Energy Management, and the Federal Energy Regulatory Commission, with others under development.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940 (BGEPA) (16 U.S.C. 668–668d) provides additional protection to these eagle species. If a proposed project or action would occur in areas where nesting, feeding, or roosting eagles occur, then utilities may need to take additional conservation measures to achieve compliance with the BGEPA.

The BGEPA prohibits the take, possession, sale, purchase, barter, offer to sell, purchase, or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit ([16 USC 668(a)]. *Take* under this statute is defined as "to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" (50 CFR 22.3). *Programmatic take* is defined as "*take* that (1) is recurring, but not caused solely by indirect effects, and (2) occurs over the long-term and/or in a location or locations that cannot be specifically identified" (50 CFR 22.26). *Disturb* is defined as "to agitate, or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior" (50 CFR 22.3). Violators may be fined up

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to $100,000 and/or imprisoned for up to one year. Individuals with subsequent convictions or who commit intentional *takes* face penalties of up to $250,000 and/or two years imprisonment.

The BGEPA has been amended to provide a permit for non-purposeful *take*, including *take resulting in disturbance* and limited *take resulting in mortality* that may occur as a result of otherwise lawful activities, provided the breeding populations are stable or increasing. Because there are no breeding populations in the eastern United States that can sustain *take*, the USFWS will not authorize *take* for golden eagles east of approximately 100° west longitude, except for *take* of nests for safety emergency situations (USFWS 2009a).

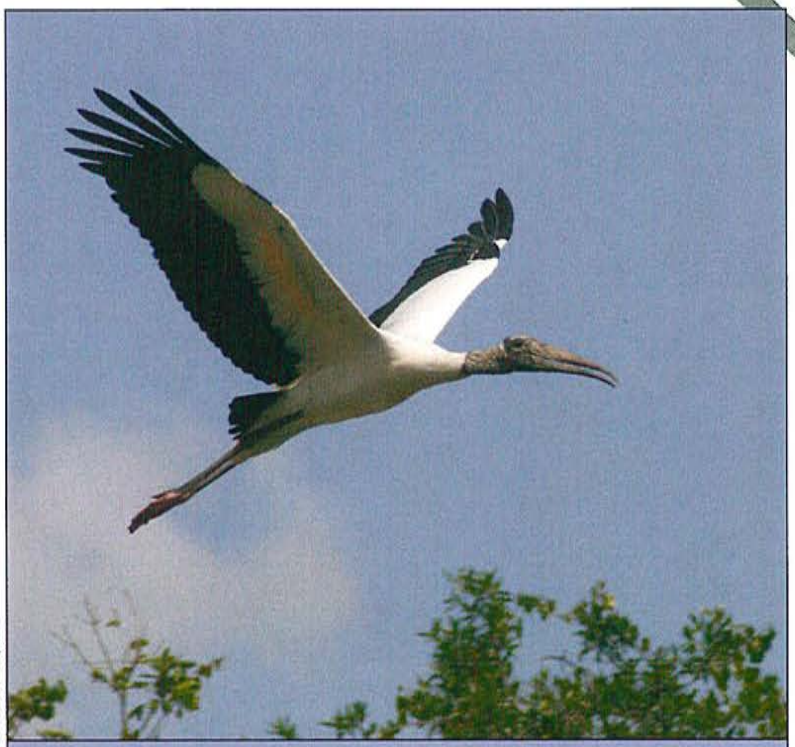

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FIGURE 3.2: Habitat Conservation Plans help landowners incorporate conservation measures for species, such as the wood stork (*Mycteria americana*), into their development plans.

Endangered Species Act

The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531–1544) protects the United States' native plants and animals that are in danger of becoming extinct and may also protect their habitats. Federal agencies are directed to use their authority to conserve listed and candidate[6] species and to ensure that their actions do not further jeopardize these species or adversely modify designated critical habitat for them. The law is administered by the USFWS and the National Marine Fisheries Service (NMFS). The USFWS has responsibility for terrestrial and freshwater organisms, while the NMFS oversees endangered marine life. These two agencies work with other agencies to plan or modify federal projects to minimize project impacts on listed species and their habitats. Protection is also gained through USFWS' financial and technical assistance partnerships with states, tribes, and private landowners.

Section 9 of the ESA makes it unlawful for a person to *take* a listed species. *Take* under the ESA is defined as "...to harass,[7] harm,[8] pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The ESA authorizes the USFWS to issue Incidental Take Permits (ITP) for *take* resulting from otherwise legal activity.

Section 10 of the ESA allows Habitat Conservation Plans (HCP) for the con-

[6] *Candidate* species are those in decline which may be added to the list of threatened and endangered species in the near future.

[7] Harass is defined as an intentional or negligent act or omission, which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly impair normal behavioral patterns including breeding, feeding, or sheltering (50 CFR 17.3).

[8] Harm is defined as an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation when it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering (50 CFR 17.3).

PREVIOUS VIEW

struction and management of facilities, e.g., transmission lines, on private lands that are used by endangered species. These plans help landowners incorporate conservation measures into their land and/or water development plans. Landowners who develop and implement HCPs can also receive ITPs that allow their activities to proceed with authorization for limited *take*.

State Policies and Regulations

States have additional bird protection regulations. A utility should consult with its respective state wildlife agency to determine whether more regulations apply and if permits are required.



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FIGURE 3.3: Canada geese (*Branta canadensis*) are protected by both the Migratory Bird Treaty Act and Canada's equivalent, the Migratory Birds Convention Act.

CANADA

Migratory Birds Convention Act

The Migratory Birds Convention Act (MBCA) of 1917 and amended 1994 (1994, c.22) is Canada's equivalent of the United States' MBTA (1918), which provides legal protection for migratory birds. One notable exception is raptors, which are protected by provincial and territorial wildlife acts instead of MBCA. The MBCA satisfies the terms of the Migratory Birds Convention of 1916, when both countries recognized concerns about overhunting waterfowl and shorebirds. The MBCA recognizes three classifications of protected birds: migratory game birds, migratory insectivorous birds, and migratory non-game birds. It further lists them by family and gives examples.

In Canada, the MBCA is administered by the Wildlife Enforcement Division of Environment Canada in cooperation with provincial and territorial governments. Enforcement of the Act is made in concert with the Canadian Wildlife Service (CWS), Royal Canadian Mounted Police, and provincial and territorial enforcement authorities.

The MBCA and its associated regulations state that "No person shall hunt a migratory bird except under authority of a permit," and "Subject to subsection 5(9), no person shall (a) disturb, destroy, or *take* a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird, or (b) have in his possession a live migratory bird, or a carcass, skin, nest or egg of a migratory bird."

Individuals, which includes corporations, who violate the MBCA and associated regulations may be subject to a fine of up to $300,000 and/or six months imprisonment. Upon summary conviction or upon indictment, fines of up to $1,000,000 and/or two years imprisonment may be applied.

PREVIOUS VIEW

Species at Risk Act

The Canadian Species at Risk Act (SARA) was enacted in 2003. The objective of SARA is to protect native species from extinction, ensure measures are taken for the recovery of threatened or endangered species, and encourage best management practices for maintaining healthy populations.

SARA adopted the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as an advisory body to assess potentially at-risk wildlife species, identify existing and potential threats to the species, and classify the status of the species (i.e., extinct, extirpated, endangered, threatened, of special concern, or not currently at risk). Established in 1977, COSEWIC is an independent committee of wildlife experts and scientists from federal, provincial and territorial governments, universities, and non-government organizations that uses the best available science to support its recommendations. Under SARA, the government of Canada will take COSEWIC's designations into consideration when establishing the legal list of wildlife species at risk (COSEWIC 2009).

SARA states that "No person shall kill, harm, harass, capture or *take* an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species." However, SARA does make allowance for the incidental *take* of animals through the issuance of permits (similar to the ESA in the United States).

Provincial Policy and Regulations

Federal and provincial governments have worked together to develop complementary policy and programs to protect species at risk. For example, the Alberta Wildlife Act and Regulations seek to protect wildlife whereby "a person shall not hunt wildlife unless the person holds a licence authorizing the person, or is authorized by or under a licence, to hunt wildlife of that kind." The legislation also states that "a person shall not wilfully molest, disturb or destroy a house,[9] nest or den of prescribed wildlife" where wildlife is defined as "big game, birds of prey, fur bearing animals, migratory game birds, non game animals, non-licence animals and upland game birds." Similarly, other provinces have enacted legislation for the protection of wildlife, including birds.

INTERNATIONAL POLICIES AND AGREEMENTS

Since 2000, there has been an increasing international awareness of the issue of bird collisions for certain species. International conventions and policies (see CMS 2011a) that are relevant to bird collisions include:

- Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)
- Convention on Biological Diversity (CBD)
- Ramsar Convention on Wetlands, List of Wetlands of International Importance
- Convention on the Conservation of Migratory Species of Wild Animals (CMS)
- MOU on the Convention of Migratory Birds of Prey in Africa and Eurasia
- MOU on the Conservation and Management of the Middle-European Population of the Great Bustard
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)
- Various European Union Directives

These agreements have resulted in research, reviews, and guidance on bird collisions that may provide some further insight into bird collisions.

[9] The term "house" includes artificial structures such as bird boxes and nesting platforms.

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PERMIT REQUIREMENTS

UNITED STATES

Federal and state permits may be required for activities that may affect species protected by the MBTA, BGEPA, ESA, or state laws. For species protected by the MBTA, utilities are encouraged to contact their regional USFWS Migratory Bird Permit Office and their state wildlife agency to identify permit requirements and, if necessary, obtain permit applications. For species protected by the ESA and BGEPA, utilities must contact their USFWS Ecological Services field office.

Migratory Bird Permits

Migratory bird permits are issued by the regional USFWS Migratory Bird Permit Offices. Permits are issued for falconry, raptor propagation, scientific collection, rehabilitation, conservation education, migratory game bird propagation, salvage, *take* of depredating birds, taxidermy, waterfowl sale and disposal, and special purpose. Annual reporting to the USFWS is required as a condition of each permit. Policy for migratory bird permits is developed by the Division of Migratory Bird Management. The regulations governing migratory bird permits can be found in 50 CFR part 13, General Permit Procedures, and 50 CFR part 21, Migratory Bird Permits.

In 2003, the USFWS issued a memorandum clarifying the definition of *take* under the MBTA as it applies to active nests (nests containing eggs or young). Under the MBTA, the collection, possession, and transfer of inactive bird nests requires a permit, but the destruction of nests that do not contain eggs or birds is permissible. This does not apply to eagles or species listed by the ESA, whose active and inactive nests are protected. The memo also stated that the USFWS may issue permits for the removal of occupied nests when public safety is at risk (see 50 CFR 21.27).

Bald and Golden Eagle Permits

BGEPA permits are administered by the regional USFWS Migratory Bird Permit Offices in coordination with the Division of Migratory Bird Management's Washington, D.C. office and the local Ecological Services field office where an eagle *take* might occur.

Under BGEPA (50 CFR parts 22.26 and 22.27), the USFWS can issue permits to *take* bald eagles and golden eagles or their nests, where the *taking* is associated with, but not the purpose of, the activity and cannot practicably be avoided. Permits may be authorized for non-purposeful *take*, which includes *take resulting in disturbance* or limited *take resulting in mortality* provided the breeding populations are stable or increasing. USFWS will not issue golden eagle *take* permits east of the 100° meridian (see BGEPA discussion on page 22).

USFWS may also issue permits for programmatic *take* (e.g., recurring *take* for an entire power line over a specified amount of time) or for individual *take* (e.g., for disturbance due to one-time construction of a power line where the location of the *take* and when it will occur are known). *Programmatic take* permits may be issued to entities, such as electric utilities or transportation providers, that may currently *take* eagles in the course of



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FIGURE 3.4: Most songbirds, such as these horned larks *(Eremophilia alpestris)*, are protected by the Migratory Bird Treaty Act.

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FIGURE 3.5: Bald eagles are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

otherwise lawful activities but who can work with the USFWS to develop and implement advanced conservation practices (ACPs). ACPs are defined as "scientifically supportable measures that are approved by the Service and represent the best available techniques to reduce eagle disturbance and ongoing mortalities to a level where remaining *take* is unavoidable" (50 CFR 22.3).

The regulations are intended to provide a mechanism—under carefully considered circumstances—where non-purposeful *take* of bald and golden eagles can be legally authorized. How-ever, BGEPA provides the Secretary of Interior with the authority to issue eagle *take* permits only if it is able to determine that the *take* is compatible with eagle conservation. This must be "...consistent with the goal of increasing or stable breeding populations."

Regulation establishes the issuance of permits for removing eagle nests where (1) necessary to alleviate a safety emergency to people or eagles, (2) necessary to ensure public health and safety, (3) the nest prevents the use of a human-engineered structure, or (4) the activity or mitigation for the activity will provide a net benefit to eagles (50 CFR 22.27). Only inactive nests may be *taken* except in the case of safety emergencies. Inactive eagle nests are defined by the continuous absence of any adult, egg, or dependent young at the nest for at least 10 consecutive days leading up to the time of *taking* the nest.

Special Purpose or Salvage or Miscellaneous Permit

In compliance with federal regulations, utilities may need certain permits to handle or "possess" injured or dead birds found along power lines. Salvaging and possessing carcasses of birds protected under the MBTA requires a Federal Special Purpose or Salvage or Miscellaneous Permit (50 CFR 21.27). This permit allows the burial or incineration of migratory birds found dead on a utility property or temporary possession for transporting to a suitable disposal location, rehabilitation facility, repository, or wildlife pathology laboratory. Permit conditions may vary but if the bird is a federally endangered or threatened species or eagle, most permits require the USFWS to be notified within 48 hours of discovery of the carcass. Depending on permit requirements, a quarterly and/or an annual report must be submitted to the USFWS regional permit office.

Endangered Species Act Consultation, Incidental Take Permit (ITP), and Habitat Conservation Plan (HCP)

When utilities propose the construction of, for example, power generation or transmission facilities where a federal nexus exists (i.e., on federal lands, with federal funding, or requiring federal authorization or permits), they

SAMPLE

must first consult with the USFWS through Section 7 of the ESA if any threatened or endangered species may be at risk. Before initiating an action, the federal agency owning the land or providing the funding or the non-federal permit applicant (e.g., an electric utility) should ask the USFWS to provide a list of threatened, endangered, proposed, and candidate species and designated critical habitats that may be present in the project area. The USFWS has developed a handbook that describes the consultation process in detail (USFWS and NMFS 1998). Based on a Biological Assessment, an ITP may be issued under Section 7 of the ESA.

When non-federal activities (i.e., lacking a federal nexus) will or may *take* threatened or endangered species, an ITP is required under Section 10 of the ESA. Approval of an ITP issued in conjunction with an HCP requires the Secretary of the Interior to find, after an opportunity for public comment, that among other things, the *taking* will be incidental and that the applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such *taking*. An HCP must accompany the application for an ITP. The HCP associated with the permit is to ensure that conservation measures are adequate for avoiding jeopardy to the species or adversely modifying critical habitat. Information about consultations and HCPs can be obtained by contacting the local USFWS Ecological Services field office.

CANADA

Both MBCA and SARA provide for permitting and authorization of incidental *take* of migratory birds and species at risk. However, for MBCA, the Canadian government, through the CWS, has declared that they will not develop the permitting system; instead they recommend that companies use due diligence to prevent incidental impacts to migratory birds through best management practices.

SARA does provide for incidental harm to a species or destruction of its critical habitat under carefully controlled circumstances provided the activity does not jeopardize the survival or recovery of the species. These provisions include permits (three-year duration) or agreements (five-year duration). These authorizations are tied to strictly prescribed conditions. The government continues to work with stakeholders to develop operational policies to better implement SARA.

The requirement to protect critical habitat for migratory birds only applies in federal lands such as national parks, national wildlife areas, and bird sanctuaries. For critical habitat located in federally protected lands, the prohibition on destruction of this habitat applies automatically once the Environment Minister posts a description of the critical habitat in the Canada Gazette (typically within 90 days after the recovery strategy/action plan is posted to the SARA Public Registry).

The Environment Minister can recommend that the Cabinet protect a migratory bird species and/or the critical habitat of a species not on federal land if there is reason to believe the province or territory is not sufficiently protecting the species. However, the decision by the Cabinet to order protection is discretionary. There is also a species and habitat harm exemption clause in SARA for activities that have been authorized by other permits or agreements. This clause has not been implemented to date (2012).

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CHAPTER 4

Understanding Bird Collisions

IN THIS CHAPTER

- Susceptibility of Birds to Power Line Collisions
- Identifying Collision Mortality
- Variability in Reported Mortality Rates
- Biological Significance of Collision Mortality
- Biological Characteristics Influencing Avian Collision Risks
- Environmental Conditions Influencing Avian Collision Risks
- Engineering Aspects Influencing Avian Collision Risks

Understanding the nature of bird collisions is essential for minimizing and mitigating them. This chapter presents what is known about bird collisions including the susceptibility of certain species, variability in reported mortality rates, biological significance of collision mortality, and the biological, environmental, and engineering factors that influence collision risk.

Some bird species have a greater collision risk than others. Because of the need for power lines to deliver electricity, engineering design requirements, and potential interaction of birds with power lines, collisions cannot be eliminated, but they can be reduced. The understanding of bird collisions has grown since 1994 and revolves around the following principles:

- Exposure to collisions is largely a function of behavior. Specific behaviors (such as flushing, courtship displays, and aerial hunting) may distract birds from the presence of power lines.
- Exposure is increased for birds that make regular and repeated flights between nesting, feeding, and roosting areas in proximity to power lines.
- Susceptibility to collisions is partially a function of wing and body size and vision. Larger, heavy-bodied birds with short wing spans and poorer vision are more susceptible to collisions than smaller, lighter-weight birds with relatively large wing spans, agility, and good vision.
- Environmental conditions (such as inclement weather and darkness) may distract birds from the presence of power lines or obscure their visibility.
- Engineering aspects, including design and placement, can increase or decrease the exposure for collisions.

SUSCEPTIBILITY OF BIRDS TO POWER LINE COLLISIONS

Summaries of studies on birds' susceptibility to collisions have primarily come from Europe (see Bevanger 1998; Janss 2000; Rubolini et al. 2005). Based on the Bevanger (1998) summary of risk, the orders of birds reported to be most susceptible to collisions included:

- Gaviforms (e.g., loons)
- Podicipediformes (e.g., grebes)
- Procellariiformes (e.g., shearwaters, albatross, petrels)
- Pelecaniformes (e.g., pelicans, cormorants)
- Cicioniformes (e.g., storks, ibis, herons)
- Anseriformes (e.g., ducks, geese)
- Falconiformes (e.g., hawks, eagles)
- Galliformes (e.g., grouse)
- Gruiformes (e.g., rails, cranes)
- Charadriformes (e.g., gulls, terns)
- Apodiformes (e.g., swifts)
- Columbiformes (e.g., pigeons, doves)
- Strigiformes (e.g., owls)
- Passeriformes (e.g., song birds)

The reasons for this susceptibility are functions of species characteristics, in particular the birds' body size, weight, wing shape, flight behavior, and nesting habits (see *Biological Characteristics Influencing Avian Collision Risks* on page 36). For example, literature shows that, in general, birds of prey are good fliers, have the ability to avoid obstacles, and are not prone to collisions. It is when they are engaged in certain activities (e.g., territorial defense, pursuing prey) that their collision risk increases (see Harness et al. 2003; Olendorff and Lehman 1986).

IDENTIFYING COLLISION MORTALITY

Reporting bird injuries and mortalities is part of the U.S. Fish and Wildlife Service (USFWS) permit requirements (see Chapter 3) and permits are an element of utility Avian Protection Plans (APPs; see Chapter 7). In order to report mortalities correctly, the affected species and the cause (collision or electrocution) needs to be properly identified. Field guides can be used to identify the bird species, and a guide for identifying raptor remains is also available (CEC 2005). The U.S. Geological Survey's National Wildlife Health Center also provides information and technical assistance for identifying bird carcasses (USGS 2011). See Appendix E for resources.

Table 4.1 lists the typical damage evident in bird carcasses from collision injuries. Electrocution injuries often occur as burn marks on the feathers and feet (see APLIC 2006). Collisions can also lead to electrocutions

TABLE 4.1: Typical evidence of bird injuries or mortalities from power line collisions.*

Evidence	Description
Predominant bone fractures	Fractured wings, legs, shoulder bones, vertebra, or skull; torn off limbs
Damage to plumage	Mechanical damage, such as torn off or broken feathers
Skin injuries	Skin torn open or off, and open muscle, sinew, and bone tissue visible; power line may leave imprint in skin where the bird struck the line; necropsy may reveal internal bleeding and bruising
Secondary damage to extremities	Limited areas of infection at open wounds, bones, sinews, and muscles
General condition of injured birds	State of shock; handicapped by injuries and secondary damage

* Source: Adapted from BirdLife International (2003)

SAMPLE

(called collision-electrocutions) if the bird's size is sufficient to make simultaneous contact with two phase conductors or with a phase conductor and grounded equipment, or if the collision causes two lines to slap together or get close enough to cause an electric arc.

VARIABILITY IN REPORTED MORTALITY RATES

It is difficult to extrapolate collision risk from one study and apply it to other power lines or compare it with other studies because of site-specific conditions and varying study methods and metrics. Likewise, many collision studies have been conducted in high risk areas and would not be applicable to lower risk areas. Numerous authors have summarized collision mortality with power lines (e.g., Faanes 1987; Bevanger 1998; Alonso and Alonso 1999; Rubolini et al. 2005; and Jenkins et al. 2010) and report mortality rates ranging from no birds killed to several hundred birds killed along a given segment of line per year. The California Energy Commission (CEC) study (Hunting 2002) provides a summary of collision mortality rates per unit area per distance. Reported mortality rates are highly variable and do not lend themselves to extrapolation to other lines because of site- and study-specific differences in:

- Species involved, such as ducks and sandhill cranes (*Grus canadensis*)
- Habitats, such as wetlands and agriculture
- Time periods and sampling regimes, such as single seasons versus multiple seasons
- Weather conditions, such as fog, wind, etc.
- Sampling biases, such as scavenger removal rates and searcher efficiency
- Types of power lines

Another limit to extrapolating bird/power line collision mortality estimates is the tendency to select worst-case scenarios as case studies (e.g., Koops 1987; Erickson et al. 2001; Manville 2005a). The CEC study (Hunting 2002) points out the difficulty in generalizing collision rates, and Bevanger (1999) provides an excellent summary of the



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FIGURE 4.1: Collision risk is highly variable among species, with heavy-bodied birds, such as this common loon (*Gavia immer*), being more vulnerable because they cannot readily maneuver.

Bibliographies of Collision Literature

Appendix A of this manual includes the literature cited and a bibliography of collision literature. An annotated bibliography of early collision literature was provided by Avery et al. (1980). In addition, the California Energy Commission hosts a searchable database on collisions: *On-Line Annotated Bibliography of Avian Interactions with Utility Structures* (CEC 2011).

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methodological issues in calculating these rates. For example, Faanes' (1987) calculation of 125 collisions/kilometer(km)/year (0.62 miles[mi]/year) for a line near a North Dakota wetland with abundant waterfowl during migration periods has been referenced by others including Bevanger (1999) and Erickson et al. (2005). Janss and Ferrer (2000) calculated collision rates of "one of the densest breeding populations of the great bustard (*Otis tarda*) in Spain," and for a large wintering population of common cranes (*Grus grus*) feeding in grain fields. Extrapolations from these studies could lead to exaggerated overestimates.

Adding to the difficulty in providing an overall assessment of collision mortality is that bird collisions do not usually cause power outages and consequently are not usually discovered. On the other hand, electrocutions are more likely to cause power outages and be reported (see APLIC 2006). To generate collision estimates for a particular power line, power line segments have to be selected randomly for mortality monitoring and should represent a diversity of habitats. Collision mortality can be relatively high or low depending upon the species, habitat, and the local circumstances. Appendix B provides recommendations for collision monitoring studies.

BIOLOGICAL SIGNIFICANCE OF COLLISION MORTALITY

Understanding the biological significance of collision mortality is necessary for developing proper reduction strategies. Collision mortality may have significance from social, wildlife policy, and biological points of view. Social and wildlife policy aspects relate to how the public and wildlife agencies consider collision mortality. The biological aspects relate to how the mortality affects bird populations. The social or wildlife policy assumption of significance is not necessarily biologically significant.



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FIGURE 4.2: Because of their higher reproductive rates, common bird species are generally at less risk of population effects from power line collisions.

From a biological perspective, significance evaluates whether collision mortality will affect the viability of a species' population. Biological significance results from an influence that significantly affects the ability of a species' population to sustain itself or increase its size.

This definition is used by population biologists to understand the influence of an adverse effect on a particular population or species. During site evaluation studies, utility biologists need to be aware of the possible impacts to rare species and to determine if the line would create a biologically significant risk as well as significant risk from a wildlife policy perspective (see Chapter 3).

Drewitt and Langston (2008) conclude that few studies of bird collisions with power lines show that collisions are biologically significant, which means individual losses from collision mortality are unlikely to affect large and robust populations. As an independent mortality factor, the effect of power line collisions on bird populations is generally thought to be compensated for in populations that have high reproductive rates (Bevanger 1998).

Biologically significant risk from collisions may occur in a population that is so small

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that the loss of a few individuals may impact local, rare, or endangered populations (Crowder 2000). Power line collisions may be significant to very small and/or declining populations, as they may not be capable of compensating for this loss (Bevanger 1998). Drewitt and Langston (2008) note that low reproductive rates and small populations of some species may further contribute to the likelihood of population effects. In addition, there are examples where collision mortality has occurred locally and concern has been expressed. Although not a federally endangered species, recent studies of sandhill cranes in Nebraska have shown that local populations can be affected by collision mortality (Murphy et al. 2009). Collisions during spring migration stopovers at major night roosts along the Platte River in Buffalo County, Nebraska, have been historically high near two 69-kilovolt (kV) transmission lines. The Newell's shearwater (*Puffinus auricularis newelli*), an endangered species in Hawaii, is an example of a species with a relatively small and restricted population that is threatened by multiple factors including power line collisions (Podolosky et al. 1998). Other threats include ground nest predation by dogs, cats, rats, pigs, and mongooses; collisions with buildings, cars, and other objects; and attraction to lights that may disorient them and cause them to fly around the light until they fall from exhaustion. Power line collisions appear to be a major contributor to the threats to Newell's shearwater's survival (Podolosky et al. 1998; Day et al. 2003; R. Podolosky, pers. comm.).

Outside North America, collision mortality is considered biologically significant for these species with low population numbers:

- Red-crowned cranes (*Grus japonensis*) in Japan (Archibald 1987, cited in Crowder 2000)
- Wattled cranes (*Bugeranus carunculatus*) in South Africa (Van Rooyen and Ledger 1999, cited in Crowder 2000)
- Capercaillie (*Tetrao urogallus*) in Norway (Bevanger 1995; Bevanger and Broseth 2004)
- Dalmatian pelicans (*Pelecanus crispus*) in northern Greece (Crivelli et al. 1988, cited in Drewitt and Langston 2008)
- Bonelli's eagle (*Aquila fasciata*) in Spain (Mañosa and Real 2001)
- Sarus crane (*Grus antigone*) in India (Sundar and Choudury 2005)
- Eagle owl (*Bubo bubo*) in Sweden (Herren 1969)
- Mute swans (*Cygnus olor*) in the United Kingdom (Kelly and Kelly 2005)

In the United States, collision mortality from power lines is considered biologically significant for two species with small populations: the whooping crane (*Grus americana*) and the California condor (*Gymnogyps californianus*).

WHOOPING CRANE

Losses of wild and reintroduced (or experimental) whooping cranes to power line collisions have been reported (Crowder 2000; Brown et al. 1987; Morkill and Anderson 1991; Stehn and Wassenich 2007). The one natural wild population, the Aransas-Wood Buffalo Population (AWBP), has been subjected to significant natural causes of mortality such that additional collision mortality is viewed as a threat to the species. The loss of 57 cranes (21.4% of the flock of 266) that died of starvation and infectious disease in the 12 months following spring 2008 (34 between spring and fall, 23 during the winter) was a serious setback (T. Stehn, pers. comm.). The additional loss of more than 10 birds per year for any reason could destabilize this species' recovery. However, the population has shown resilience with 279 whooping cranes at the Aransas National Wildlife Refuge in the spring of 2011 (T. Stehn, pers. comm.) compared to 247 in the spring of 2009.

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FIGURE 4.3: The United States' population of endangered whooping cranes has had such significant mortality from natural causes that additional power line collision mortality is now viewed as a threat to the species.

The actual percentage of whooping crane mortality caused by collisions with power lines is hard to extrapolate for the AWBP because monitoring the small population during migration over such a large area (Figure 4.4)[10] is so difficult. In the 1980s, two of nine radio-marked juvenile whooping cranes in the AWBP died within the first 18 months of life as a result of power line collisions; that is 33% of total post-fledging losses (n = 6) of the radio-marked birds during the study (Kuyt 1992). Five of 13 known causes of mortality (38%) for the AWBP between April and November from 1950 to 1987 resulted from collisions with power lines (total mortality from all causes equaled 133 cranes) (Lewis 1992).

Collisions have been reported in other whooping crane populations as well. In the non-migratory Florida population, 20 out of 166 cases with known causes of mortality (12%) were from collisions with power lines, and in the migratory Wisconsin population, 3 out of 18 mortalities (17%) were from collisions with power lines (Stehn and Wassenich 2007). From 1950 to 2008, out of 508 fledged whooping cranes that have died, only 44 (8.7%) of the carcasses were recovered (C. Strobel, USFWS, unpubl. data). Of the 44 carcasses recovered, no cause of death could be determined for 17. Of the remaining 27 carcasses where a cause of death was established, 9 (33%) were from power line strikes and 18 (67%) were from other causes (e.g., disease, predators, and shooting).

[10] The whooping crane migration corridor is 322 km (200 mi) wide and extends 4,023 km (2,500 mi) from Wood Buffalo National Park in the Alberta and Northwest territories in Canada to the Aransas National Wildlife Refuge on the Gulf Coast of Texas (see Stehn and Wassenich 2007).

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CALIFORNIA CONDOR

The federally endangered California condor was rescued from extinction when the last remaining wild individuals were captured from the mountains of southern California in 1987 to establish a captive breeding and reintroduction program. In 1991, reintroduction of captive-bred individuals began in select areas of the southwestern United States. As of December 2011, the total wild population of California condors was 210 individuals (NPS 2011). Reintroduced individuals from the captive breeding program have come into contact with power lines and collision mortality has occurred. For example, in a six-month period, three of eight condors that died in the wild died after colliding with power lines (D. Pearson, pers. comm.).

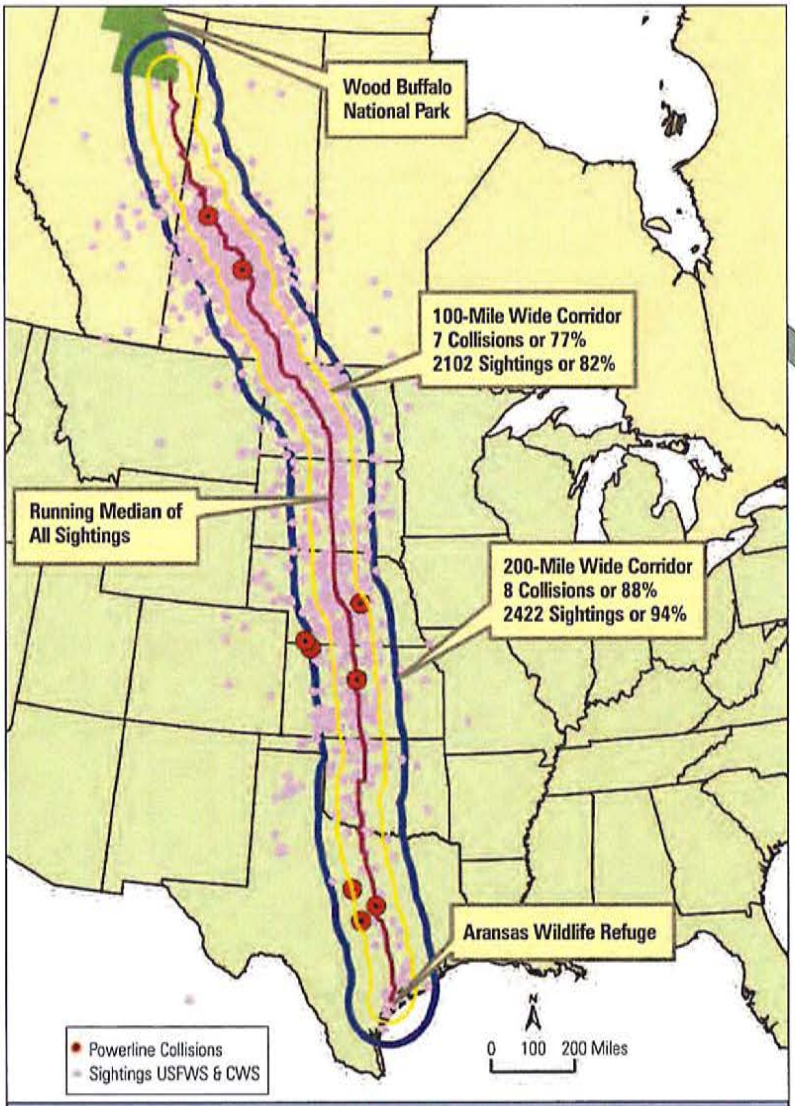

FIGURE 4.4: Whooping crane migration corridor in North America (2005 data from Stehn and Wassenich 2007).



FIGURE 4.5: Collision mortality has occurred with the expansion of the reintroduced population of the endangered California condor.

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PREVIOUS VIEW

BIOLOGICAL CHARACTERISTICS INFLUENCING AVIAN COLLISION RISKS

Different bird species have different collision risks based on their biology, behavior, habitat use, and inherent abilities to avoid risk (e.g., Savereno et al. 1996) (see *Susceptibility of Birds to Power Line Collisions*, page 30). A number of biological characteristics influence the susceptibility of species to collisions with power lines:

- Body size, weight, and maneuverability
- Flight behavior
- Vision
- Age and sex
- Health
- Time of day and season
- Habitat and habitat use

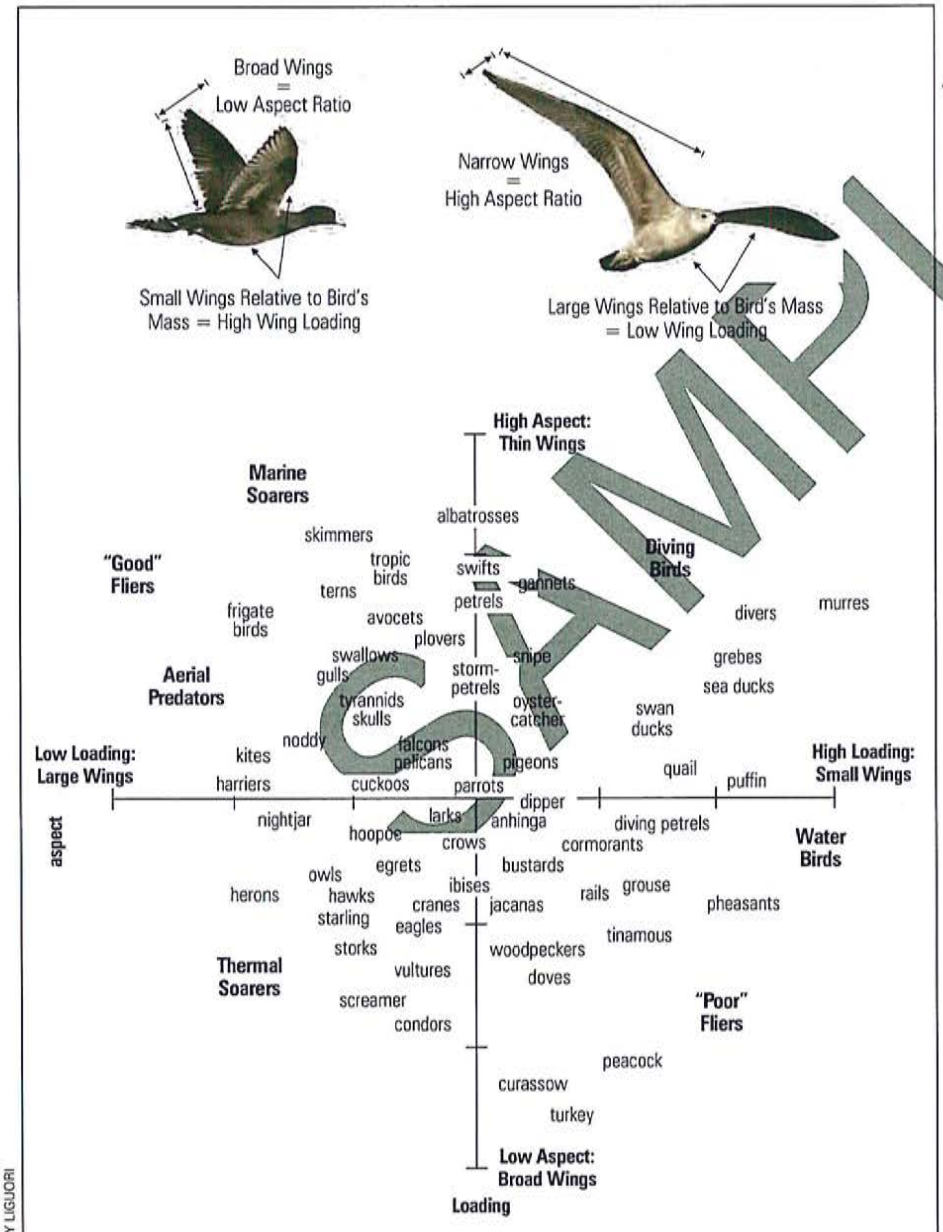

FIGURE 4.6: Wing loading and aspect ratio, among other factors, influence susceptibility to collisions (after Bevanger 1998).

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Knowing what avian species are involved, when they are present, and how they use the habitat along a power line route will help to estimate risk.

BODY SIZE, WEIGHT, AND MANEUVERABILITY

Several studies of collision vulnerability have addressed the relationship between bird size and maneuverability (e.g., Bevanger 1994, 1998; Janss 2000; Crowder and Rhodes 2002; and Rubolini et al. 2005). They classified birds based on weight and with these characteristics quantified wing loading (the ratio of body weight to wing area) and wing aspect ratio (ratio of the square of the wing span to the wing area) (Figure 4.6). Using Rayner's characterization (Rayner 1988), bird species were grouped according to the relationship of wing loading and wing aspect ratio and analyzed for collision susceptibility (Bevanger 1998). He developed six categories: poor flyers, waterbirds, diving birds, marine soarers, aerial predators, and thermal soarers. Bevanger (1994, 1998), Janss (2000), Crowder and Rhodes (2002), and Rubolini et al. (2005) have also evaluated different species and their collision susceptibility using wing loading and wing aspect ratio. They found in general that birds

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with high wing loading are more susceptible to collisions than birds with low wing loading; and that birds with low aspect ratios are more susceptible than birds with high aspect ratios. Birds with high wing loading and low aspect ratios represent poor fliers. Bevanger (1998), supported by Janss (2000) and Rubolini et al. (2005), also found this to be true.

High wing loading birds are frequently reported as collision casualties, including large, heavy-bodied birds with large wing spans such as herons (Mead et al. 1979), cranes (Walkinshaw 1956; Tacha et al. 1979; Brown et al. 1987), swans (Banko 1956; Beer and Ogilvie 1972), pelicans (Willard et al. 1977), and condors (D. Pearson, pers. comm.). These and similar species generally lack the maneuverability to quickly avoid obstacles.

Heavy-bodied, fast fliers are also vulnerable to collision. This characteristic is typical of most waterfowl, coots, rails, grebes, pigeons and doves, and many shorebirds (e.g., sandpipers and plovers). For example, waterfowl accounted for the majority of collision mortality at a site in the San Luis Valley, Colorado (Brown and Drewein 1995). Researchers have also noted that species with long legs and necks collide more often than those with more compact profiles (NUS Corporation 1979, unpubl., cited in Hunting 2002).

In comparison, terns with low wing loading and smaller body size are considered agile fliers and have a keen ability to avoid lines despite their high potential exposure. Henderson et al. (1996) found only two casualties beneath wires in a study of a common tern (*Sterna hirundo*) colony located within an industrial complex, where birds of all age classes and both sexes were making hundreds of flybys per hour (>10,000 flybys observed).

Body size and maneuverability do not explain all collision risk. Other factors can also contribute. For example, gulls and terns have low wing loading, yet they can be subject to collisions because of behavioral



FIGURE 4.7: Birds with high wing loading, such as swans, are more susceptible to collisions.

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characteristics, such as flocking, spending large amounts of time in the air, and flying at night. Although the low wing loading (light body) gives gulls and terns a more buoyant, graceful, and potentially slow flight speed, they are over-represented in Janss' mortality data set because of their large abundance at his study sites. This point is also made by Bevanger (1998) who cites observational studies by Meyer (1978), James and Haak (1980), and Beaulaurier (1981) to assert that gulls were 50 to 100 times less likely to collide with power lines when compared with ducks.

Passerines (songbirds) were reported in Bevanger (1998) to have a great deal of variation in flight morphology, yet most are not particularly heavy bodied or thin winged. Certain songbirds such as European starlings (*Sternus vulgaris*) may be so abundant that their representation among power line collision casualties may actually be attributed to abundance rather than susceptibility (Janss 2000). On the other hand, passerine carcasses are so small that they are much more difficult to discover and may be under-reported (Scott et al. 1972, cited in Drewitt and Langston 2008).

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FLIGHT BEHAVIOR

Understanding the flight behavior of birds active near a power line can be useful in identifying the potential risk for collisions and how those risks might be reduced. The following flight behaviors have been reported in the literature (e.g., Drewitt and Langston 2008) as influencing collision risk:

- Flocking
- Flight altitude patterns of migrating and non-migrating birds
- Courtship, nest building, and feeding flights to and from and around the nest, especially for colonial species
- Flight ability of fledglings and juveniles
- Flights between nesting/roosting and foraging areas

Flocking species, such as waterfowl and wading birds, are more vulnerable to collisions than solitary species (Bevanger 1998; Crowder 2000; Crowder and Rhodes 2002; Drewitt and Langston 2008). The density of large flocks leaves little room to maneuver around obstacles; in fact, birds sometimes collide with each other when panicked (Brown 1993). Bevanger (1998) and Drewitt and Langston (2008), citing several studies, conclude that flocking behavior may lead to greater susceptibility, as trailing birds have obstructed views of an upcoming obstacle. Crowder (2000) and Crowder and Rhodes (2002) observed that flocks react to power lines at a greater distance from the line than do solitary birds. Scott et al. (1972) and James and Haak (1980) stated that flocking behavior was an important factor in starling collisions, as did Blokpoel and Hatch (1976) for snow geese (*Chen caerulescens*). A number of birds within large flocks of sandhill cranes were involved in power line collisions in the Platte River area, Nebraska; in several instances collisions of some birds within flocks were observed (Murphy et al. 2009).



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FIGURE 4.8: Flocking species, such as these snow geese, can be more vulnerable to collisions.

Flight altitude is a function of species and environmental conditions such as winds, thermal conditions, visibility, precipitation, and time of day, as well as the type of flight (Newton 2008). Two types of bird flight altitude are observed: migrating or non-migrating.

Migrating birds take advantage of thermals and stronger tail winds when conditions permit, allowing them to conserve energy (Newton 2008) while staying well above power lines. In general, flight altitudes of migrating birds range from a couple hundred meters (m) (several hundred feet [ft]) to more than 6,000 m (20,000 ft). Weather conditions (e.g., wind speed and direction) influence flight altitude of migrants (see *Weather Conditions and Visibility*, page 48). Most transmission towers in the United States range from 15.2 m (50 ft) to less than 60.9 m (200 ft)[11] high depending upon design and voltage. If a

[11] Some structures exceed 61 m (200 ft) in height especially at river crossings and to clear other lines that might otherwise intersect (M. Schriner, pers. comm.; D. Bouchard, pers. comm.).

PREVIOUS VIEW

bird's flight altitude is at or below the height of power lines, collision risk can increase.

There are two basic types of migrating birds: long distance and daily migrants. Long distance migrants can fly thousands of kilometers (miles) without stopping and will have the least exposure to power lines during migration (e.g., some shorebirds, swallows, swifts, and terns). Most long distance migrants migrate at night, resting and feeding during the day (Manville 2007a). Daily migrants take shorter flights and make numerous stops to rest and feed (Newton 2008). Daily migrants include cranes, ducks, geese, and raptors. If power lines are in their landing or take-off paths, collision risk increases.

For non-migrating birds, flight altitude is likely to be within the range of power line height. Their flight is a function of their feeding, reproductive, and foraging behaviors. These behaviors usually occur within approximately 200 m (660 ft) of the ground, which can expose birds to collision risk when in the proximity of power lines. For predatory birds, the exposure to collision risk can be related, in part, to the pursuit of prey. Bevanger (1994) suggests that aerial hunters such as swifts, swallows, and certain raptors, such as the peregrine falcon (*Falco peregrines*), golden eagle (*Aquila chrysaetos*), and goshawk (*Accipiter gentilis*), typically have excellent maneuverability and very good vision. Yet because they chase prey at high speeds, the presence of a power line may not be perceived soon enough to avoid a collision with it.

Flight related to nesting behavior can increase collision risk if nests occur in close proximity to power lines. Such behavior includes courtship (e.g., aerial displays and pursuit), nest building, fledgling flights, feeding flights to and from the nest, territorial defense, and general flying around the nest or colony. These behaviors are most important for birds that nest in colonies, such as herons and egrets. Risks can also be associated with the age of a bird (i.e., adults and juveniles). Older birds are often acclimated to the presence of a line and will exhibit lower collision risk through well-developed flight patterns. Fledgling birds have less control of the flights and are more vulnerable to collisions than adults (see *Age and Sex*, page 41). There may also be risks for birds crossing a power line from the nesting site to a foraging area. Again, this is most important for colonial birds that will travel together to feed (see also *Habitat and Habitat Use*, page 44). Collision risks to foraging birds will occur when birds departing from and returning to a colony have to cross power lines. Their risk will be a function of the direction of foraging flights and the frequency of crossings. Mojica et al. (2009) reported 21 bald eagle (*Haliaeetus leucocephalus*) mortalities attributed to power line collisions in a study in Maryland conducted from 1985 to 2007.

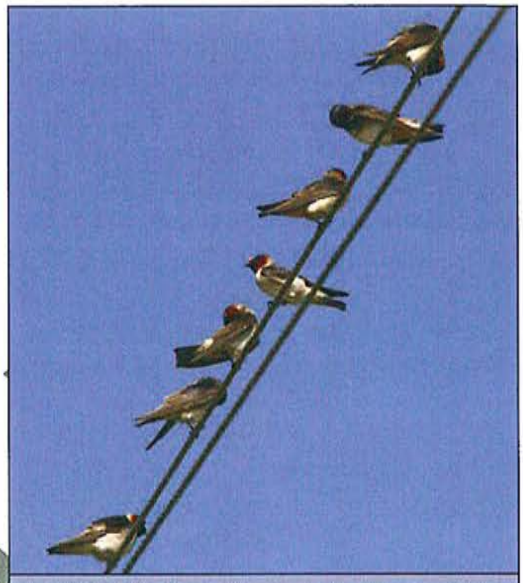

FIGURE 4.9: Aerial hunters that forage in flight within a couple hundred meters (several hundred feet) of the ground, such as swallows, can become collision victims.

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VISION

Information on the visual acuity of birds relative to power lines is generally lacking (Bevanger 1998). However, when they are able to see power lines, birds do exhibit avoidance behavior. The use of line marking devices that increase the visibility of lines has confirmed this (see Chapter 6).

For birds, detecting power lines depends on the visibility of the wires and on the characteristics of their vision. Compared to humans, the frontal vision of many bird species is not high-resolution, and many species mainly use their lateral vision to detect details (Martin 2011). Birds often tend to look downwards when in flight (e.g., to look for conspecifics [their own kind] or food), which for some species puts the direction of flight completely inside their blind zone (Martin and Shaw 2010; Martin 2011; CMS 2011a).

Some birds have highly developed vision that they use to capture prey and avoid predators (Gill 1995). The eyes of most birds are on the sides of their heads, which allows them to see things on each side at the same time as well as in front of them. This wide field of vision enables birds to spot predators and obstacles. However, widely spaced eyes can make judging distances and depth perception more difficult, except in the area where the eyes' fields-of-view overlap.

In addition, birds have blind spots caused by the length, width, and position of their bills. For some species, depending upon the size and movement of their bill, these blind spots can reduce the visual field. Researchers have noted that swans' poor frontal vision makes them more susceptible to collision (Martin and Shaw 2010). Martin and Shaw (2010) provided evidence that some species, such as bustards and cranes, have extensive blind spots in the frontal hemisphere and that downward head movement (forward pitch) greater than 25 degrees and 35 degrees, respectively, can render them blind in the direction of travel. If this occurs, objects directly ahead of the bird may not be detected during flight regardless of the visual capacities of the bird's eyes or the size and contrast of the object.

Raptors' eyes are closer to the front of their heads, giving them binocular vision, which is important for making distance judgments while pursuing prey. Having depth perception also makes them less vulnerable to collisions than birds with eyes on the sides of their head.

Birds with eyes adapted to underwater vision, such as ducks, tend to be emmetropic (objects are in sharp focus) in water and slightly myopic (nearsighted) in air (Jones et al. 2007). This may affect their ability to detect small diameter wires as they approach them at high speeds. A red-breasted merganser (*Mergus serrator*) was observed colliding with a shield wire with no reaction prior to the collision, and other mergansers were observed flying within 30.5 cm (12 in) of the shield wire with no reaction (N. Turley, pers. comm.). These observations suggest that the



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FIGURE 4.10: Swans' poor frontal vision, along with their large size, increases their susceptibility to collisions.

AMPLIFY

mergansers were not aware of the wire, which indicates that vision characteristics may play a role in collision risk. Examples of other birds in this group with eyes adapted to underwater vision include loons, grebes, other diving ducks (buffleheads, scoters, and eiders), gannets, and kingfishers.

Some species have the ability to keep objects at different distances in focus simultaneously. For example, they are able to scan the horizon while keeping the ground in focus during flight, regardless of changes in elevation. This is believed to be achieved by asymmetry of the lens and cornea about an optical axis (Jones et al. 2007). This results in the eye being emmetropic in some parts of the visual field (the lateral and upper lateral visual fields) and myopic in others (lower lateral visual fields). For prey species such as pigeons, these characteristics allow the bird to scan the horizon for predators and conspecifics while foraging for objects on the ground. This same ability is also found in quail and sandhill cranes (Jones et al. 2007), but is generally not possessed by raptors or other species that must capture mobile prey.

In the last two decades, research on avian vision has indicated that ultraviolet sensitivity is an important component of avian vision. Birds detect a wider bandwidth of light in the violet and ultraviolet (UV) spectrum (440 nanometers [nm] to 10 nm) than humans do. This difference in sensitivity may relate to many different aspects of bird behavior including prey detection, foraging, display and mating, navigation, and circadian rhythm (Hart et al 1998; Bennett and Thery 2007). Based on this research, UV materials have been applied to line marking devices to help birds detect hazards that otherwise would not be seen. However, these UV materials have not been systematically tested in collision studies.

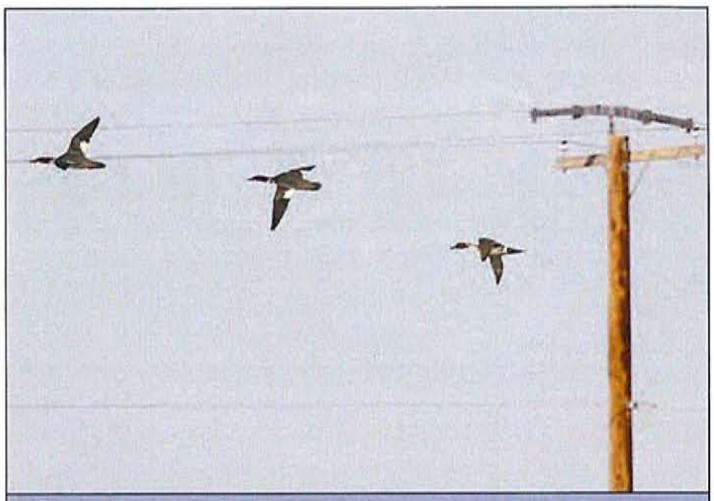

FIGURE 4.11: Because they are nearsighted and fly at high speeds, mergansers may be unable to readily detect small diameter wires as they approach them.

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Regardless of a bird's vision, environmental conditions such as inclement weather and the time of day (e.g., low light or dark) can reduce a bird's ability to see even marked power lines. A number of line modification and marking strategies can be used to reduce the effect of these factors (see Chapter 5 and Chapter 6).

AGE AND SEX

Age and sex have a species-specific influence on collision risk. Crowder (2000) cites numerous studies showing that juveniles are more susceptible than adults (Thompson 1978; McNeil et al. 1985; Brown et al. 1987; Crivelli 1988; Savereno et al. 1996; Mathiasson 1999) but also notes two examples where adults are more susceptible (Ogilvie 1966; Anderson 1978). Brown et al. (1987) and Morkill and Anderson (1991) demonstrated statistically that juvenile sandhill cranes col-

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lided with power lines more frequently than their proportion of the population would indicate. Conversely, Anderson (1978) found that adult mallards (*Anas platyrhynchos*) were more vulnerable to collisions than juveniles. Ogilvie (1966) suggested that age was not a factor in collision susceptibility for mute swans.

Many authors suggest that young birds or those unfamiliar with the area are more vulnerable than experienced birds (Anderson 1978; Thompson 1978; McNeil et al. 1985). The less-controlled flight of young birds also increases their collision risk. These birds are generally believed to be more susceptible to both electrocution and collision, though this may be confounded by the greater proportion of young birds in the population (Bevanger 1998). Most (11 of 14 = 78.6%) of Newell's shearwater collisions at a Kauai, Hawaii, power line were non-breeding birds, though many of those were likely subadults. The proportions of non-breeding adults and subadults in the population were not reported (Cooper and Day 1998). Juveniles of many migratory species are especially at risk because they have not yet encountered nor learned to avoid the assortment of risks they face.



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FIGURE 4.13: Endangered Newell's shearwater mortalities at a Kauai power line were mostly non-breeding adult and subadult birds.

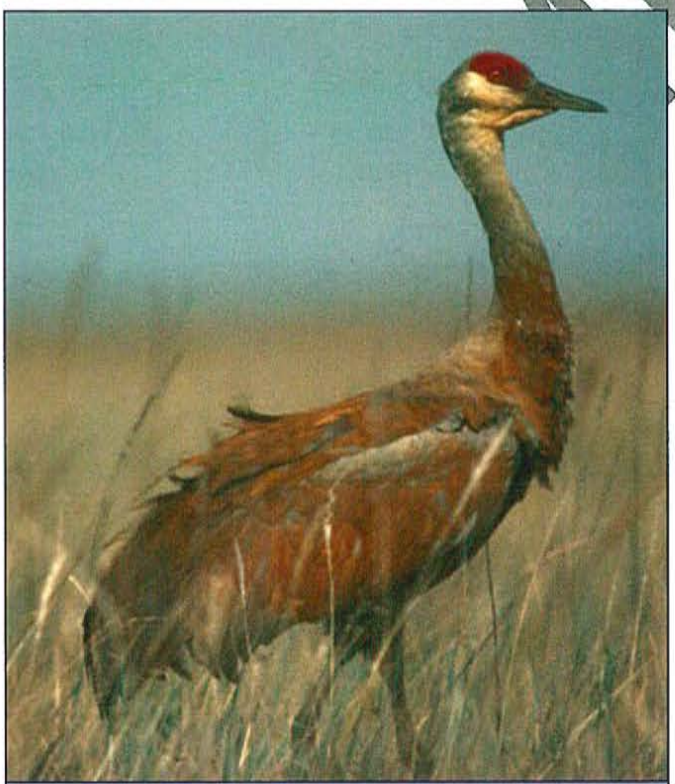

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FIGURE 4.12: Some juvenile birds, such as sandhill cranes, collide with power lines more frequently than their adult counterparts.

Less information about the differing vulnerability of sexes exists because comparative data are rarely available. However, several studies have presented evidence that male ducks are more prone to collisions than females (Boyd 1961; Avery et al. 1977; Willard et al. 1977; Brown and Drewien 1995). The courtship and pursuit behaviors of male ducks greatly increase their frequency of local flights and can distract them from seeing and avoiding power lines. Distractions for other species also include pursuit of mates, competitors, or prey, which can increase collision risk (Willard et al. 1977; Anderson 1978).

PREVIOUS VIEW

HEALTH AND CONDITION OF THE BIRD

Studies of birds killed by power line collisions indicate that poor health may increase collision risk. Mute swans with elevated blood lead levels had higher collision risk than did healthier birds (Kelly and Kelly 2005). Low weight swans and swans with heavy burdens of toxins were over-represented among swans killed by collisions in Sweden (Mathiasson 1999).

The ability of the bird to maneuver can also be impaired by entanglement with fishing lines and other anthropogenic materials. Manville (2005b) reported on entanglement issues involving Canada geese (*Branta canadensis*) and other waterbird species with six-pack beverage rings and monofilament fishing line, along with plastic debris ingestion, all of which may increase their susceptibility to power line collisions due to weakened conditions, altered aero-dynamics, and impaired health.

Collision mortality can also lead to health effects in populations of birds. In rare instances, collisions that occur in high enough numbers can indirectly contribute to some diseases, such as botulism. Malcom (1982) reported the deaths of several thousand grebes and ducks from botulism that were initiated by the victims of collisions with a transmission line in south central Montana. The collision victims fell into a wetland where their carcasses provided the energy substrate in which dormant *Clostridium botulinum* spores became active. These bacteria produce a toxin that invertebrates consume and concentrate without ill effects. Those toxin-laden invertebrates (e.g., fly-egg-maggot) become food for other ducks and a vicious cycle can develop and become protracted (Rocke and Friend 1999), much as Malcom observed.



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FIGURE 4.14: Gulls (pictured) and waterfowl tend to make feeding flights at dusk and dawn, when reduced light increases collision risk.

TIME OF DAY AND SEASON

Time of Day

Studies have shown that time of day is important to collision frequency in daily flights and during migration. Different species generally feed at different times of day. Non-breeding birds, including migrating species, generally feed continuously during the day and are considered to have continuous exposure to power lines in the vicinity of their feeding areas. When birds are nesting, they often show a periodicity in feeding.

Collisions are much more likely during the night than the day (Scott et al. 1972; Krapu 1974; Anderson 1978; and James and Haak 1980; all cited in Crowder 2000; Pandey et al. 2008). Gulls and waterfowl tend to make feeding flights after sunset and before sunrise. Many waterbird species regularly fly at night in response to tidal cycles or prey activity (Black and Collopy 1982; Erwin 1977; Robert et al. 1989; Dodd and Colwell 1998) or predator avoidance. Inability to see the wires due to low light conditions probably raises the collision risk for these species (Scott et al. 1972; Krapu 1974; James and Haak 1980; Brown and Drewien 1995). At the San Luis National Wildlife Refuge Complex in California, bird flight diverters were effective on waterfowl but not on coots, which authors attribute to the fact that coots

AMPLIFY

fly at night and cannot see the diverters (Ventana Wildlife Society 2009).

Species that migrate at night, such as songbirds and herons, may be vulnerable to collisions if weather forces them to fly at low altitudes. However, generalizing from one species to another or one habitat to another that nocturnal flight behavior may be more risky than diurnal flight behavior needs to be cautioned. Deng and Frederick (2001) investigated nocturnal bird flights of wading birds in the vicinity of a 550-kV transmission line adjacent to the Everglades in south Florida. They observed nine species of wading birds including herons, egrets, and wood storks (*Mycteria americana*). The investigation showed that nocturnal-flying wading birds were less responsive to the power lines than diurnal-flying birds; however, the birds generally flew higher over the power lines at night than during the day. No collisions were observed but the authors stated that the sampling period was short (118 hours). One of the suggested reasons for the lack of collisions was that the birds were acclimated to the presence of the line.

Similarly, radar data collected by Harmata et al. (1997) along the Missouri River indicated that birds flying at night flew at heights well above power lines. By flying higher at night, waterbirds and other species may lower collision risk with natural and anthropogenic obstacles. However, there may be risks from lines that occur in the departing and arriving zones for roosting or foraging habitats. For example, dark-rumped petrels (*Pterodroma phaeopygia*) and Newell's shearwaters in Kauai, Hawaii, crossed much closer to power lines in morning seaward flights than in evening landward flights, and all recorded Newell's shearwater collisions occurred during morning flights (Cooper and Day 1998).

Season

Seasonal bird abundance is also correlated with collision mortality. For example, seasonal flight behavior differences resulted in more wintertime collisions for ptarmigan in Norway (Bevanger and Broseth 2004). Migration seasons generally pose a greater risk to migrating birds because of both higher flyover frequency and unfamiliarity with local landscapes. The nighttime proportion of crane and waterfowl collision mortality versus total collision mortality was 31.8% in the fall (1990) during migration and 7.7% in the spring (1991) in San Luis Valley, Colorado (Brown and Drewein 1995).

Willard (1978) described a situation in the Klamath Basin, Oregon, that illustrates how both collision mortality and its population effects can increase during the breeding season. At Lower Klamath Lake National Wildlife Refuge, adult American white pelicans (*Pelecanus erythrorhynchos*) flew low over canals and collided with power lines while searching for food. For this species, this meant a double loss: first, the loss of the adult that collided with the line, and second, the loss of the young, which rarely fledge after one parent is lost because both parents must forage extensively to feed them.

HABITAT AND HABITAT USE

Power lines located near habitats with high avian use (such as nesting, foraging, roosting, and resting sites) may pose greater exposure to collisions for some species. For example, power lines between foraging and roosting sites of wading birds will be frequently crossed, which increases the collision risk potential. This is especially true when only a short distance separates the two habitats. Birds in these situations typically fly at low altitudes, potentially putting them at the height of power lines. Willard et al. (1977) suggested that overhead wires within a single habitat (e.g., within a wetland) are more likely to cause collisions than those between two habitats (e.g., wetlands and uplands); other studies have found the opposite to be true (e.g., Faanes 1987; Brown et al. 1987; Morkill and Anderson 1991).

SAMPLE

The critical questions are how often, and in what numbers, do birds fly across a power line during their daily routines? For example, in a study in the San Luis Valley of Colorado, Brown et al. (1987) found that power lines dividing wetlands (used for roosting) from grain fields (used for feeding) caused the most collisions for sandhill cranes and field-feeding waterfowl. This occurred because these habitats encouraged the birds to cross the lines at low altitudes several times each day. However, the same power lines had little effect on diving ducks, which had restricted their activities to wetlands. Thus, the risk of a particular power line depends in part upon the way each species uses the adjacent habitat.



FIGURE 4.15: Power lines located between the foraging and roosting sites of wading birds, such as this white ibis *(Eudocimus albus)*, may result in higher collision risk.

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Power lines, including those that border habitat such as a wetland used by many birds, may present little risk if the adjacent habitat separated by the power lines is not attractive to birds (e.g., a city rail yard). Conversely, if the adjacent habitat is a grain field, collisions may result in fall and winter for field-feeding birds that make daily flights between wetland roosts and foraging sites, including sandhill cranes, Canada geese, mallards, and pintails (*Anas acuta*) (Thompson 1978; Brown et al. 1987; Morkill and Anderson 1991). The same line may represent lower risk during the breeding season when these birds remain in wetlands throughout the day. Although forested habitats located near power lines can



FIGURE 4.16: Research conflicts on whether or not overhead wires within a single habitat, such as this wetland, are more likely to cause collisions than those between two habitats.

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PREVIOUS VIEW

sometimes reduce collision risk (see *Managing Surrounding Lands* on page 58), in some forested habitats where there are open clearings for the power lines, collision risk may be higher for birds that fly across the open corridor while going between forested areas.

During migration, birds make stopovers in their preferred habitats. When migratory birds' staging, roosting, resting, and foraging areas are located near power lines, especially when ingress or egress coincides with inclement weather, collision risk increases (Manville 2005a, 2009a). This can be especially true when there are large concentrations of birds; for example, sandhill cranes that number in the tens of thousands along the Platte River in Nebraska (Murphy et al. 2009).

Some habitats, such as lakes and ponds, have seasonal use patterns. Proximity to shoreline habitat was linked to bald eagle collisions (21) and electrocutions (24) at Aberdeen Proving Grounds, Maryland (Mojica et al. 2009). Higher collision mortality was found at power lines near shorelines used as feeding areas. The 16,000 hectare (39,537 acre) area on Chesapeake Bay had 42 resident pairs and seven known communal roosts used by migrants from the north and south during the winter and summer months, respectively. In a high bird concentration area along Lake Ontario, double-crested cormorants (*Phalacrocorax auritus*) were the most commonly reported collision victim, although they were over-represented relative to their abundance in the area, and gulls and waterfowl were the next most commonly reported species to collide with lines (Barrett and Weseloh 2008). A PacifiCorp study calculated the distance of collision mortalities to the nearest water body using survey data collected in Oregon, California, Idaho, Utah, and Wyoming from 2004 to 2009 (S. Liguori, PacifiCorp, unpubl. data) (Table 4.2).

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TABLE 4.2: Average distance of collision mortalities from nearest water body.*

Species	Sample Size	Average Distance
Snow goose *(Chen caerulescens)*	37	82.3 m (270 ft)
American white pelican *(Pelecanus erythrorhynchos)*	17	82.6 m (271 ft)
Tundra swan *(Cygnus columbianus)*	3	89.3 m (293 ft)
Sandhill crane *(Grus canadensis)*	7	119.8 (393 ft)
Great blue heron *(Ardea herodias)*	7	154 m (505 ft)
Mallard *(Anas platyrhynchos)*	5	213.4 m (700 ft)

* Source: PacifiCorp, unpubl. data

ENVIRONMENTAL CONDITIONS INFLUENCING AVIAN COLLISION RISKS

Environmental conditions that can increase the risk for collisions with power lines include:

- Land uses
- Weather conditions and visibility
- Sudden disturbances

The relative importance of these conditions varies with location, season, species, and different populations of the same species.

LAND USES

Land uses, such as conservation, recreational, residential, agricultural, and industrial, have

habitats and management practices that can attract or discourage bird use. Collision risk depends on the location of power lines within these areas and the bird species that are drawn to them.

Conservation and Nature-Based Recreation Lands

Conservation areas and wildlife refuges vary greatly in size and habitat type and are often managed for specific types of wildlife and/or nature-based recreation uses. Many conservation lands have distribution lines that supply their power needs and may also be crossed by transmission lines. These lines may present collision risk depending on the habitats, species, and human activities present. The potential for disturbing and flushing birds into nearby power lines can be higher in recreation areas due to increased human activity or lower if resident birds are acclimated to human activity. Power lines that cross high avian-use habitats such as wetlands or are placed between foraging and roosting areas may also result in a higher risk of bird collisions (see *Habitat and Habitat Use* on page 44). Although a proposed power line route may not be able to avoid such conservation areas, managers need to be aware of the potential risks so they may be minimized (see Chapter 5).



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FIGURE 4.17: Power lines crossing agricultural fields with seasonally attractive crops or residue can contribute to collision risk for some flocking species, such as cranes, waterfowl, songbirds, and these trumpeter swans (*Cygnus buccinator*).

Residential and Urban Recreation Lands

Residential and urban recreation lands vary widely in their attractiveness to birds (e.g., Chace and Walsh 2006). Generally, urban recreation lands such as parks and golf courses are interspersed within or between densely populated residential areas. These lands often become habitat islands. For example, they may have small wetlands that are used by various protected birds. Distribution lines may be especially plentiful in residential and recreational areas and can pose a collision risk, depending on the susceptibility of the species, when situated in the flight patterns of birds.

Agricultural Lands

Agricultural fields and ponds can attract birds; for example, grain crops are seasonally attractive to many flocking species such as cranes, waterfowl, and blackbirds, along with rodents that attract raptors. Because grain fields are used only as feeding areas by these species, they may be attractive when they are in close proximity to nesting, roosting, or wintering habitat. Agricultural fields, especially those that are managed with burning or flooding or have nearby wetlands, can also attract a variety of bird species during staging and migration and may even result in shortstopping, i.e., drawing birds to these attractive sites for the winter rather than their historical wintering sites (Viverette et al. 1996). Collision problems may develop when birds must cross power lines to make daily, low-altitude flights between feeding areas and nesting or roosting sites. See also *Habitat and Habitat Use* (page 44).

Industrial Lands

Industrial lands sometimes provide attractive bird habitat. Gulls, vultures, crows, ravens, and

SAMPLE

other scavengers often gather at landfills in large numbers. Cooling ponds at electricity generation facilities, municipal sewage ponds, settling ponds at mines, and other industrial water bodies can attract waterbirds, shorebirds, and raptors. As with other types of land use, the degree of hazard posed by power lines will vary depending upon the proximity of the lines to these avian-use areas (see *Habitat and Habitat Use* on page 44). If bird collisions become a problem, property managers may be able to choose from a variety of options to modify or discourage bird use of the area (see *Managing Surrounding Lands* on page 58).

WEATHER CONDITIONS AND VISIBILITY

Weather conditions play a very important role in both the visibility of power lines and in the behavior of birds in flight during migration and local movements, such as daily foraging activity. When weather conditions interact with biological characteristics (e.g., flight behavior, wing loading and aspect ratio, and season), collision risk may be dramatically affected.

Adverse weather conditions, such as fog, dense cloud cover, high and variable wind speeds, precipitation, and reduced or zero visibility are associated with greater collision risk. Reduced visibility and high wind speeds can also cause birds to fly at lower altitudes, potentially putting them at the same height as power lines. The influence of weather on flight altitude was reviewed in depth by Shamoun-Baranes et al. (2006), and the effect of weather on flight height and behavior has been observed in many bird species (Drewitt and Langston 2008; Newton 2008).

Weather and biological factors are often interrelated and may affect flights within high bird-use areas. The timing of daily flights may subject certain species to adverse weather conditions associated with collisions, such as fog (Scott et al. 1972; Tacha et al. 1979) or wind (Brown 1993). This is especially true in coastal and low-lying areas that are frequently foggy or windy. When possible, birds will avoid flying in heavy precipitation or fog. Problems most often occur when birds unexpectedly encounter these conditions. Storms or fog can arise quickly and birds may collide with power lines when attempting to leave feeding areas for protected roosts (Wheeler 1966; Tacha et al. 1979). In foul weather, birds may be attracted to lighted areas on the ground (Manville 2007a). If power lines are also in or near those areas they could be in the landing approach of the attracted birds and become a collision risk (see *Lighting*, page 52).

Wind, wind shear, and turbulence most often appear to influence collisions when birds fly at power line heights. Some birds decrease flight altitude in high winds (Scott et al. 1972; Raevel and Tombal 1991). Poor conditions—wet feathers, precipitation, high winds, wind gusts, and turbulence—also hamper birds' ability to control flight and further increase collision risk (Walkinshaw 1956; Avery et al. 1977; Willard et al. 1977; Anderson 1978). In high-velocity winds, birds may collide with other birds, buffeting them into fully visible and familiar power lines (Brown et al. 1987; Morkill and Anderson 1991; Raevel and Tombal 1991; Brown and Drewien 1995).

In the San Luis Valley, Colorado, collisions occurred more frequently on days with winds >24 km per hour (15 mi per hour) (Brown and Drewein 1995). Collisions were also more likely with tailwinds, which increase a bird's ground speed, than with headwinds, which have the opposite effect (Savereno et al. 1996). Crowder (2000) reviewed older evidence of power line collisions resulting from stormy (Wheeler 1966), foggy (Tacha et al. 1979), or windy (Brown et al. 1987; Morkill and Anderson 1991) conditions. These studies showed that wind, especially associated with stormy weather, is an important contributor to collisions. It has been suggested that birds, such as gulls, with a high aspect ratio and low wing loading are more susceptible to being blown into lines than other bird

SAMPLE



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FIGURE 4.18: Birds usually initiate migration in favorable weather conditions, but when they encounter inclement weather they may decrease their flight altitude, which increases collision risk when power lines are present.

species without these physical characteristics (Bevanger 1998).

The impact of weather is also related to season, as adverse weather may pose a greater risk during migration (APLIC 2007) and can influence the initiation of migration (Shamoun-Baranes et al. 2010). Songbirds usually begin migration in favorable conditions, but may encounter inclement weather en route. The weather hazard may be worsened when migratory birds respond to fog and precipitation by decreasing their flight altitude (Gauthreaux 1978a) or by attempting to land (Manville 2007a). In known or historic staging, roosting, resting, feeding, or stopover areas for migratory birds located in immediate proximity to power lines, there can be a substantial increase in collision risk, especially when bird ingress or egress coincides with inclement weather (Manville 2005a, 2009a). This effect is magnified when flocks are very large, as with migrating sandhill cranes in the Platte River area of Nebraska (Murphy et al. 2009).

The flight altitudes of migratory birds can vary greatly and are strongly correlated with winds aloft, air clarity, turbulence, thermals, and weather, both day and night. In particular, thunderstorms and low cloud ceiling conditions are known to cause nocturnally migrating songbirds to land or to fly at lower altitudes that increase collision risk, particularly with illuminated structures (Winkelman 1995; Gill et al. 1996; Erickson et al. 2001; Johnson et al. 2002; Kerlinger 2003). Various radar studies have estimated that under normal weather conditions, 84% to 97% of nocturnally migrating songbirds fly at altitudes of 125 m (410 ft) or more above ground level where they are not exposed to risk of collision with power lines (Mabee and Cooper 2002; Cooper 2004; Mabee 2004).

SUDDEN DISTURBANCES

Sudden disturbance can panic and flush birds, especially flocks of birds, into nearby power lines and has been well documented as a contributing factor to collisions (Krapu 1974; Blokpoel and Hatch 1976; Anderson 1978; Brown et al. 1984; Archibald 1987). Birds may be flushed by vehicles, trains, pedestrians, aircraft, farm equipment, hazing, hunters, predators, etc., along ROWs and may collide with power lines in their effort to escape (APLIC 2007). Crowder (2000) reviewed older evidence of power line collisions resulting from sudden disturbance of geese by vehicles (Schroeder 1977) or airplanes (Blokpoel and Hatch 1976). One such disturbance resulted in a collision event with mallards during Crowder's (2000) field study. Murphy et al. (2009) support the idea that most sandhill crane collisions at Platte River, Nebraska, occur when closely congregated birds are flushed after dark. In Washington, roosting American white pelicans collided with an adjacent distribution line when flushed during the night by a passing train, even though line marking devices were installed (S. Liguori, PacifiCorp, pers. comm.).

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ENGINEERING ASPECTS INFLUENCING AVIAN COLLISION RISKS

The following engineering aspects can influence the risk of collisions with power lines:

- Diameter of lines (shield wires versus phase conductors)
- Line placement (proximity to avian habitat)
- Line orientation (relative to biological and environmental factors)
- Line configuration (aligned vertically or horizontally and the number of lines)
- Structure type (guyed versus self-supporting)
- Lighting (steady burning versus blinking)

DIAMETER OF LINES

The smaller diameter of transmission line shield wires compared to phase conductors influences the risk of collisions, with shield wires being the lines most often involved (Scott et al. 1972; Willard et al. 1977; Brown et al. 1987; Faanes 1987; APLIC 1994; Savereno et al. 1996; Jenkins et al. 2010). Because of their smaller diameter (1 to 1.3 centimeters [0.4 to 0.5 inches]) compared to phase conductors (2.5 to 5 cm [1 to 2 in]) and their position above the phase conductors, shield wires are the least visible type of power lines and they are in the flight path of birds that gain altitude to avoid the more obvious phase conductors. The shield wire protects, or shields, the phase conductors from lightning strikes.

Distribution lines consist of phase conductors and a neutral wire, which is at the same level or below the phase conductors. Though it is not absolute, most birds gain altitude to avoid an obvious line, which implies that neutral lines are less likely to be involved in collisions.

LINE PLACEMENT

The proximity of power lines to bird take-off and landing areas can affect collision risk (Lee 1978; Thompson 1978; Faanes 1987), but no specific setback distance has been found in the literature. Brown et al. (1984, 1987) found that no sandhill crane or waterfowl collisions occurred where distances from power lines to bird-use areas were ≥1.6 km (1 mi). Faanes (1987) found that collision rates dropped off dramatically after 400 m (1,312 ft). Faanes (1987) stated that "among the sites I examined, power lines situated 400 m (1,312 ft) or more from the edge of the water generally had lower observed mortality than sites where the power line was within this distance." Quinn et al. (2011) found no bird carcasses under power lines that were situated more than 500 m (1,640 ft) from the edge of the water; at distances of 60 m (197 ft), collision mortality dropped off dramatically ($p = 0.0012$, $df = 3$). See also *Habitat and Habitat Use* on page 44. See Chapter 5 for examples of risk and reduced risk situations.

LINE ORIENTATION

Orientation of power lines relative to biological characteristics (e.g., flight behavior, season, habitat, and habitat use) and environmental conditions (e.g., topographical features and weather patterns) can influence collision risk. When planning power line routes, features that are traditional flight corridors, such as mountain ridges, river valleys, and shorelines, should be considered (Colson and Yeoman 1978; Faanes 1987). Power lines that parallel primary bird flight paths pose less risk than a perpendicular orientation (Crowder 2000; Scott et al. 1972; McNeil et al. 1985). For example, the perpendicular orientation of a line relative to a topographical feature poses a greater collision risk to local and migrating birds than a parallel orientation (see Figure 4.19).

Lines that are at or below the height of nearby trees rarely present a problem to small tree-dwelling birds because of their maneuverability; furthermore, large birds will gain altitude to fly over the tree line and consequently avoid the power line (Thompson 1978; Raevel and Tombal 1991). For example,

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FIGURE 4.19: Orientation of power lines parallel to ridges or narrow, low altitude flyways presents a lower risk of collision than perpendicular orientation.

a power line that crosses a narrow river bordered by trees that are taller than the line is likely to have a lower collision risk than lines crossing broad rivers because most birds will fly over the tree tops to cross the narrow river valley (CMS 2011a).

Strong tail winds can be detrimental to birds' ability to execute avoidance maneuvers. Brown (1993) suggested that north-south orientation of lines increased collision frequency for cranes and waterfowl in the San Luis Valley, Colorado, because birds crossing them on an easterly heading were often subjected to prevailing westerly winds. See also *Biological Characteristics*, on page 36, and *Weather Conditions and Visibility* on page 48.

LINE CONFIGURATION

Line configuration—phase conductors aligned vertically or horizontally, and the number of conductors—is a collision factor that intuitively makes sense, but there are too few studies to draw conclusions. Most researchers agree that keeping the vertical arrangement of multi-conductor transmission lines to a minimum is beneficial because it reduces the height of the collision zone. However, a single-pole vertical structure is often esthetically more acceptable and requires less ROW width.

Thompson (1978) and others (Bevanger 1998; Crowder 2000; Drewitt and Langston 2008) have suggested that clustering lines (i.e., several power lines sharing the same ROW) may reduce the risk of collisions because the resulting network of wires is confined to a smaller area and is more visible. Birds only have to make a single ascent to cross lines before resuming their preferred altitude. However, when there is decreased visibility, collision risk for birds may increase where several lines are clustered together. In addition, when there are two shield wires at different heights, and only the higher one is marked, there may be collisions at the lower unmarked shield wire, thus both shield wires may need to be marked (S. Liguori, pers. comm.). See Chapter 5 for examples of risk and reduced risk situations.

STRUCTURE TYPE

Because of the collision risk posed by guyed communication towers (e.g., Shire et al. 2000; Manville 2007a; Gehring et al. 2009; Gehring et al. 2011; Longcore et al. 2012), the question of collision risk associated with guyed power line structures has occasionally been asked. Guy wires on power line structures are used for support and stability especially where a line ends (deadend structure) or changes direction (e.g., makes a 90-degree turn). There is no published information to suggest that guyed power line structures pose a significant collision risk for birds. PacifiCorp has surveyed over 120,000 poles in six states and has not found collision victims at any of the guyed structures (S. Liguori, pers. comm.). Based on exposure alone, the relative short lengths of the guy wires and the low heights on power lines pose much less risk to birds than do the longer, multiple guy wires on communication towers whose height can

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exceed 300 m (>1,000 ft; Gehring et al. 2011). In addition, some types of lighting on communication towers can attract birds into the collision zone in low visibility weather. Because transmission towers are, with very few exceptions, unlit, they are not expected to have the same risk.

LIGHTING

Studies of bird collisions with communication towers and other tall structures have shown that steady-burning white or red lights can disorient migrating birds at night especially when migration coincides with inclement weather (Manville 2007a, 2009; Gehring et al. 2009, 2011). This disorientation can cause birds to collide with the lighted structure, guy wires on a communication tower, or each other. It can also cause the birds to circle the light source, which may also result in exhaustion and injury or death. Collision incidence on lighted communication towers, for example, depends on the type and intensity of the lights (i.e., steady burning, blinking, or strobe) as well as whether the birds are navigating visually or magnetically. In a Michigan communication tower study, extinguishing steady-burning, L-810, red side lights, while leaving on the red, blinking incandescent pilot warning lights, reduced bird collision mortality by up to 72% (Manville 2007a; Gehring et al. 2009). However, any light, including blinking incandescent and strobe lights, can cause some bird attraction, even during clear weather (Manville 2009a).

In the United States, any structure that is ≥60.9 m (200 ft) above ground level is subject to Federal Aviation Administration (FAA) lighting requirements for aviation safety. Transmission towers in the United States are typically <60.9 m (200 ft) tall[12] and do not have lights. However, shorter structures may also require lighting depending on their location (e.g., in proximity to airports). If lighting is used on transmission lines, it should be compatible with FAA regulations, the Canadian Aviation Regulation, and USFWS bird protection guidelines, and these agencies should be consulted on lighting. The FAA no longer recommends using L-810 steady-burning red lights.[13] In general, the USFWS recommends avoiding lights, particularly steady-burning lights, and using motion- and heat-sensitive lighting where feasible (e.g., for infrastructure security lighting).

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[12] Some structures exceed 60.1 m (200 ft) in height, especially at river crossings and to clear other lines that might otherwise intersect (M. Schriner, pers. comm.; D. Bouchard, pers. comm.).

[13] This change is expected to be included in the revision to the FAA's 2007 lighting circular, which is underway at this time (2012). As a preliminary step, in June 2012 the FAA published the results of its pilot conspicuity studies on the elimination of steady-burning red (L-810) side lights at communication towers.



CHAPTER 5

Minimizing Collision Risks

IN THIS CHAPTER

- Opportunities for Minimizing Collision Risks
- Modifying Existing Power Lines
- Planning New Power Lines
- Public Participation to Address Social and Cultural Issues

There are a number of design and engineering strategies for minimizing collision risk with power lines. This chapter introduces evaluation studies and risk reduction strategies for modifying existing lines and planning new lines. This chapter also discusses how to address social and cultural issues through public participation programs.

OPPORTUNITIES FOR MINIMIZING COLLISION RISKS

By working together, engineers and biologists can identify and address collision issues when modifying existing lines and planning new lines (Figure 5.1). Collision issues typically develop or are discovered long after a power line is built, which makes minimizing collision risk more difficult. However, early evaluation of factors that influence collisions (see Chapter 4) can reduce collision potential and may reduce the need for costly modifications later.

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Engineers and biologists can reduce collisions when...

Modifying Existing Power Lines	Planning New Power Lines
Evaluation studies include: • Collision monitoring to examine the causes and conditions associated with the risk and to help determine the type and effectiveness of modifications. • Avian risk assessment and spatial analysis to prioritize line segments for modification.	*Evaluation studies include:* • Spatial analysis that considers habitat variables, species, behavior, and other factors to help choose the optimal route. • Field assessment to identify species, abundance, and high bird-use areas. • Avian risk assessment to evaluate collision risk along potential routes.
Risk reduction options include: • Line marking to increase the visibility of the line. • Managing surrounding land to influence bird use. • Removing the shield wire if lightning is not an issue or if lightning arresters can be used instead. • Increasing the diameter or changing the configuration of wires when a line is being rebuilt. • Rerouting the line if all other attempts have been exhausted and populations are significantly impacted. • Burying the lines if feasible and warranted.	*Risk reduction options include:* • Line placement that takes migratory patterns and high bird-use areas into account. • Line orientation that considers biological and environmental factors such as bird flight paths, prevailing winds, and topographical features. • Line configuration that reduces vertical spread of lines, clusters multiple lines in the same right-of-way (ROW), increases the visibility of lines, and/or decreases the span length if such options are feasible. • Line marking to increase the visibility of the line. • Burying lines if feasible and warranted.

FIGURE 5.1: Opportunities and strategies for minimizing collision risks.

MODIFYING EXISTING POWER LINES

EVALUATION STUDIES FOR LINE MODIFICATIONS

If a significant collision risk has been observed along a segment of line, it may be possible to eliminate or minimize the risk by modifying the line in various ways. Line modifications should be supported by collision monitoring studies that examine the causes and conditions associated with a high collision rate (e.g., bird species involved, avian use patterns, mortality rates, weather, and biological significance of mortality levels). Although collision monitoring study methods must be tailored to site-specific biological, environmental, and engineering factors (see Chapter 4), basic, standardized ornithological field survey procedures should be used to produce results that would be comparable to other studies. Appendix B presents considerations and issues for designing site-specific

Comparing the Effectiveness of Line Modifications

Assessments of line modification effectiveness are often based on pre- and post-modification mortality (Rigby 1978; Beaulaurier 1981; Archibald 1987; Brown et al. 1987). Although evaluations based on casual observations or limited sampling of collisions contribute to the knowledge of line modification effectiveness, more rigorous studies are necessary to adequately compare the effectiveness of various measures (e.g., Crowder 2000; Yee 2007, 2008; Ventana Wildlife Society 2009; and Pandey et al. 2008).

study methods for collision monitoring. Once monitoring data are collected, line modification options can be evaluated to identify, quantify, and balance existing risks with the effectiveness and risks posed by the modifications.

Collision Monitoring Studies

To design a collision monitoring study, a number of key questions need to be answered:

- What species is/are at risk?
- What is the magnitude of risk?
- Does this risk contribute to population level impacts?
- What biological, environmental, and engineering factors contribute to collision risk?
- Is the study protocol scientifically sound?
- What are the regulatory and policy considerations of collisions?
- What methods effectively minimize collisions for new and existing power lines?

Collision monitoring results should include the following information:

- Collision rates among species and between sexes and ages (if known) within a single species
- Collision rates expressed as the number of bird collisions relative to the number of birds that are exposed to the line in the strike zone, i.e., collisions/flybys
- Biological, environmental, and engineering factors affecting collision risks (see Chapter 4)
- Mortality corrected for site-specific sampling bias (see Appendix B)
- Behavioral responses of different species to the lines and to line marking devices or other modifications
- Effectiveness of line marking devices based on changes in mortality after marking devices were installed or other line modifications were made

These and other monitoring considerations are discussed in greater detail in Appendix B.

To understand the mortality risk for an entire line, it is essential to study representative segments of the line rather than focusing only on high collision segments, since doing so will overestimate the overall mortality risk. The study method should ensure that test and control segments are of comparable length and that they have as much environmental homogeneity as possible (see Appendix B). On lines with high environmental variability across their length, stratified random sampling may allow the investigator to treat the segments similarly enough to collect meaningful data.

The greatest problem faced by researchers in most field studies is controlling for external variables (e.g., Alonso and Alonso 1999; Jenkins et al. 2010; Barrientos et al. 2011). The results of Brown and Drewien (1995) support the hypothesis of Thompson (1978) that collision rates are not predictable from one study to another and one season to another. They found that rates varied among species, seasons, and years and attributed much of the variability to changes in the local environment, which, in turn, influenced bird densities (see also Blair 1996). This suggests that, ideally, studies should compare test

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and control line segments within the same time period.

Regardless of whether assessments are made before or after line modification or by using test and control segments, collision risk comparisons are most meaningful if collisions are expressed in relation to bird numbers or, preferably, flybys. This allows a collision rate to be calculated. Where feasible, observations of birds' avoidance behavior when crossing the lines are valuable in understanding how a line affects flight behavior. Actual mortality may be low, which presents a statistical challenge in comparing retrofitting options. This condition should be anticipated and integrated into the study design (see Appendix B).

Collision monitoring studies should incorporate the basic methods used in other mortality evaluations (see Appendix B) including:

- Defining the collision zone for birds crossing lines
- Establishing an adequate search area for mortalities (increasing with the height of the line)
- Obtaining sampling bias estimates for injuries, searcher efficiency, scavenger removal, and habitat differences

Evaluation of bird behavior at marked and unmarked lines provides insight to collision rates. Morkill and Anderson (1991) and Brown and Drewien (1995) demonstrated that bird responses varied with marked and unmarked lines. Observations should be made on marked and unmarked portions simultaneously to minimize environmental variability. For example, Deng and Frederick (2001) showed that the number of birds flying above or below marked and unmarked lines was not statistically significant; however, they observed that the birds approaching a marked line reacted earlier than birds approaching an unmarked line.

Behavioral criteria evaluated may include:

- Type of reaction to lines
- Distance from the line that the reaction occurred
- Height above the line when crossing

Because these estimates require evaluations by observers, it is important to standardize survey procedures (see Appendix B). All observers should be given training and practice time before the study begins and, when possible, the same observers should be used throughout the study. Brown and Drewien (1995) found that most observers required about 12 hours of practice before they became consistent. As an alternative to field observers, the Bird Strike Indicator (BSI), a vibration sensing and recording tool, can be installed on lines to detect bird strikes (see box, page 57). However, the BSI does not identify what species struck the line; hence, mortality monitoring or field observations, which would also reveal pre-strike behavior, would be required.

Avian Risk Assessment and Spatial Analysis

Avian risk assessment and spatial analysis can be used to prioritize segments of line for modification. See *Evaluation Studies for Siting New Power Lines* on page 64.

OPTIONS FOR MODIFYING EXISTING LINES

Potential options for line modification include line marking, managing surrounding land, removing the shield wire, changing the diameter or configuration of wires, and rerouting or burying existing lines where feasible. Utilities are encouraged to work with wildlife agencies (see Chapter 3) to evaluate collision risks to species of concern and options for reducing those risks. Typically, the first option is marking high risk segments of the line and/or managing the surrounding lands. Redesigning, reframing, relocating, or

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Remote Sensing with the Bird Strike Indicator

The Bird Strike Indicator (BSI) is an automated vibration sensing and recording tool designed by Electric Power Research Institute (EPRI) to detect bird strikes on overhead lines. Previously, the only means for identifying whether collisions were occurring was for observers to monitor lines and to conduct ground surveys for bird carcasses. Manually monitoring bird collisions is labor-intensive, expensive, and its effectiveness is limited to daylight hours. Carcass surveys may correct for lack of monitoring during low-light periods, but these are often associated with vegetation, water, and scavenger detection biases (see Appendix B). Some birds also may fly beyond the search zone after the collision. If the collision itself was not observed then this type of contact would be missed by standard monitoring methods.



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FIGURE 5.2: The Bird Strike Indicator, a tool used to detect bird strikes with power lines, can be installed from a bucket truck or helicopter.

BSI sensors can be installed on phase conductors or shield wires. Each installation will be unique to the surrounding environment. For example, the lightweight accelerometers in BSIs are meant to detect stress waves caused by avian collisions, but in one study, BSIs also picked up the vibrations from daily trains (M. Schriner, pers. comm.). For a horizontal line configuration, the BSI is only needed on the outside wires (M. Schriner, pers. comm.). The BSI generates a collision log including the wire struck along with the date, time, and temperature. The BSI wirelessly transmits these data to a base station in real time. Base stations serve multiple sensors simultaneously and are accessible through an interface. Each sensor is designed for up to six months of autonomous operation between battery replacements. The units check and report their health each morning and can be reprogrammed remotely.

Research during the development of the BSI (Pandey et al. 2008) and independent trials conducted afterwards (Murphy et al. 2009) demonstrated that the BSI is as reliable as human observers for detecting collisions during daylight. The technology is especially useful for monitoring collisions in low-light or no-light conditions and over-water crossings where carcass recovery is compromised. However, unlike human observations, BSI does not identify the species that struck the line; mortality monitoring or field observations would be required to determine this. The BSI has also been successfully used to monitor communication tower guy wire collisions in Cold Bay, Alaska, which demonstrated that the BSI allows continuous line monitoring under all lighting and weather conditions (R. Harness, pers. comm.).

As of 2012, a new companion technology to the BSI, called the Bird Activity Monitoring System (BAMS), is in its technical development phase with EPRI funding and is envisioned as an intelligent, image-based, sensing and recording tool that will assist with detailed study of wildlife interactions with various types of structures including power lines.

burying power lines may not be economically or technically feasible. Such options are usually a last resort and only contemplated when an avian resource has been documented to be seriously affected.

Line Marking

Most studies have shown a reduction in collisions and/or an increase in behavioral avoidance at marked lines when compared to unmarked lines, but this can vary with location, type of line marking device, and bird species (Jenkins et al. 2010; Barrientos et al. 2011; see Chapter 6 for detailed information on devices and effectiveness). There are three general categories of line marking devices: aerial marker spheres, spirals, and suspended devices (swinging, flapping, and fixed). Large diameter wire may also improve line visibility and has been used with line marking devices to reduce risk of collision-electrocutions and collisions (see Chapter 6). Line marking devices are selected based on product availability and durability, cost, ease of installation, compliance and legal issues, spacing and positioning, safety codes related to ice and wind loading, corona effects, esthetics, and potential for vandalism.

Lighting has also been successfully used to reduce collisions. In Washington, a spot light (using the line as a power source) was installed in an uninhabited area to illuminate a section of marked distribution line at night. This effectively reduced collisions of American white pelicans (*Pelecanus erythrorhynchos*) that roost adjacent to the distribution line. The pelicans had collided with the line when flushed during the night by passing trains, even though line marking devices were installed (S. Liguori, PacifiCorp, pers. comm.). In Botswana and South Africa, the Mace Bird Lite, a spiral device with a fluorescent light, has been used to reduce flamingo collisions (Eskom 2003; Eskom Transmission 2009; see *Devices Available in Other Countries* on page 97).

When using lighting, the effects of lighting on birds as well as applicable regulations for lighting should be considered (see *Lighting* on page 52).

Managing Surrounding Lands

The location and condition of habitat and the surrounding or nearby land uses, such as wetlands and agriculture, and their proximity to power lines influences collision risk (see Chapter 4). Modifying habitat, land uses, or management practices to influence bird use in strategic areas can reduce collision risk where there is a willing agency or landowner. Sometimes, land management can be less costly and more effective than other line modifications. Options are discussed for conservation, recreation, residential, agricultural, and industrial land uses.

Planting Trees

Where climate and location will allow, planting native trees that will grow to or above the height of nearby power lines, without interfering with line operations, may prevent collisions by forcing birds to gain enough altitude to clear the more visible tree line (Thompson 1978; Raevel and Tombal 1991). For instance, greater white-fronted geese (*Anser albifrons*) flew over power lines more in woodlands than over lines in rice fields in Japan (Shimada 2001), and areas with shorter trees had higher collision rates than areas with taller trees for ptarmigan in Norway (Bevanger and Broseth 2004). For mitigation purposes, tree planting is a long-term strategy because of the time it takes for trees to grow to the desired height; thus, short-term mitigation would likely be necessary in the interim. Because trees can potentially cause operational and reliability problems with lines, a design engineer and a forester should be consulted concerning minimum clearances and line maintenance requirements so appropriate tree species and planting locations can be determined.

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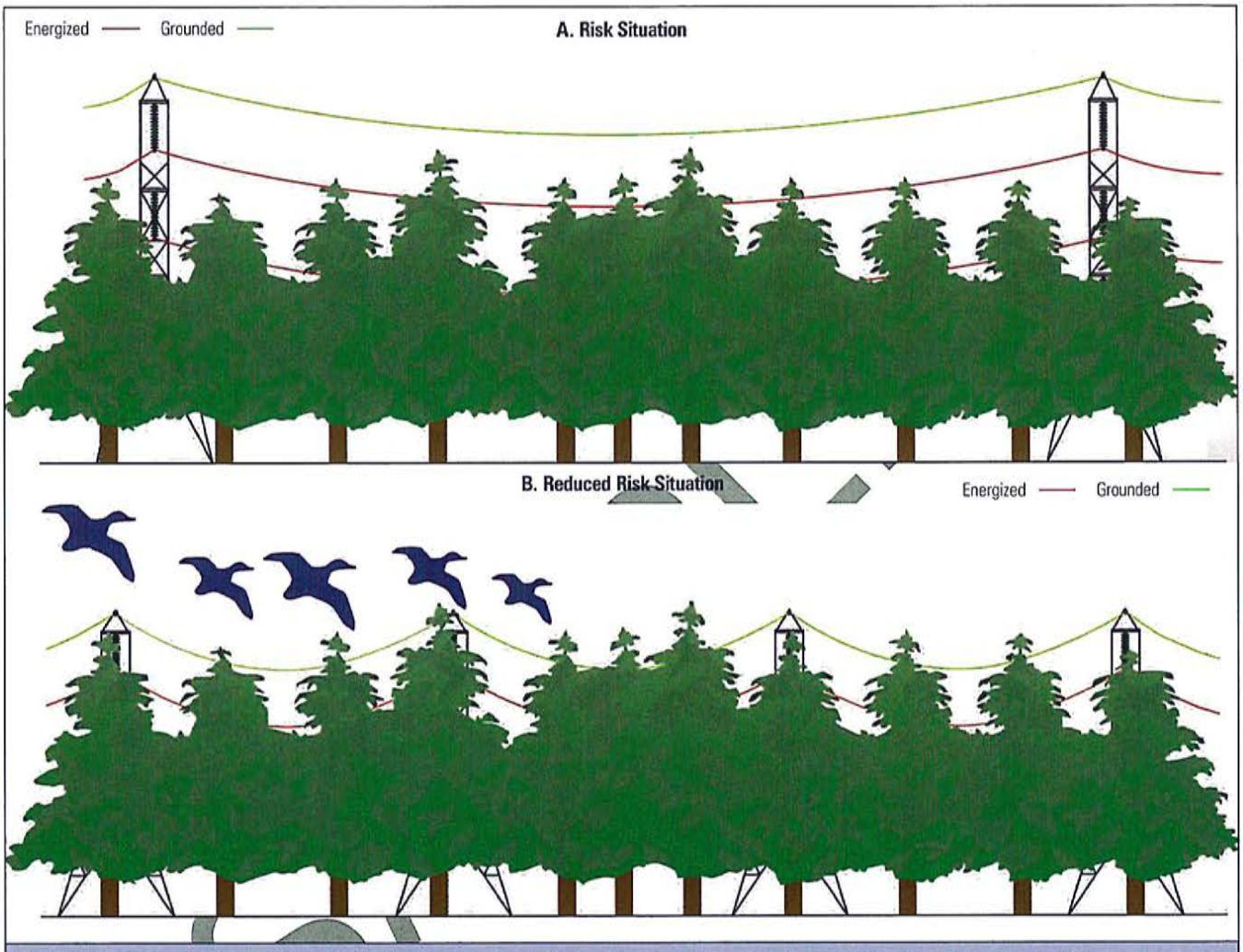

FIGURE 5.3: Reducing collisions in wooded areas. A tree line or other obvious obstacle at the appropriate height warns birds to gain altitude, which results in birds flying over the power line screened by the trees (after Thompson 1978).

Removing Disturbances

Reducing and modifying human access points to decrease the likelihood that human activities will disturb birds where they congregate near power lines can reduce collisions caused by frightening and flushing birds into the power lines (see *Sudden Disturbances* on page 49). Restricting access roads on power line ROWs to utility-related activities is an option that may be open to landowners or land managers. Conservation area managers and private landowners can limit or prohibit hunting or other high-disturbance activities near power lines. On public access roads, speed limit restrictions and signage indicating bird-use areas may reduce flushing of birds. Crane and waterfowl collisions at Bosque del Apache National Wildlife Refuge in New Mexico were reduced simply by having personnel drive slowly and stop when birds

were on refuge roads, which allowed the birds to leave the area without panic. However, this was not successful enough and the lines were eventually buried. (J. Bradenburg, pers. comm.)

Habitat Modification on Conservation, Recreation, and Residential Lands

Land managers and landowners may be able to manipulate bird habitat to minimize collision risk. For example, when waterfowl need to use two distinct habitat types (e.g., one for feeding and one for roosting), they will generally select those that are closest to each other. If a power line divides those habitats, the collision risk is greater. It may be possible to create both habitat types on one side of the line to reduce the crossing frequency (see *Line Placement* on page 66).

Management Practices on Agricultural Lands

Sometimes it is possible to enlist the help of landowners to modify management practices, including the timing of practices that may be attractive to birds, such as burning or flooding fields, where a line is experiencing a high collision rate. For example, in the San Luis Valley, Colorado, farmers plow barley stubble into the ground in preparation for planting in late fall and early spring—times when sandhill and, in the past, whooping cranes (*Grus canadensis* and *Grus americana*) forage in the stubble. The cranes may collide with power lines that border these fields, especially when feeding very close to the line. Through a program sponsored by utility companies, farmers were encouraged to begin plowing the stubble closest to the lines before the birds arrived. This reduced the risk of collisions by causing

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FIGURE 5.4: Habitat modifications, such as cooperative programs to encourage earlier plowing of grain stubble, which is attractive to migrating sandhill cranes, may help to reduce collision risk.

the birds to forage farther from the lines where the stubble remained standing (C. Bryant, pers. comm.).

Discourage Bird Use of Industrial Lands

For industrial features such as landfills, cooling ponds, municipal sewage ponds, settling ponds at mines, and other industrial water bodies, property managers can choose from a variety of options that will discourage bird use, such as covering garbage, placing nets over a pond, and using visual or sonic deterrents. Cost, effectiveness, and maintenance should be considered when evaluating bird dissuasion options.

Removing the Shield Wire

Removal of the shield wire from transmission structures (AC or DC) can reduce bird collisions (Beaulaurier 1981; Brown et al. 1987), but is rarely a viable option because it exposes the lines to lightning strikes, which jeopardize service reliability (Figure 5.5). Shield wires are typically installed on the top of transmission structures to protect the phase conductors from lightning strikes and the electric grid from lightning related power outages. This overhead shielding has proven to be the most effective and economical lightning protection for transmission lines.

The lightning arrester system, one alternative to the shield wire, is effective when used on lines with distribution voltages from 4.2 to 35 kilovolts (kV) and provides sufficient protection to the line and associated equipment. However, lightning arresters may not be a viable option due to cost, design characteristics, and effectiveness for transmission voltages. Their presence would also increase the electrocution risk to birds that perch on power line structures. Because the shield wire often incorporates a fiberoptic communication line, the cost of modifications to the communications system would also need to be included in the analysis.



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FIGURE 5.5: Removing shield wires can reduce bird collisions but leaves the lines unprotected from lightning strikes and jeopardizes service reliability.

Changing the Line Configuration

When collisions cannot be reduced by another method such as line marking or managing surrounding lands, the configuration of an existing line can sometimes be changed to minimize collisions. This is usually only possible for new construction or when a line is being rebuilt. Effective design changes would need to be based on studies of the flight behaviors of the bird species at risk (see *Evaluation Studies for Line Modifications*, page 54). In addition, the redesigned section(s) of line would need to be compatible with the rest of the line. Options for changes might include:

- Lowering the height of the lines (e.g., below the tree line)
- Changing the wire diameter
- Bundling wires
- Using spacers to improve visibility

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- Rearranging wire configuration (e.g., converting from vertical to horizontal)
- Changing the structure type to increase its visibility
- Decreasing span length (e.g., by adding a pole mid-span)

Rerouting Existing Lines

If all other attempts to reduce significant collision risks to an acceptable level have been exhausted, rerouting may need to be considered. This option would require routing analysis, acquisition of a new or additional ROW, removal and relocation of existing structures, and a scheduled outage for the work. The rerouting analysis should include a comparative risk assessment to evaluate the collision risk for the new line (i.e., whether its risk is measurably lower than that of the existing line) to determine if the rerouting is justified (see *Avian Risk Assessment* on page 65). Environmental benefits and economic cost should be part of the risk analysis. Given the potential land costs and limited options for ROW , together with the cost of structure changes, the economics and logistics of rerouting make this option rarely possible.

Burying Power Lines

Burying power lines with voltages less than 345 kV have been proposed to reduce collisions. However, there are innate characteristics of buried lines that make them only rarely feasible. These include voltage and type of cable, land use patterns, soil conditions, regulatory acceptance, outage risk and reliability requirements, termination facility requirements, length and operating limits, and other environmental concerns. Depending on these characteristics, the cost of buried power lines can vary from 3 to 20 times that of an overhead line (Bumby et al. 2009).

Voltage and Type of Cable

As the voltage increases, costs increase. The type of cable (power line) used also affects the cost. Current options include paper-insulated cable installed in oil-filled pipes, and solid dielectric cables installed in conduits or buried directly in the earth with selected backfill (see *Soil Conditions*, page 63).

Lines ≥69 kV are normally installed in pressurized, oil-filled pipes in order to eliminate voids and moisture pockets in the cable insulation. They have an excellent reliability record when properly designed, installed, and maintained. The oil also tends to dissipate the heat generated by the current flow in the cables. If the oil can be circulated under pressure, the capacity and reliability of the cable will be enhanced.

Solid dielectric cables are currently being used for 115-kV and 230-kV applications. They are less reliable than oil-filled pipes. The preferred design is to place them in a conduit so that construction in highly developed areas may move rapidly and the necessary excavation can be covered quickly to reduce the impact and inconvenience to the public. The conduit also provides some physical protection to the cable from accidental excavations.

Land Use Patterns (Urban, Rural, etc.)

In highly developed areas where other utilities are buried (e.g., water, sewer, gas, communication), costs and space are at a premium. In rural areas, some conflict may exist with pipelines, rivers, and lakes (see Figure 5.6 and *Environmental Concerns* on page 63). In undeveloped areas, geologic formations may prevent economical trenching. In addition, underground lines require termination areas at both ends, similar to small substations, to accommodate the overhead-to-underground transitions.

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FIGURE 5.6: Buried power lines may be a solution to bird collisions in some instances, but can cost from 3 to 20 times more than overhead lines and have other environmental impacts.

Soil Conditions

The soils must be able to dissipate heat during periods of high electricity demand. Soil condition also directly affects construction cost (i.e., sandy soils are more easily trenched than rocky soils). In many cases, the spoils from the cable trench have to be hauled away and replaced with heat-dissipating sands to meet the cable design standards.

Regulatory Acceptance

Utility regulatory commissions set rates and control costs. This can have a direct bearing on the feasibility of an underground project. There are documented projects where regulatory commissions have instructed the parties requesting underground construction to pay the difference in installation cost (e.g., Colorado Public Utility Commission Decision No. R82-93).

Outage Risk and Reliability Requirements

Cable failures are difficult to locate and the line must be dug up for repairs and maintenance. Extended outages normally result because of the length of time it takes to locate and repair a fault in the cable. Certain customers, such as hospitals and large industrial or mining operations, have higher reliability requirements than others.

Requirements for Termination Facilities

These include access for large equipment, a fenced area, transition structures, switches and other protective equipment, a transmission line tower or distribution structure, and in some cases a pumping station. Such overhead electrical facilities should be designed to minimize avian electrocution risk (see *Suggested Practices for Avian Protection on Power Lines*, APLIC 2006).

Length and Operating Limitations

As the length of the line increases, the operating limitations are approached and the options to address this will further increase costs.

Environmental Concerns

Environmental damage can result if a buried power line is near or crosses a waterway or is in wetlands or other sensitive habitats (Figure 5.6). If an oil-filled pipe leaks, the oil would contaminate the water and surrounding soils. Ground disturbance during construction, repairs, and maintenance can result in large, permanent displacement of excavated soil and subsequent issues with re-establishing native vegetation and preventing the overgrowth of invasive species. A University of California study (Bumby et al. 2009) found that underground power lines have more environmental impacts than overhead power lines for all categories and most scenarios in southern California.

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PLANNING NEW POWER LINES

EVALUATION STUDIES FOR SITING NEW POWER LINES

The potential for avian/power line interactions can be identified and addressed during corridor and routing evaluations such as spatial analysis, field assessment, and avian risk assessment. Methods for these evaluations differ because every route is unique with regard to the species, habitat, and line design. Ornithologists or wildlife biologists knowledgeable in local bird issues should be consulted for pertinent information on bird movement patterns and the presence of species of concern that could be affected by collisions with power lines. Habitats that influence bird presence and movement may present a collision risk and should be identified. Other biological, environmental, and engineering factors that contribute to collision risk should be understood (see Chapter 4) and considered as well.

Spatial Analysis

The siting process for new lines is in large part a geospatial analysis that facilitates the selection of a route that is compatible with regulatory, land use and availability, environmental, economic, and engineering considerations. Spatial analysis of habitats has been aided by the development of GIS software, which can help identify and characterize risk. GIS is often preferred because it can predict the optimal route by incorporating all the variables under consideration. Features in some GIS software systems can apply segment weighting to help determine the optimal route. GIS software specifically for siting and routing power lines has been developed by the Transmission Line Siting Methodology research project (see EPRI 2006). It uses a multi-step approach that starts with a large study area (corridor) and through various levels of evaluation selects potential routes and a preferred route. GIS software can also be used to create maps, which may be used to rank habitats for their prospective bird use within potential line routes. This approach is especially useful when species of concern occur along a proposed route.

About GIS

GIS (geographic information systems) software incorporates, stores, analyzes, manages, and presents data linked to a specific geographical location. It merges cartography, statistical analysis, and database technology. As a tool, GIS software helps decision-makers understand and predict the relationships between human uses and natural resources such as wildlife and habitat.

Field Assessment

Field assessment can often minimize collision risks (see Chapter 4) by identifying high-use bird habitats to avoid during route evaluation. Study designs should be scientifically defensible and developed to meet the needs of the project. Ideally, the following information should be obtained during the field assessment:

- Presence and abundance of bird species in the vicinity of the alternative routes
- Occurrence of species of concern, such as endangered species
- Location of habitat used by birds of concern
- Daily and seasonal use patterns for each species, including a differentiation between migration and daily use

This information can be obtained by using standard bird survey techniques, such as point counts, and from existing avian databases, such as the Christmas Bird Count and eBird (see Appendix E).

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Avian Risk Assessment

Avian risk assessment can be used to characterize the collision risk of a planned or existing line and to prioritize the segments that need to be modified. Risk assessment is a systematic process for characterizing the probability of an adverse effect occurring (USEPA 1998). It has been adapted for a

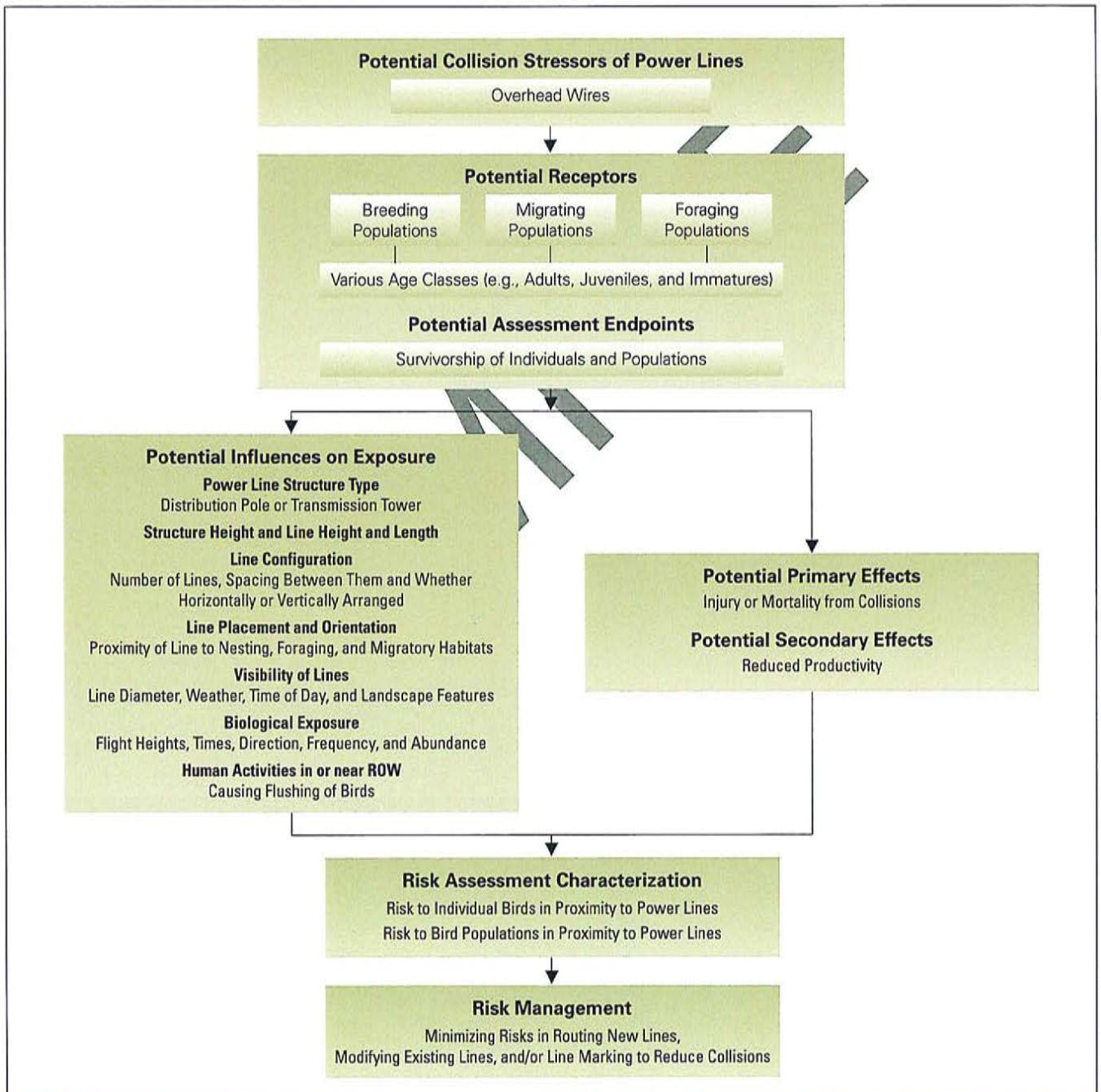

FIGURE 5.7: Conceptual model of avian collision risk assessment.

wide range of applications, including avian/power line interactions. Avian risk assessment in this context evaluates the collision risk that a power line may pose to birds. It includes several steps: problem formulation (e.g., identifying species affected and specific collision issues), characterization of exposure and effects, risk assessment, and risk management. Figure 5.7 presents a conceptual model of avian collision risk assessment.

Both qualitative and quantitative estimates of risk can be used. One or both of these approaches may be appropriate depending upon the type of risk characterization required and the data available.

Qualitative risk assessment provides a non-numeric narrative description of risks. The resulting risk statement is descriptive (not mathematically quantifiable) and provides an estimate of risk, such as low, moderate, high, etc. This approach uses existing information about the proposed site, its ecological resources, literature on the physiology and behavior of species of concern, and reported effects (e.g., accounts of known collision mortality at existing power line projects). Implementing a qualitative methodology does not generally require field studies before construction, but uses site visits to confirm conditions and supplement available information.

Quantitative risk assessments provide estimates of the number of birds anticipated to be at risk to collisions. A quantitative approach accounts for, among other things, the spatial configuration of the stressor (power lines) and the spatial and temporal exposure of the receptor (birds) (i.e., the number of receptors that interact with the stressors in question).[14] Quantitative risk assessments can be developed using literature and other data but, because this method is typically used when greater precision is needed, it is frequently supplemented by site-specific data on power line engineering and/or design and site-specific observations and studies to further assess collision potential.

Sometimes a tiered risk assessment can be used starting with a qualitative assessment and proceeding to a quantitative assessment. For example, if more than one route is being compared for risks, a higher or lower risk ranking may be appropriate using a qualitative approach. If a specific prediction of the amount of mortality is required, a quantitative or modeled approach may be appropriate. Spatial analyses have been used with quantitative modeling to identify and prioritize high risk bird collision areas with varying degrees of success depending upon the quality and quantity of the data (see Heck 2007; Shaw et al. 2010; and Quinn et al. 2011).

OPTIONS FOR MINIMIZING COLLISION RISK DURING ROUTE EVALUATION

Engineering aspects such as line placement, line orientation, and line configuration all contribute to either increasing or decreasing the level of collision risk relative to biological and environmental factors (see Chapter 4). However, line routing is primarily a function of the origin and destination of the power being carried by these lines (see Figure 5.8), so other options such as line marking in areas where there is unavoidable collision risk and burying power lines where feasible and warranted may need to be considered.

Line Placement

Broadly, line routing should consider migratory patterns, areas of high bird use, and, if available, historical bird abundance information. On a finer scale, proximity to bird habitats (e.g., wetlands, trees, and other roosting, nesting, and foraging sites) is an important

[14] A stressor is a hazard in the environment that is capable of causing an adverse effect on a receptor. A wildlife receptor can be wildlife individuals, populations, or habitats that are subject to the potential impacts of a stressor.

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Terminology Used When Planning New Transmission Lines

For transmission line planning, the following terms may have different meanings to various stakeholders. Figure 5.8 illustrates these terms, which will be used in this manual in the following way.

Planning is the process that identifies the need for a transmission line to deliver electricity from the generation facility to a load or demand center.

Siting determines where the ends of the line need to be—Point A and Point B.

Corridor or study area is usually a rectangular boundary between Points A and B within which the alternative and preferred transmission line routes are plotted.

Alternative routes through the corridor are identified based on a long list of considerations that include endangered species and wildlife habitat. Examples of additional considerations are:

- Cities and towns
- Landowner agreement
- Crossings, such as highway, water, other power lines
- Airports
- Heliports
- Cemeteries
- Communication towers
- Historic places and archaeological sites
- Wetlands
- Land availability
- Land use
- Homes/businesses/schools
- Hospitals
- Parks/recreation
- Pipelines
- Churches
- Wells
- Bridges
- Topography
- Line voltage, design, engineering, and construction

Determining a route through public land is distinctly different than through private land. On public land, an agreement with only a few landowners is necessary; whereas on private land, hundreds of landowners may be involved along with a diversity of land uses and concerns to consider.

The **preferred route** is suggested by the utility. After stakeholder participation, the public utility commission determines the final route, which may be the preferred route, an alternative route, or a combination of the preferred and alternative routes.

The **right-of-way (ROW)** is the land that will be used for the power line. Easements along the ROW give utility crews access to the line for maintenance and are legal agreements, including compensation, between the utility and the landowner.

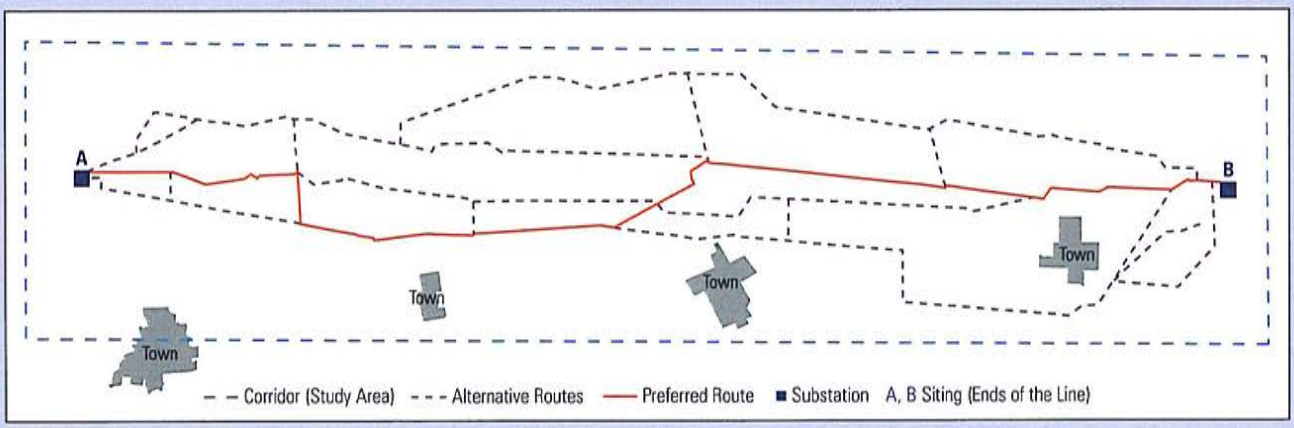

FIGURE 5.8: Schematic of the terminology used when planning new transmission lines.

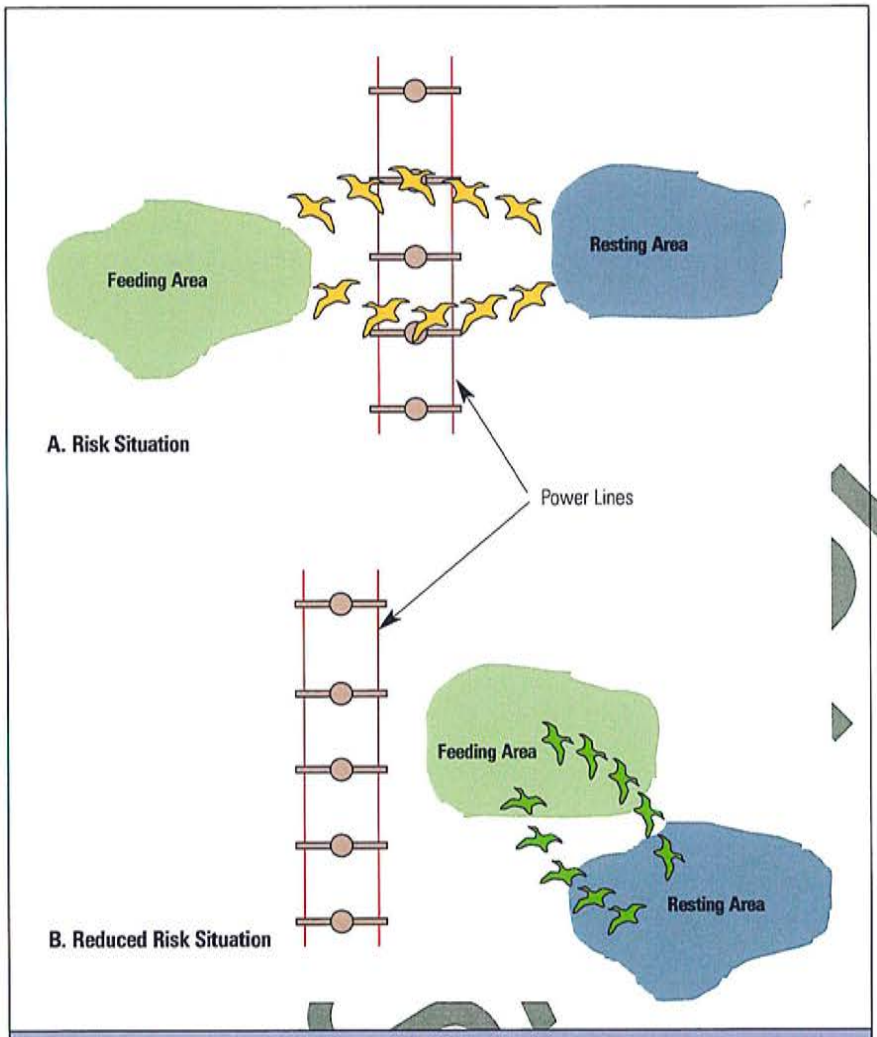

FIGURE 5.9: Potential collision risk (A) has been reduced (B) when bird-use areas are on the same side of the line (modified from Thompson 1978).

consideration when selecting a line route (see Chapter 4). The proximity of power lines to bird take-off and landing areas can affect the risk of collision (Lee 1978; Thompson 1978; Faanes 1987; Brown et al. 1984, 1987; Heck 2007; Quinn et al. 2011). For results of studies on distance of collision mortalities from specific areas, see *Habitat and Habitat Use* (page 44) and *Line Placement* (page 50). Spatial analysis with GIS is useful for evaluating different power line placement options relative to bird migration and habitat use patterns (see *Spatial Analysis* on page 64).

Line Orientation

Orientation of power lines relative to biological characteristics (e.g., flight behavior, season, and habitat use) and environmental conditions (e.g., weather patterns and topographical features) can influence collision risk. When planning power line routes, features such as mountain ridges, river valleys, and shorelines that are in traditional flight corridors should be considered (Colson and Yeoman 1978; Faanes 1987; Figure 5.10). Power lines that parallel primary bird flight paths pose less risk than a perpendicular orientation (Crowder 2000; Scott et al. 1972; McNeil et al. 1985). For example, the perpendicular orientation of a line relative to a topographical feature poses a greater collision risk to local and migrating birds, whereas a parallel orientation reduces risk.

Where perpendicular orientation cannot be avoided, forest habitats located near power lines can sometimes reduce collision risk (see Figure 5.3) Lines that are at or below the height of nearby trees rarely present a problem to small tree-dwelling birds because of their maneuverability; furthermore, large birds will gain altitude to fly over the tree line and will consequently avoid the power line (Thompson 1978; Raevel and Tombal 1991). For example, a power line crossing a narrow river bordered by trees that are taller than the line is likely to pose a lower collision risk than a broad river crossing because most birds will fly over the tree tops to cross the narrow river valley (CMS 2011a).

Strong tail winds can be detrimental to birds' ability to maneuver. Brown (1993) suggested that north-south orientation of lines increased collision frequency for cranes and waterfowl in the San Luis Valley, Colorado, because birds crossing them on an easterly heading were often subjected to prevailing westerly winds.

Line Configuration

Line configuration—phase conductors aligned vertically or horizontally and the number of conductors—is a collision factor that intuitively makes sense, but there are too few studies to draw conclusions. Most researchers agree that keeping the vertical arrangement of multi-conductor transmission lines to a minimum is beneficial because it reduces the height of the collision zone. However, a single-pole, vertical structure is often esthetically more acceptable and requires less ROW width.

Thompson (1978) and others (Bevanger 1998; Crowder 2000; Drewitt and Langston

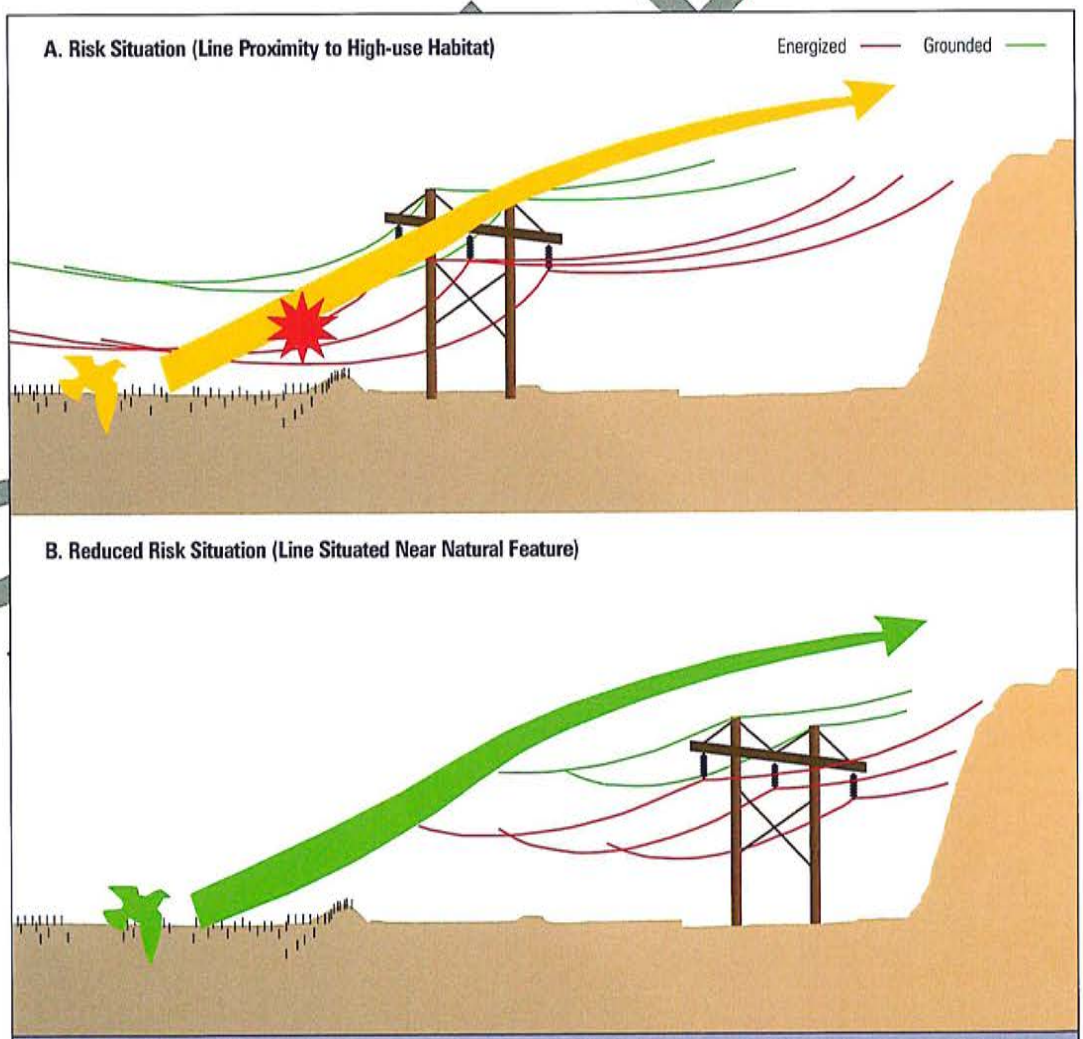

FIGURE 5.10: Routing with respect to local topographic features (after Thompson 1978).

2008) have suggested that clustering lines (i.e., several power lines sharing the same ROW) may reduce collision risk because the resulting network of wires is confined to a smaller area and is more visible. Birds only have to make a single ascent and descent to cross lines in this arrangement (Figure 5.11 and Figure 5.12). However, when there is decreased visibility, collision risk for birds may increase where several lines are clustered. When there are two shield wires at different heights, and only the higher one is marked, there may be collisions at the lower unmarked shield wire; both shield wires may need to be marked (S. Liguori, pers. comm.).

Other configuration options include:

- Lowering the height of the lines (e.g., below the tree line)
- Changing the wire diameter
- Bundling wires
- Using spacers to improve visibility

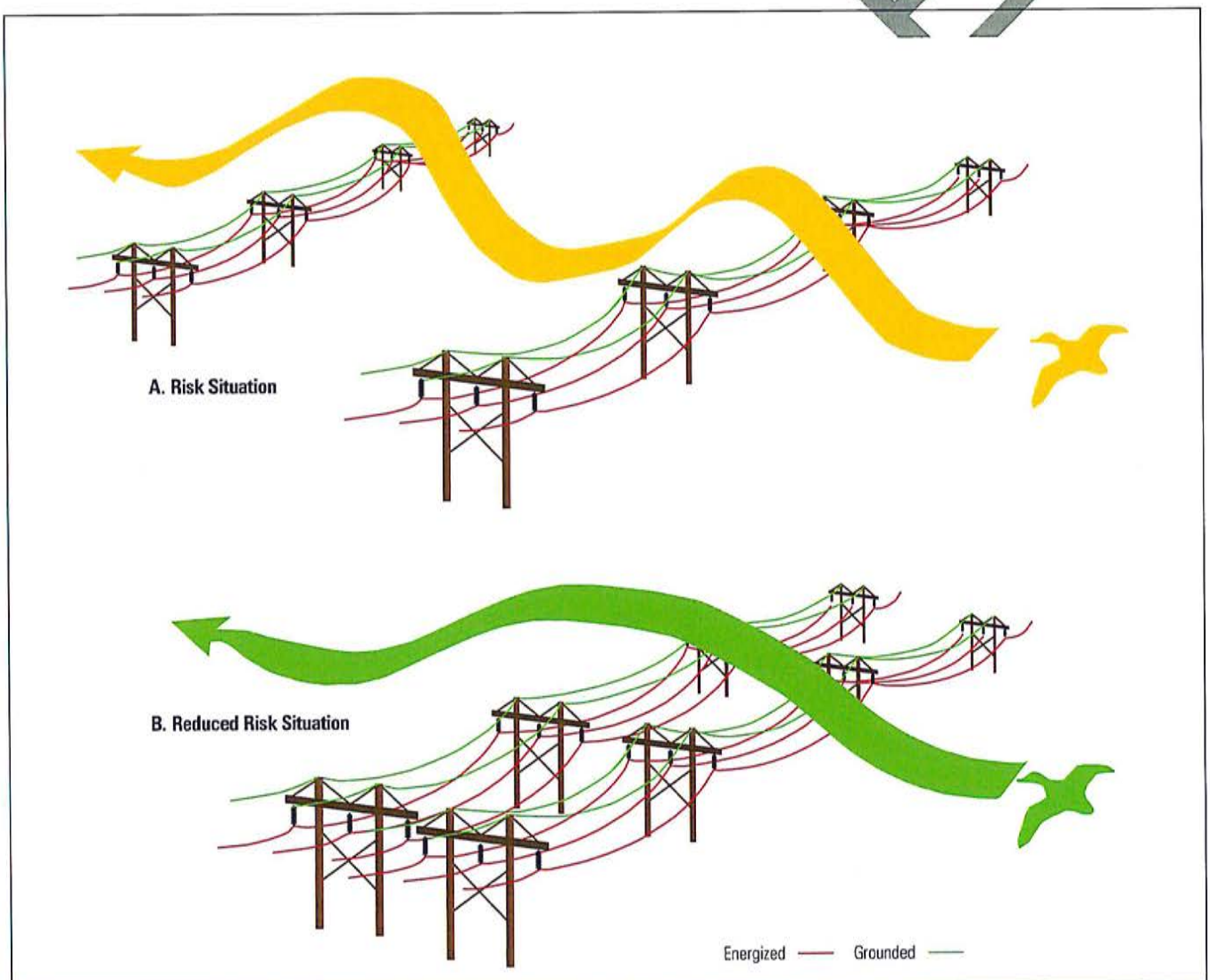

FIGURE 5.11: Reducing collisions by clustering lines in one right-of-way (after Thompson 1978).

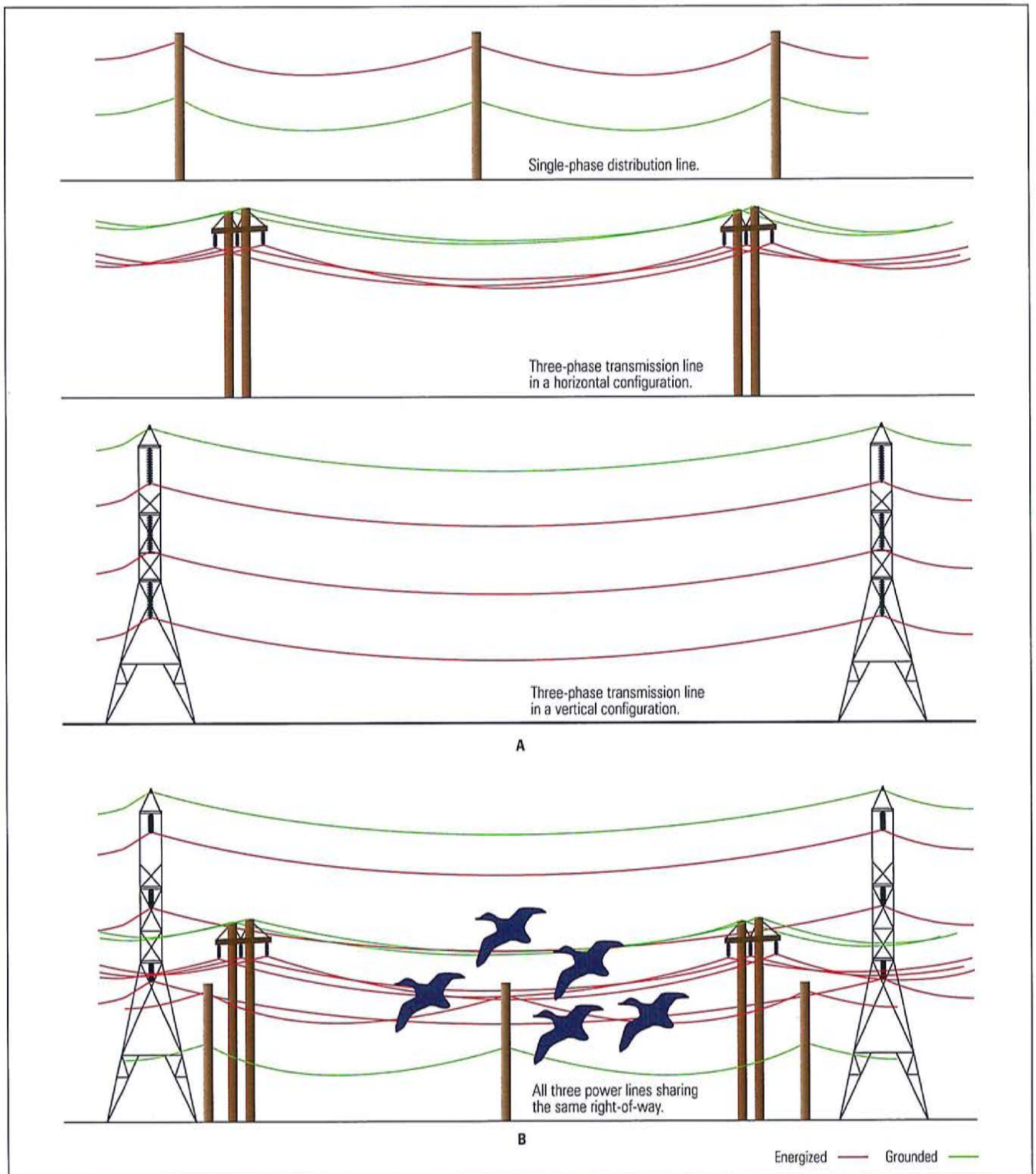

FIGURE 5.12: Collision risks for separate (A) and clustered (B) lines (after Thompson 1978).

- Rearranging wire configuration (e.g., converting from vertical to horizontal)
- Changing the structure type to increase its visibility
- Decreasing span length (e.g., by adding a pole mid-span)

Line Marking

In areas where there is collision risk, line marking devices should be considered. Most studies have shown a reduction in collisions and/or an increase in behavioral avoidance at marked lines when compared to unmarked lines, but this can vary with location, type of line marking device, and bird species (Jenkins et al. 2010; Barrientos et al. 2011; see Chapter 6 for detailed information on devices and effectiveness). There are three general categories of line marking devices: aerial marker spheres, spirals, and suspended devices (swinging, flapping, and fixed). Large diameter wire may also improve line visibility and has been used with line marking devices to reduce risk of collision-electrocutions and collisions (see Chapter 6). Line marking options are based on accessibility of the line, product availability and durability, ease of installation, cost, compliance and legal issues, spacing and positioning, safety codes related to ice and wind loading, corona effects, esthetics, and potential for vandalism.

Burying Power Lines

See the discussion on *Burying Power Lines* under *Options for Modifying Existing Lines* (page 62).

PUBLIC PARTICIPATION TO ADDRESS SOCIAL AND CULTURAL ISSUES

The public may have concerns about power line design and placement, including esthetics, environmental effects, wildlife, and safety. Vandalism is also a persistent problem—electrical equipment and line marking devices can become targets. When a utility is taking steps to minimize collision risk, a public participation program can help build positive relationships, increase public knowledge, identify and respond to public concerns, and promote responsible behavior (e.g., discouraging vandalism of line marking devices).

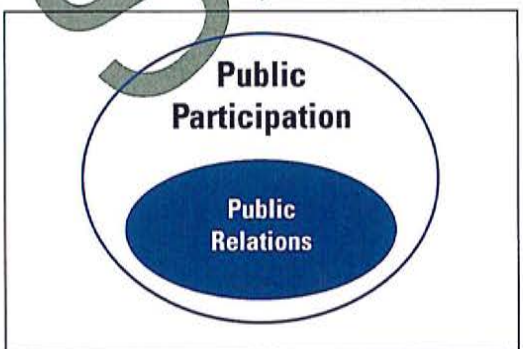

FIGURE 5.13: Public participation programs may provide information through a public relations campaign, but they also go further to engage the public in discussions and decision making (after EEI 2001).

WHAT IS PUBLIC PARTICIPATION?

Public participation is different from public relations or public information programs. While a public relations campaign provides information to the public, public participation programs actively engage the public in discussions and decision making. A well-designed public participation program requires the expertise of someone who can communicate technical information in an easily accessible way, facilitate groups, and cultivate trust with stakeholders. For a public participation program to succeed, the commitment and involvement of top management including the key decision makers is essential.

Utilities can use a variety of public participation tools to address social and cultural aspects of collision risk (see EEI 2001 and Appendix E for resources). Exhibits, signs, publications, web pages, and public announcements can be used to inform the public. Other techniques, such as webcasts, public

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forums, interviews, polls, retreats, citizen advisory panels, social media communications, and workshops promote engagement in the process. All efforts should be based on knowledge of the target audiences, consistent messages, audience participation in building a shared understanding, complete and objective information, and partnerships with supportive organizations and businesses. Edison Electric Institute's (EEI) *Introduction to Public Participation* (EEI 2001) is an excellent source of practical information for electric utilities.

Case Study: How Public Participation Benefitted Transmission Line Routing

The Project: Florida Power & Light (FPL) Crane-Bridge-Plumosis Transmission Line in southeast Florida (Martin and Palm Beach counties).

The Issue: FPL sought licensing for a 64.4-kilometer (40-mile) transmission line that traversed two densely populated counties. The route chosen for the power line generated some controversy because it included residential areas and a sensitive environmental tract. Alternative routes were proposed and submitted by various non-governmental and neighborhood groups as well as individuals. Continued opposition was expected.

Public Participation: A Citizens Advisory Panel (CAP) was appointed that included members from many different interest groups. The CAP recommended a route that was similar to the one originally recommended by FPL staff and consultants. FPL chose the panel's route.

The Result: The chosen route was initially rejected by the permitting agency but formed the basis of the final approved route.

Benefits of Public Participation: By establishing and working with the CAP, FPL precluded numerous separate meetings with different interest groups. The CAP increased understanding and support for the project despite initial opposition by individual parties. The discussions led to acceptable compromises, and costly appeals and reviews were avoided. In the end, FPL had an approved route that was similar to their preferred route and many members of the CAP felt positive that their input resulted in an improved project. The goodwill developed in the community benefited FPL's public image and set the stage for better relations on future projects.

(Modified from a case study that originally appeared in EEI 2001)

BENEFITS OF EFFECTIVE PUBLIC PARTICIPATION

Past experience shows that public participation has a record of creating cooperative working relationships (EEI 2001). According to EEI (2001), public participation:

- Reduces delays and costs associated with controversy and litigation. It often reduces implementation time because the public already supports or accepts the decision.
- Builds a positive relationship with the public, which is important even when it is necessary to make an unpopular decision.
- Develops and maintains credibility even with those who disagree with a given decision. A negative public image in one arena can affect a company's bottom line and trigger opposition in other arenas.
- Creates collaborative problem solving for achieving better and more acceptable decisions. When people believe that utility decisions are being imposed on them, they are more likely to increase their opposition.
- Gathers information from the public that the utility needs to make informed decisions.
- Can improve programs and policies, which will enjoy greater support.
- Can help management understand that technical issues have important social components. Some decisions appear to be technical, but are actually decisions about values.

CREATING A STRUCTURED PROGRAM

There are three phases to establishing a successful public participation program: decision analysis, program planning, and implementation. For case studies and a thorough description of how to plan and implement a public participation program use *Introduction to Public Participation* (EEI 2001) as your guide.

Phase 1: Decision Analysis

Clearly identify the decision-making process for the project and establish what role the public will play. Consider who will be affected by the project and if public support for the project is needed. Determine whether regulatory requirements or constraints may limit the opportunities for public participation. A thorough decision analysis will ensure that you engage the public for the right reasons and are not promising something that is not in your power to provide.

Phase 2: Program Planning

Successful participation plans address the needs and goals of both the utility and the public. The steps in creating a participation plan are:

- Identify the issues that will be important and assess the level of controversy of each. Issues and concerns typically focus on one or more of the following: mandate, economics, health, proximity, values, and existing uses of the property or area.
- Identify the parties (stakeholders) that need to be represented in the process. Invite a cross-section of the public including those who will be affected, those with a vested interest, and those who have decision-making power.
- Determine the goals for your public participation program. Goals provide focus and a course of action for the process. Clearly defined goals also make it easier to evaluate the success of the process.
- Define the level of public participation needed and state this clearly when inviting participants. In some cases, the public may be making decisions, while in other cases they may be providing support or recommendations.
- Select appropriate techniques of public participation based on the issues, level of controversy, and audience. Techniques, such as newsletters, web pages, exhibits or news releases provide information, whereas focus groups, meetings, workshops, polls, and interviews foster active public participation and collaboration.
- Outline the decision-making process including all steps from identifying the problem to formulating, evaluating, and selecting alternative approaches.

Phase 3: Implementation

Implement the program according to the collaboratively developed plan. During implementation, participants may see the need to make adjustments or changes, so be flexible and prepared.

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Characteristics of Successful Public Participation

Successful public participation programs often do the following:

- Make public participation an integral part of the project, rather than an afterthought.
- Commit to a decision-making process at the outset and maintain that commitment.
- Ensure that the interested public is involved in all phases of decision making: definition of the problem, range of possible alternatives, criteria used to evaluate alternatives, and selection of the final course of action.
- Carefully assess the needs of different audiences and choose techniques appropriate for all groups and for the information that will be collected.
- Ensure that management is engaged and has endorsed the program. This will create a climate of acceptance, which is essential to meaningful public participation.



CHAPTER 6

Line Marking to Reduce Collisions

IN THIS CHAPTER

- Overview of Line Marking Devices
- Effectiveness of Designs
- Marking Constraints and Considerations
- Line Marking Devices
- Large Diameter Wire

A common observation in collision studies is that birds show the ability to avoid a power line if they see the lines early enough. Many of these studies indicate that collision risk can be lowered by more than half and, in some cases, by as much as 80% after lines have been marked. This chapter discusses what is known about line marking, including the different devices, their reported effectiveness, and considerations in their use.

OVERVIEW OF LINE MARKING DEVICES

Studies suggest that the majority of bird collisions occur with the smallest diameter wire, which is typically the shield wire located above the phase conductors on transmission lines (e.g., Savereno et al. 1996) or the phase conductor and neutral wire on distribution lines. Most collisions occur mid-span (e.g., Eskom Transmission 2009). As a result, most of the efforts to reduce bird collisions have focused on marking the shield wires on transmission lines and the phase conductors on distribution lines. As discussed in Chapter 4, different biological, environmental, and engineering factors contribute to birds' ability to see and avoid a power line; each should be considered when choosing among line marking options.

There are three general types of line marking devices: aerial marker spheres, spirals, and suspended devices (swinging, flapping, and fixed). In addition, large diameter wire, though not a marking device, may also improve line visibility and has been used with line marking devices to reduce risk of collision-electrocutions and collisions (see *Large Diameter Wire* on page 100). Since 1994, aerial marker spheres, spirals, and suspended devices have been further developed. Advances include changes to shape, colors and color patterns, and attachments, along with UV resistance, which improves durability and colorfastness. Other designs have been developed, but are not currently available in the United States (see *Devices Available in Other Countries* on page 97).

Because there are few comparative studies, no single device is considered to be the best performing. However, Jenkins et al. (2010) concluded that any sufficiently large line marking device that thickens the appearance of the line for at least 20 centimeters (cm) (7.8 inches [in]) in length and is placed with at least 5 to 10 meters (m) (16.4 to 32.8 feet [ft]) spacing is likely to lower collision rates by 50% to 80%. In addition, the South African Electric Supply Commission (Eskom Transmission 2009) describes its use of spirals and suspended devices on transmission lines and recommends suspended devices over small-diameter spirals because their swinging or flapping motion makes them more visible and more effective.

Devices can be purchased in a variety of colors, which may be important but there are insufficient comparative studies to provide firm conclusions. In general, what seems to be effective is to alternate the colors to make the lines more obvious (Eskom Transmission 2009). For aerial marker spheres, yellow seems to be the preferred choice over international orange because they provide better contrast in poor light conditions.

Table 6.1 provides a general description of the most commonly used devices that are available in the United States.

TABLE 6.1: Summary of data on line marking devices available in the United States.*

Name†	Description	Dimensions	Spacing§	General Comments on Effectiveness§
Aerial Marker Spheres				
Aerial Marker Spheres or Aviation Balls	Large, colored spheres that attach to wires.	Diameter ranges from 23 cm (9 in) to 137 cm (54 in). The 23 cm (9 in) and 30.5 cm (12 in) are most often used for line marking.	Up to 100 m (328 ft) apart. See Table 6.3 for details.	Reduction in collisions noted in certain situations. Sometimes this marker is used in conjunction with other line marking devices. See Table 6.4 for details.
Spirals				
Spiral Vibration Damper (SVD)	Extruded plastic (PVC) spiral device that fits over the shield wire and distribution conductors.	Various lengths, ranging from 112 to 165 cm (46 to 65 in), to fit different conductor sizes.	Often placed about 3 m (9.8 ft) apart on the shield wire. Stagger on distribution lines to prevent interphase contact.	Reduction in collisions noted. Not as commonly studied as other line marking devices. See Table 6.6 for details.
Bird-Flight™ Diverter (BFD)	Spiral device made from high impact PVC that attaches at one end to the shield wire or distribution conductor and increases in diameter at the other end.	Lengths range from 17.8 to 59.7 cm (7 to 23.5 in). Diameter at the large end ranges from 3.8 to 12.7 cm (1.5 to 5 in).	Ranges from 4.6 to 21 m (15 to 68.9 ft) apart. See Table 6.7 for details.	Shows varying amounts of effectiveness in collision risk reduction and flight behavior alteration. Commonly included in collision studies. See Table 6.8 for details.
Swan-Flight™ Diverter (SFD)	Similar to the BFD, but this device attaches at both ends with the larger diameter spirals in the center.	Lengths range from 50.8 to 116.8 cm (20 to 46 in). Diameter of central spiral ranges from 17.8 to 20.3 cm (7 to 8 in).	Ranges from 15 to 30 m (49.2 to 98.4 ft) apart. See Table 6.9 for details.	Shows varying amounts of effectiveness in collision risk reduction and flight behavior alteration. Commonly included in collision studies. See Table 6.10 for details.

Continued

PREVIOUS VIEW

TABLE 6.1: Summary of data on line marking devices available in the United States.* (cont.)

Name†	Description	Dimensions	Spacing§	General Comments on Effectiveness§
Suspended Devices				
General Designs	Swinging and fixed devices; plastic flapper of various shapes and colors with reflective and glowing surfaces; connected to a clamp that attaches to the power line.	Size and shape varies with device and design.	5 to 30 m (16.4 to 98.4 ft) apart. Staggering devices on parallel lines is recommended. See Table 6.11 for details.	Shows varying amounts of effectiveness in collision risk reduction and flight behavior alteration. Commonly included in collision studies. See Table 6.12 for details.
FireFly™	Swinging and fixed models; rectangular devices with reflective and glowing surfaces; connected to a clamp that attaches to the power line.	Acrylic plastic tag measures 9 cm x 15 cm (3.5 in x 6 in).	4.6 to 15.2 m (15 to 50 ft) apart. See Table 6.13 for details.	Shows varying amounts of effectiveness in collision risk reduction and flight behavior alteration. See Table 6.14 for details.
BirdMark BM-AG	Swinging perforated disk has a reflective center and spins and flutters, it also glows; connected to a clamp that attaches to the power line; perforations allow device more wear resistance in high wind locations.	29.21 cm (11.5 in) long with a 13.33-cm (5.25-in) diameter disk.	4.6 m (15 ft) apart	Mentioned in reviews, but no scientific studies were found.

* Source: Summarized from available literature and Hunting (2002); see *Line Marking Devices* on page 85 for detailed information and sources.
† This table only includes devices that are available in the United States; see *Devices Available in Other Countries* on page 97.
§ Summarized from different sources and studies with varying methodologies, environments, and species; see tables in *Line Marking Devices* for detailed information and sources.

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EFFECTIVENESS OF DESIGNS

EARLY STUDIES (1960 TO 1994)

In Europe during the 1960s and 1970s, numerous studies addressed the effectiveness of different devices to make power lines more visible so collision rates could be reduced. Most of these studies tested aerial marker spheres (aviation balls) and various types of plastic or rubber strips attached to the lines. These studies found that increasing the visibility of lines resulted in a statistically significant reduction of collision risk.

In 1964, a 275-kilovolt (kV) line near Teeside, England, was marked with 15-cm (6-in) black vanes (flags). Koops and de Jong (1982) reported that this effort was successful in reducing bird collisions, although no quantitative data were given. Renssen et al. (1975, cited in Beaulaurier 1981) investigated several marking schemes: black, white, and orange aerial marker spheres on the shield wire.

Overall, the dozen or more studies during this period (see lists in Beaulaurier 1981 and Hunting 2002) found that marking devices ranged from no effect to a 60% reduction in collisions. The limitation of these early studies was that most were conducted over a short period of time or they were not held to rigorous experimental protocols. Often, quantifying and comparing flight intensities over marked and unmarked lines were not done.

In addition, the durability of these devices was often very limited because of the plastic and cloth materials used.

LATER STUDIES (1995 TO 2012)

Testing and reporting on the effectiveness of line marking devices have broadened to include the behavioral responses of birds approaching power lines. Hunting (2002), Lislevand (2004), Jenkins et al. (2010), and Barrientos et al. (2011) identified approximately two dozen studies that have focused on the effectiveness of certain devices for selected species. However, most of these studies involved transmission lines, and relatively few have looked at the comparative effectiveness of different devices. Hunting (2002) also concluded that making recommendations on the comparative device effectiveness is not possible due to the variation in study designs.

Barrientos et al. (2011) conducted a meta-analysis of published and unpublished collision studies to evaluate whether line marking reduced the number of collisions and which devices might be more effective. Although they showed that line marking reduced collision rates by 78%, the variability in study designs made it impossible to compare the effectiveness of these devices with different species, in different habitats, in different weather conditions, or on different line configurations. Barrientos et al. (2012), a before-after-control-impact (BACI) study of the effectiveness of two spiral devices (the smaller bird flight diverter and the larger swan flight diverter), concluded that line marking is an effective way of reducing mortality on distribution and transmission lines. Their estimate of overall effectiveness was significant, but not as high as others have reported; more definitive predictions were not possible because of study design and data limitations.

Comparison studies that use the same monitoring time intervals, control for habitat differences, and standardization of the periodicity of carcass searches are necessary to determine the device best suited to a given set of environmental conditions and species intended for protection. The following examples reflect various approaches to studying the effectiveness of line marking devices. (For studies on the effectiveness of each device, see *Line Marking Devices* on page 85.)

In San Luis Valley, Colorado, Brown and Drewien (1995) evaluated the effectiveness of two devices: yellow spiral vibration dampers (SVDs) and yellow swinging fiberglass plates with a diagonal black stripe (30.5 cm × 30.5 cm [12 in × 12 in]). Marked segments 0.8 kilometers (km) (0.5 mile [mi]) long were compared with unmarked segments of equal length during spring and fall seasons over a three-year period. They found that SVDs reduced sandhill crane (*Grus canadensis*) and waterfowl mortality by 60% and the swinging plates reduced mortality by 63%. Flight intensities were quantified. Evaluation of the flight behavior of sandhill cranes, Canada geese (*Branta canadensis*), and ducks at marked and unmarked lines indicated that birds reacted to marked lines by increasing their altitude and reaction distance. Although both devices significantly reduced mortality, the swinging plates damaged power lines.[15] The authors suggested that the silhouette of the swinging plate also provided an important benefit in low-light conditions.

In west-central Spain, Janss and Ferrer (1998) studied the effectiveness of three devices (white spiral, series of crossed bands, and thin black strips) on marked and unmarked transmission (380 kV and 132 kV) and distribution (13 kV) lines over a four-year period. The three devices were examined by comparing marked to unmarked spans

[15] The concept of swinging plates has developed into a variety of suspended devices. This new generation of suspended devices has reduced the line-wear problem while maintaining effectiveness.

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along the same power line. Monthly carcass searches were conducted without correcting for monitoring biases (see Appendix B). The species exhibiting the highest mortality included bustards, cranes, and shorebirds. The white spiral devices (30 cm × 100 cm [11.8 in × 39.4 in]), similar to a Swan-Flight™ Diverter (SFD), reduced expected mortality by 81% for all birds. The series of two black, crossed bands (35 cm × 5 cm [13.8 in × 1.9 in]) reduced expected mortality by 76% for all birds but not for great bustard (*Otis tarda*). The thin black strips (70 cm × 0.8 cm [28.6 in × 0.3 in]) placed at 12-m (39.4 ft) intervals from the central conductor did not reduce mortality. The authors state that the data could not be used for statistical comparison of effectiveness of the different diverters for specific species.



FIGURE 6.1: Studies at the San Luis National Wildlife Refuge show that the line marking devices tested work well for most species, the exception being the American coot, which is more vulnerable to collisions because it primarily flies at night.

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The Ventana Wildlife Society (2009) conducted a comparative effectiveness study of Bird Flight™ Diverters (BFD) and SFDs at six sites at San Luis National Wildlife Refuge Complex in California. Although approximately 800 hours of observation were made during three winter seasons from 2005 to 2008, few collisions were observed. However, many reactions to power lines were documented, such as altitude changes or sudden changes in flight direction called flutter or flare. The birds exhibited reactions at greater distances from power lines after flight diverters were installed, especially on lines with SFDs. Estimated total collisions were significantly higher for the unmarked control lines than for the lines marked with BFDs or SFDs. The difference in estimated total collisions between control lines and marked lines was even greater when the analysis excluded the American coot (*Fulica americana*), which primarily flies at night and accounted for approximately half of all carcasses found. The study concluded that both diverters were ineffective for the American coot. The study also suggested that site-specific differences can influence the effectiveness of diverters.

Western Area Power Administration conducted a line marking study along 3.2 km (2 mi) of line in 2006, 2007, and 2008 (WAPA 2011). Three line marking devices were used: SFD, BirdMark (solid orange), and FireFly™. The study occurred near Coleharbor, North Dakota, along the Audubon causeway, which separates Lake Audubon on the east from Lake Sakakawea on the west. More than 1,000 bird carcasses (from road mortality and collisions with power lines) and 300 hours of observational data were collected. The results indicated that marking the line decreased the number of observed flyovers for the majority of species; rather than flying over the lines, birds turned and flew parallel to the line. The study also indicated that the differences in device efficacy were minimal.

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Regardless of the variability in studies on the effectiveness of devices, most studies have shown a reduction in collisions and/or an increase in behavioral avoidance when compared to unmarked sections of a line.

MARKING CONSTRAINTS AND CONSIDERATIONS

The choice of marking device is often based on consideration of product availability and durability, cost, ease of product installation, compliance and legal issues, spacing and positioning, safety codes related to ice and wind loading, corona effects, esthetics, and vandalism. Utilities are encouraged to investigate and test products before installing them on a large scale. A general discussion of these considerations is presented here. For specific considerations on each device, see *Line Marking Devices* on page 85. For additional information on what devices may be appropriate, utility companies can consult with the manufacturer and with other utilities.

PRODUCT AVAILABILITY AND DURABILITY

Three general types of devices are available in North America: aerial marker spheres, spirals, and suspended devices. In addition, larger diameter wire can be considered for increasing line visibility. Several distributors supply these devices, so utility managers should consult with their suppliers for available options. Other devices have been developed, but are not currently available in the United States (see *Devices Available in other Countries*, page 97).

The durability of line marking devices and diverters was a commonly reported concern in the 1990s and 2000s. Since then most manufacturers have redesigned these devices to withstand ultraviolet (UV) light degradation, and they have improved the attachment clamps on suspended devices so that damage to the power line is reduced or eliminated—device specifications can be obtained from the manufacturer.

Static devices (such as spirals) and dynamic devices (such as some suspended devices) have different durability. Static devices have been more durable since they do not have moving parts. However, they have had limited success in South Africa since they can be less visible than dynamic devices. It is assumed that the motion is what makes the dynamic devices more visible. The disadvantage of dynamic devices is that they are subject to wear and have a more limited useful life than static devices. Some dynamic devices can also cause wear damage on the power line (Eskom Transmission 2009). In high wind areas, some devices with moving parts broke within several months (PacifiCorp, unpubl. data).

COST CONSIDERATIONS

Costs will vary with power line access, installation method, type of device, spacing, number of devices needed, and durability of the device. These depend in part on the line design, voltage, and length of line to be marked. Cost will also vary if the marking is done during construction of new lines or retrofitting existing lines. Power lines that are higher or over a water body (e.g., rivers, lakes, etc.) can be difficult to access and require more costly installation methods, such as a boat or helicopter. The durability of each device also varies, which makes long-term maintenance and impacts on line reliability additional considerations in cost estimates. Product cost contributes the least to the overall cost of line marking.

EASE OF INSTALLATION

The various types of line marking devices require different installation techniques: from the ground, bucket truck, boat, helicopter, line trolley, or other means. Some devices can be attached by hand and others need to be attached by a hot stick. Devices that coil onto

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FIGURE 6.2: A helicopter crew installing line marking devices on a power line.

lines may be easier to install by hand, if possible, than by hot stick. Some, such as suspended devices, may be installed by either one or two people, and a tool may be required for one-person installation.[16] In areas where access to the power line is difficult, product durability may be a more important consideration than ease of installation. For products with a shorter lifespan, the ease of product removal for repairs or replacement should also be considered.

COMPLIANCE AND LEGAL ISSUES

Associated issues must be considered to ensure that the line marking system complies with all applicable company, industry, and legal requirements. Installation must not reduce National Electrical Safety Code (NESC) clearance requirements, cause damage to standard power line hardware, conductors, and/or supporting structures, or affect the line or system reliability. Attachment procedures must adhere to worker and industry safety standards and be compatible with standard industry tools and equipment. Where facilities are shared, the easement documents may have restrictions concerning additions or modifications. In addition, legal counsel of some utility companies may object to the use of aerial marker spheres for preventing bird collisions because they prefer that the spheres only be used in compliance with Federal Aviation Administration (FAA) regulations to mark hazards to aircraft.

SPACING AND POSITIONING

Spacing and positioning determine the ability of marking devices to increase line visibility, the number of devices needed to mark each span, and how much the marking will add to the ice and wind loading. Over the years, studies have discussed spacing and positioning of devices on power lines. However, there have been no systematic comparisons of devices and their spacing and positioning. The following are general recommendations for spacing and positioning. For specific recommendations on each device, see *Line Marking Devices* on page 85.

Spacing recommendations vary depending on species considerations, environmental conditions, line location, and engineering specifications (e.g., wind and ice loading, conductor size, and the presence or absence of the shield wire). In general, intervals of 5 to 30 m (16 to 98 ft) have been most commonly used and recommended for all but the aerial marker spheres (aviation balls), where a greater spacing is used, and SVDs, where less spacing is used (see Table 6.1). Jenkins et al. (2010) concluded that any sufficiently large line marking device that increases the diameter of the line by at least 20 cm (8 in) for a length of at least 10 to 20 cm (4 to 8 in) and is placed at intervals of 5 to 10 m (16 to 32 ft) is likely to lower general collision rates by 50% to 80%.

For positioning, Eskom Transmission (2009) recommends marking only 60% of a span, the central portion of the shield wires on transmission lines, since this is where

[16] A utility should consult with its safety department to determine appropriate practices for individual or crew work.

SAMPLE

TABLE 6.2: Distance of collision mortalities from the nearest pole (parallel to distribution lines in the right-of-way).*

Taxa or Species	Sample Size	Distance	
		Mean Std Dev	Range
Geese	43	11.9 ± 10.7 m (39 ± 35 ft)	0.6 to 45.7 m (2 to 150 ft)
Ducks	25	16.2 ± 13.1 m (53 ± 43 ft)	0.6 to 48.8 m (2 to 160 ft)
Swans	5	18.6 ± 9.4 m (61 ± 31 ft)	6.1 to 60.9 m (20 to 200 ft)
Raptors	12	37.5 ± 11.9 m (123 ± 39 ft)	18.3 to 54.9 m (60 to 180 ft)
Great blue heron (*Ardea herodias*)	7	17.4 ± 12.8 m (57 ± 42 ft)	1.5 to 33.5 m (5 to 110 ft)
American white pelican (*Pelecanus erythrorhynchos*)	16	19.8 ± 15.2 m (65 ± 50 ft)	1.8 to 45.7 m (6 to 150 ft)
Sandhill crane (*Grus canadensis*)	6	21.9 ± 16.5 m (72 ± 54 ft)	6.1 to 45.7 m (20 to 150 ft)

* Source: PacifiCorp, unpubl. data

SAMPLE

most collisions occur. In surveys conducted from 2004 to 2009 in Oregon, California, Idaho, Utah, and Wyoming, PacifiCorp (unpubl. data) found that most waterfowl collision mortalities were found mid-span in the right-of-way (ROW), parallel to distribution lines, at distances of 12 to 18 m (39 to 61 ft) from the nearest pole (Table 6.2); typical span lengths were 91.5 to 121.9 m (300 to 400 ft). Sandhill cranes (*Grus canadensis*), American white pelicans (*Pelecanus erythrorhynchos*), and raptors were found farther from the nearest pole than were other species (PacifiCorp, unpubl. data.). These distances can help direct the placement of line marking devices (Figure 6.3).

Another commonly recommended strategy is to stagger the devices on parallel lines in the same plane to increase the visual density of the marked power line (Figure 6.4 and Figure 6.5). This would also reduce the number of markers on each individual line and each line's ice and wind loading.

SAFETY CODES: ICE AND WIND LOADING

The NESC identifies minimum safety and engineering standards for power lines within the United States. The NESC ice and wind loading and safety criteria for conductors and supporting structures must be reviewed prior to marking. These guidelines are used when designing a line so the constructed power lines meet or exceed NESC criteria. In addition, some states have adopted additional codes and regulations that further specify design criteria.

When any device is added to an overhead power line, it adds to the weight or loading of the line. Ice or wind adds still more loading to the line and supporting structures. The added weight of the devices and the extra wind and ice loading must not exceed line

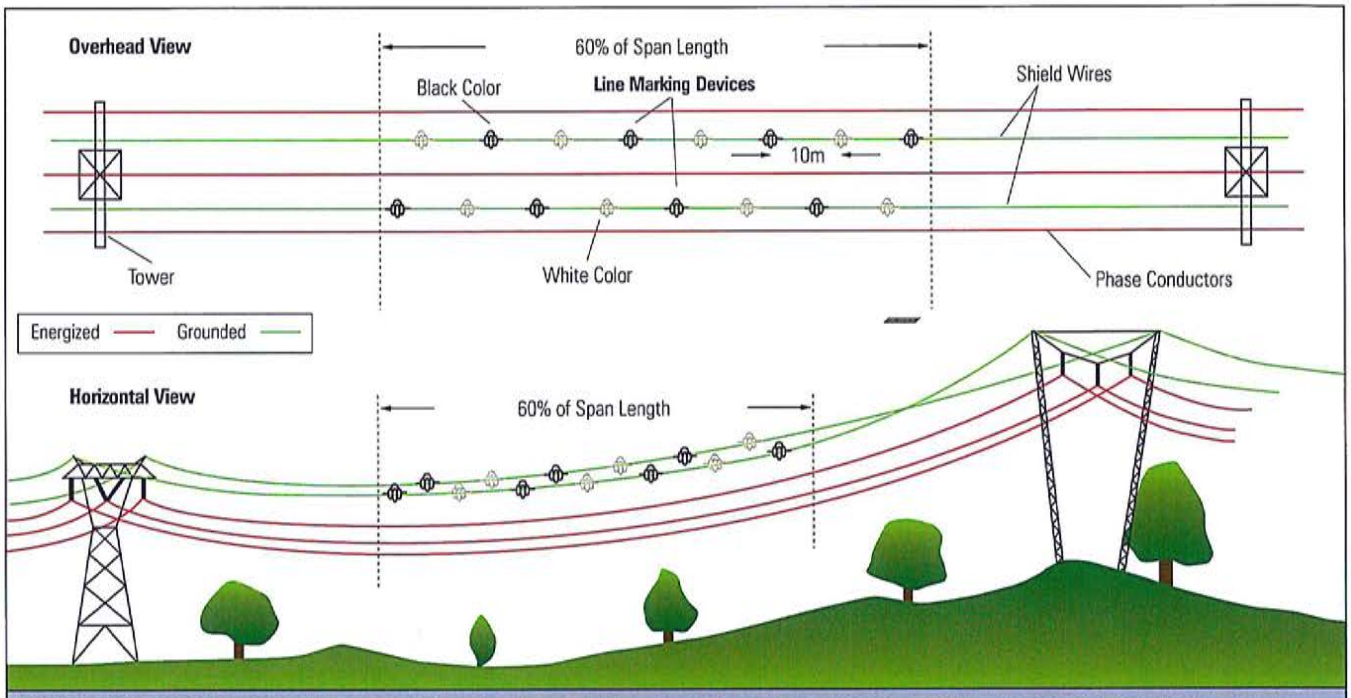

FIGURE 6.3: Positioning of line marking devices on the central portion of two shield wires on transmission lines (after Eskom Transmission [South Africa] 2009).

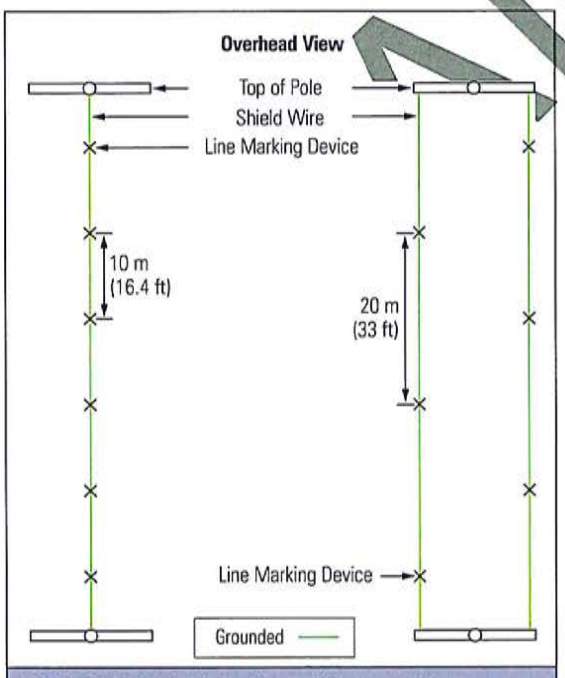

FIGURE 6.4: Positioning of line marking devices on one shield wire or staggered on two parallel shield wires.

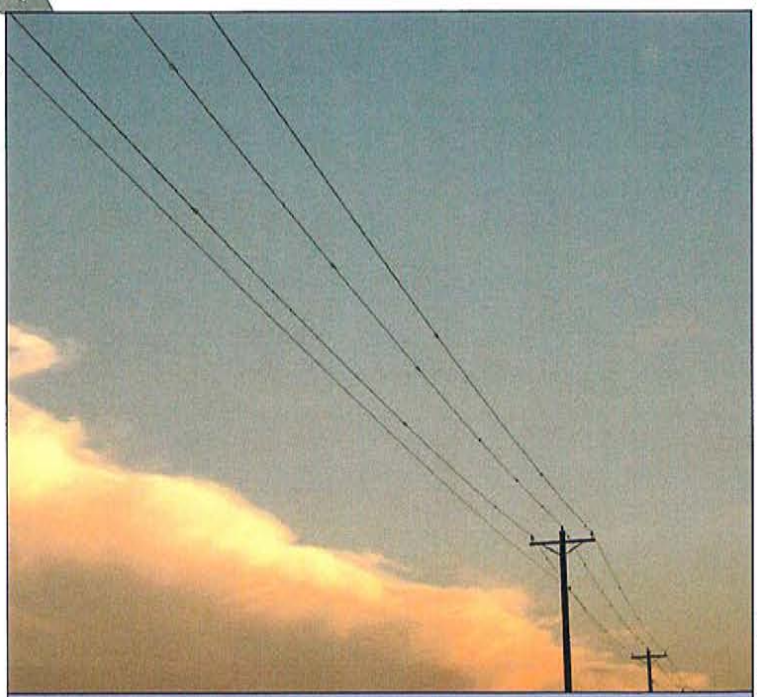

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FIGURE 6.5: Line marking devices staggered on a distribution line.

PREVIOUS VIEW



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FIGURE 6.6: When a device is added to a power line, it may add to the loading of the line, which further increases under icy or windy conditions and may also cause problems for deicing operations.

design limits and code requirements or cause additional sag that could lead to interphase contact (one conductor contacting another) and an outage. Consultation with the design engineers is imperative to ensure that adding any type of line marking device will not exceed design criteria. For existing lines, additional loading must be considered when retrofitting with line marking devices. When designing new power lines that may require marking, include allowances for the additional loading of those marking systems to prevent safety criteria from being exceeded.

CORONA EFFECTS

Electric corona occurs when the voltage of a phase conductor, typically 115 kV or greater, ionizes the surrounding air, which also becomes a conductor (Hurst 2004). Corona can degrade certain materials over time (Hurst 2004). Corona discharges appear as bluish tufts or streamers around the phase conductor, generally concentrated at irregularities on the conductor surface. A hissing sound, an odor of ozone, and local radio interference often occurs. Sharp corners of energized parts and voids, bubbles, and other heterogeneous components within solid materials (e.g., diverters) can cause corona effects.

Hurst (2004) tested several devices (Bird Flapper, FireFly™, BirdMark BM-AG, BFD, and SFD) at three simulated voltages. The study found that most of the devices had very little or no corona at 115 kV (except for some of the suspended devices) but did have corona effects at 230 kV and 345 kV. The best-performing devices at 115 kV were the BFD and the SFD, neither of which had any detectable corona discharge. At 230 kV, the BFD and the SFD had a medium level of corona, whereas suspended devices were characterized with a high level. At 345 kV, all of the devices had a very high level of corona. The corona generally occurred at the point of attachment to the phase conductor and at the top of the Bird Flapper and FireFly.

ESTHETICS

Visual management and esthetics have become concerns related to the construction or modification of power lines. With appearance as a consideration, dull rather than shiny materials are now widely used for overhead lines. Consequently, power lines were designed to blend with the background and be as invisible as possible, particularly in heavily forested areas. However, with growing concern about bird collisions, design goals are changing toward making the line acceptable to people but not invisible to birds.

If the power line is located where the viewshed is an environmental value, such as on or near public land or in residential areas, the addition of line marking devices may become an esthetic issue. For public lands and resi-

SAMPLE

Using Public Participation to Address Social Constraints of Line Marking

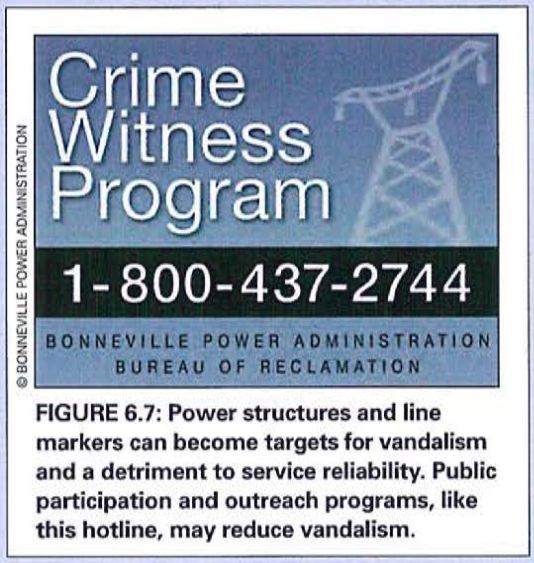

FIGURE 6.7: Power structures and line markers can become targets for vandalism and a detriment to service reliability. Public participation and outreach programs, like this hotline, may reduce vandalism.

Participation and outreach programs can increase public support for strategies such as line marking and can change or reduce behaviors such as vandalism. This can make it easier for a utility to meet requirements for electrical reliability and customer satisfaction while reducing risks to birds. See Chapter 5 for a discussion on using public participation to address social issues that influence collision risk. Appendix E includes resources.

dential areas, the marking system should be effective and acceptable in appearance. Public participation and outreach programs can increase support for line marking in areas where viewshed or esthetics are concerns, which could avoid the need for making a trade-off between esthetics and collisions (see *Public Participation* in Chapter 5).

VANDALISM

Vandalism is a persistent problem with overhead power lines, particularly from irresponsible shooters. In general, the poles, insulators, towers, signs, and line marking devices can become targets when lines traverse sparsely populated areas. As a result, electrical conductors have been damaged or severed, and extensive outages have resulted. Repair and replacement costs are ultimately borne by the utility companies and ratepayers. In addition, some customers with critical electricity needs, such as hospitals and mining operations, have had to rely on emergency back-up measures in order to maintain safety levels (A. D. Miller, pers. comm.). When evaluating any line marking system, the potential for vandalism should be addressed. Public participation and outreach programs may help reduce or prevent vandalism (see *Public Participation* in Chapter 5).

LINE MARKING DEVICES

AERIAL MARKER SPHERES (AVIATION BALLS)

Aerial marker spheres (or aviation balls) were one of the earliest devices used in an attempt to reduce bird collisions (Figure 6.8 and Figure 6.9). Originally they were used to warn aircraft pilots of power lines. These large, colored balls are usually attached to distribution phase conductors or transmission shield wires. They are available in a variety of diameters: 23 cm (9 in) to 137 cm (54 in). The most often used sizes for line marking are 23 cm (9 in) and 30.5 cm (12 in).

Aerial marker spheres are available in a variety of colors, including international orange, gloss white, or gloss yellow. Studies

SAMPLE

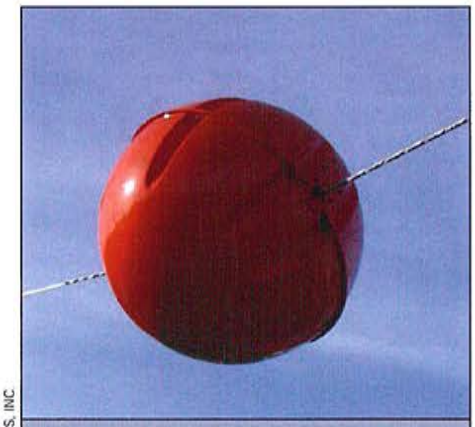

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FIGURE 6.8: Aerial marker spheres, also known as aviation balls, were designed to make power lines more visible to aircraft operators.



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FIGURE 6.9: Aerial marker spheres in use on a power line above a wetland habitat.

SAMPLE

regarding the effectiveness of color for warning pilots have shown that international orange is not the most effective color for all lighting conditions (Electrical World 1986). The FAA suggests a combination of international orange, gloss white, or gloss yellow for marking lines for aircraft. In bird collision studies, yellow has been shown useful because it reflects light better at dawn and dusk, and it does not blend in with the background colors as readily as international orange.

Recommended spacing between spheres generally ranges from 30 to 100 m (100 to 328 ft) (Table 6.3 and Table 6.4). For an existing line that crosses water, where the addition of aerial marker spheres may not be suitable, a separate (non-energized) cable for the purpose of holding the aerial markers could be installed. In this application, a larger size cable (visible to birds) should be used so that it does not contribute to bird collisions. This may provide adequate marking to reduce collisions.

TABLE 6.3: Spacing and positioning for aerial marker spheres (aviation balls).*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
Aerial Marker Spheres (Aviation Balls)	30 to 100 m (98.4 to 328 ft) apart (APLIC)	Spacing is not critical and will depend upon local conditions. The general rule is 20 m (65.6 ft) apart (Preformed Line Products)	Up to 100 m (328 ft) apart. Some studies staggered devices on parallel lines to increase visual density.

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.

† See Table 6.4 for study details and sources.

TABLE 6.4: Representative studies for aerial marker spheres (aviation balls).

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
Yellow spheres with black vertical stripe, 30 cm (11.8 in)/spacing: irregular intervals	Nebraska/ sandhill cranes	Transmission, 69 kV to 345 kV	Behavioral avoidance was greater (birds flew higher and reacted sooner) for marked versus unmarked line	Significantly reduced collisions	Morkill and Anderson 1991
Yellow aviation balls with black stripes, 30 cm (11.8 in)/spacing: 100 m (328 ft); staggered on opposing shield wires for a visual effect of 50 m (164 ft)	South Carolina/ various waterfowl species	Transmission, 115 kV	Behavioral avoidance was greater (birds reacted sooner) for marked versus unmarked line	Collision rate was 53% lower at marked line	Savereno et al. 1996
Yellow aviation marker ball with 20.3 cm (8 in) black dots/spacing: not provided	Hawaii/ shearwaters	–	–	Reduced collisions	Telfer 1999 cited in Bridges et al. 2008

PLE

Considerations for Aerial Marker Spheres (Aviation Balls)

- Improper design or installation of aerial marker spheres on phase conductors or shield wires can cause spheres to work loose and slide to the center of the span or be pushed by wind to the end of a span. Line damage from this may cause an outage.
- Aerial marker sphere size should be compatible with the design constraints of the line. For example, very large spheres can be heavy and should only be used on lines that can handle this weight.
- Adding aerial marker spheres can affect line tension and structure design more than other devices, particularly in areas where heavy ice and wind loading occurs. Accommodating the additional loading could affect construction costs.
- When installed on higher voltage conductors, there can be corona damage (depending on the type of marker balls). To avoid corona damage, marker balls designed for installation on higher voltage lines, though more costly, should be used.
- Spheres are moderately labor-intensive to install on an existing line, but less costly when added to a new line during construction.
- Although aerial marker spheres are more costly per unit than spirals, the overall cost of marking new or existing lines would be about the same because fewer spheres would be required.
- The legal counsel of some utility companies objects to the use of aerial marker spheres to prevent bird collisions. They prefer that spheres be used only in compliance with FAA regulations to mark hazards to aircraft.
- Depending upon the location, aerial marker spheres can be targets for irresponsible shooters.
- The size and number of aerial marker spheres used may result in visual degradation of environments where esthetics are important (tourist areas, scenic mountain views, historic areas, etc.)

SPIRALS

Spirals available in the United States include spiral vibration dampers (SVDs), Bird-Flight™ Diverters (BFDs), and Swan-Flight™ Diverters (SFDs).

Spiral Vibration Damper (SVD)

Spiral vibration dampers (SVDs) are pre-formed PVC spirals that were designed to reduce line vibration (aeolian vibration), but were also found to increase line visibility and

to reduce collision risk. Aeolian vibration is induced by low-velocity winds of 4.8 to 12.9 km per hour (3 to 8 mi per hour)



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FIGURE 6.10: Spiral vibration dampers act to reduce line vibration, and they also make power lines more visible to birds.

(Figure 6.10). SVDs change the airfoil of a power line under normal and icing conditions to reduce conductor gallop.

SVDs are available in various lengths, ranging from 112 to 165 cm (46 to 65 in), to fit different wire sizes. Standard SVDs are made of solid thermal plastic. They are available in gray or yellow with UV stabilizers that help the devices retain color, flexibility, and durability when exposed to extreme sunlight and weather conditions. They are also available in a yellow, high-impact PVC.

SVDs are often placed about 3 m (9.8 ft) apart on transmission line shield wires (Table 6.5 and Table 6.6). For distribution lines, to prevent interphase contact and increase line visibility, SVDs should be staggered so that every third one is on an alternate phase conductor.

SAMPLE

TABLE 6.5: Spacing and positioning for spiral vibration dampers (SVDs).*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
Spiral Vibration Damper (SVD)	2.7 m (9 ft) on the shield wire. On distribution phase conductors, stagger SVDs to prevent interphase contact. (APLIC)	–	3.3 m (10.8 ft) apart (Brown and Drewien 1995)

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.

† See Table 6.6 for study details and sources.

TABLE 6.6: Representative studies for spiral vibration dampers (SVDs).

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
Yellow spiral vibration dampers, 1.27 cm × 112 to 125 cm (0.5 in × 44 to 49.2 in) / spacing: 3.3 m (10.8 ft)	Colorado/ waterfowl and sandhill cranes	Distribution, 7.2 kV Transmission, 69 to 115 kV	Reacted sooner and changed flight patterns in marked versus unmarked lines	Reduced mortality by 60%	Brown and Drewien 1995

Considerations for Spiral Vibration Dampers

- When installed on triangularly spaced distribution lines, SVDs should be staggered on all three phase conductors. Despite their light weight, if they are only applied on the top or ridge phase conductor, wind or ice may make the top phase sag, which may cause interphase contact.
- When installed on a single shield wire, given the relatively light weight of SVDs, the rate of coverage, and the distance between the shield wire and the phase conductors, line sag on the shield wire would rarely present an issue.
- SVDs are not recommended for use on transmission phase conductors (AC or DC) with voltage ≥230 kV because of corona effects (see *Corona Effects*, page 84). However, future design materials may address this issue.
- Installation of SVDs is moderately labor intensive on lower-height distribution lines and more so on transmission lines that range from 15.2 to 59 m (50 to 195 ft) above the ground.



FIGURE 6.11: The Bird-Flight™ Diverter is a spiral device made of PVC.

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Bird-Flight™ Diverter (BFD)

BFDs are preformed, increasing-radius spirals made of extruded, high-impact PVC (Figure 6.11 and Figure 6.12). One end of the spiral grips the power line while the radius quickly increases toward the other end of the spiral. BFDs were developed in Great Britain and have been used in Europe since the early 1970s and more recently in the United States and South Africa. They are also called "small pigtails" in South Africa (Eskom Transmission 2009). Since 1994, more designs have become available.

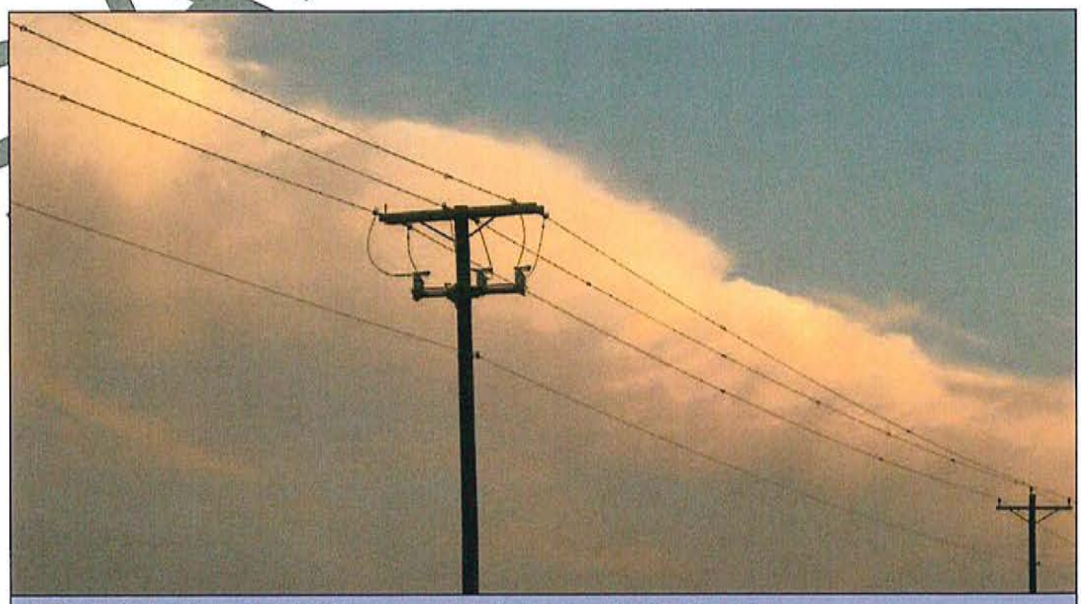

FIGURE 6.12: Bird-Flight™ Diverters installed on a distribution line.

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SAMPLE

TABLE 6.7: Spacing and positioning for Bird-Flight Diverters (BFDs).*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
Bird-Flight Diverter (BFD)	4.9 to 15.2 m (16 to 50 ft) (APLIC) 10 m (32.8 ft), staggered (Eskom) 21 m (68.9 ft) (Iberdrola)	4.6 m (15 ft) apart depending upon local conditions (Preformed Line Products)	5 m (16.4 ft), 10 m (32.8 ft), 15 m (49.2 ft), and 20 m (65.6 ft). Some studies staggered devices on parallel lines to increase or maintain visual density and to reduce and distribute loading equally.

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions. Manufacturer recommendations are the closest spacing that would be required.
† See Table 6.8 for study details and sources.

Various sizes of BFDs are available to fit different line diameters. The lengths can range from 17.8 to 59.7 cm (7 to 23.5 in). The diameter of the spiral at the large end of the diverter ranges from 3.8 to 12.7 cm (1.5 to 5 in). UV stabilizers are added to the PVC to protect BFDs from sunlight. They are produced in a variety of colors, such as yellow, orange, red, green, brown, gray, and black, and some glow.

Spacing recommendations for BFDs vary (Table 6.7 and Table 6.8). In the Netherlands, wires have been marked in bird-collision zones using 10 cm (3.9 in) spirals at 5 m (16.4 ft) intervals. This reportedly has an average mortality reduction of approximately 90% (Koops 1993). For the United States, one manufacturer (Preformed™ Line Products) recommends 4.6 m (15 ft) spacing intervals depending upon local conditions. In studies conducted in the Netherlands, marking devices have been staggered on parallel shield wires so that the line marking devices appear to be 5 m (16.4 ft) apart (Koops 1979; Koops and de Jong 1982; Koops 1987). On each shield wire, however, they are 10 m (32.8 ft) apart. Staggering line marking devices on alternate lines reduces the loading that a single marked line would otherwise have to bear.

Considerations for Bird-Flight Diverters

- BFDs add some aeolian vibration stabilization since their profile changes the airflow over the line.
- BFDs are not recommended for use on transmission line phase conductors (AC or DC) with voltage ≥230 kV because of corona effects (see *Corona Effects*, page 84). However, future design materials may address this issue.
- Eskom has used BFDs in South Africa for years with no reports of mechanical failure (van Rooyen 2000) although some red PVC devices have faded.
- BFD installation is labor intensive whether by bucket truck, boat, helicopter, or line trolley. Robotic installation devices are being developed.

SAMPLE

TABLE 6.8: Representative studies for Bird-Flight Diverters (BFDs).

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
White BFD, 5 cm (1.9 in) diameter/ spacing: 5 m, 10 m, and 20 m (16.5, 32.8, and 65.6 ft) White BFD, 10 cm (3.9 in) diameter/spacing: 15 m (49.2 ft)	Netherlands/ various species	–	–	When spaced at 20 m (32.8 ft), they reduced collisions by 58%. Total mortality was reduced by 57% to 89%, depending upon the size and spacing	Koops 1987; Koops and de Jong 1982; Koops 1993 (cited in Janss and Ferrer 1998)
Red spiral BFD, 30 cm (11.8 in) maximum diameter, 1 m (3.3 ft) long/spacing:10 m (32.8 ft)	Spain/various species including cranes and bustards	Transmission, 380 kV with dual shield wires	61% reduction in birds crossing the lines, more birds flying over, fewer flying through lines	60% reduction in collisions	Alonso et al. 1994
Yellow and gray BFD	Indiana/ waterfowl	Transmission, 345 kV		Reduced bird collision by 73.3% compared to unmarked lines	Crowder 2000
Yellow PVC BFD spirals, 25 cm (9.8 in) diameter, 80 cm (31.5 in) length /spacing: 10 m (32.3 ft); staggered on both shield wires	Colombia/ night flying rallids, herons, and ducks	Transmission, 500 kV	Birds detected BFD line at a greater distance than unmarked line, fewer flew at conductor height	Reduction in collision frequency for marked versus unmarked lines, but collision rate was highly variable regardless of line condition	De La Zerda and Roselli 2003
Yellow and gray BFD/ spacing: 4.6 m (15 ft); staggered on 3 phase conductors	California/ waterfowl	Distribution	Birds exhibited greater reactive distances	Reduced waterfowl collisions, but not coot collisions (coots fly at night)	Ventana Wildlife Society 2009
Small spirals, 10 cm (3.9 in) diameter, 24 cm (9.4 in) long/ spacing was not provided	Spain/various species including bustards, storks, and doves	Distribution and transmission	–	Reduced collisions overall after line marking (9.6%)	Barrientos et al. 2012

SAMPLE

Swan-Flight™ Diverter (SFD)

The SFD is another spiral design, which is also called a Double Loop Bird Flight Diverter (Figure 6.13 and Figure 6.14). SFDs have two gripping ends and a central spiral with a larger diameter.

Sizes are available to fit different conductor diameters. The lengths can range from 50.8 to 116.8 cm (20 to 46 in). The diameter of the central spiral can range from 17.8 to 20.3 cm (7 to 8 in). SFDs are extruded in yellow and gray high-impact PVC with UV



FIGURE 6.13: The Swan-Flight™ Diverter is a double-ended spiral device.

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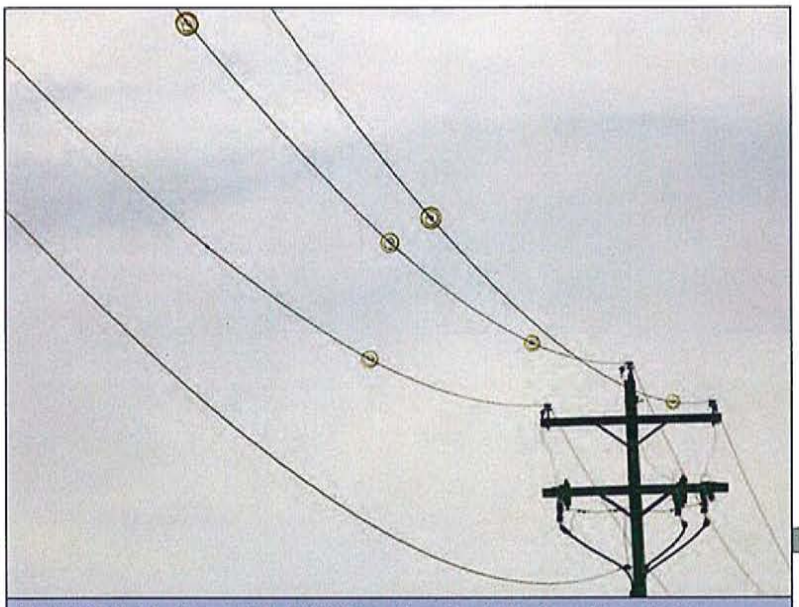

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FIGURE 6.14: Swan-Flight™ Diverters installed on the phase conductors of a distribution line.

stabilization. Gray is the standard color but SFDs are available in: black, blue, brown, green, purple, red, orange, and pink, and some that glow.

Spacing depends upon local conditions (Table 6.9 and Table 6.10).

Considerations for Swan-Flight Diverters

- SFDs can be used on the shield wires of high-voltage lines.
- SFDs on the line add some aeolian vibration stabilization since their profile changes the airflow over the line.
- SFDs are not recommended for use on transmission line phase conductors (AC or DC) with voltages ≥230 kV because of corona effects (see *Corona Effects*, page 84). However, future design materials may address this issue.
- Wind and ice loading should be considered, as these have been a concern in Canada and the northern United States (N. Heck, pers. comm.).
- Colors of some SFDs may fade.
- Installation is labor intensive whether done from bucket truck, boat, helicopter, or line trolley. Robotic installation devices are also being developed.

TABLE 6.9: Spacing and positioning for Swan-Flight Diverters (SFDs).*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
Swan-Flight Diverter (SFD)	15.2 m (50 ft) (APLIC) 21 m (68.9 ft) (Iberdrola)	Spacing is not critical and will depend upon local conditions. The recommended ranges are 10 to 15 m (32.8 to 49.2 ft) (Preformed Line Products) up to 30 m (98.4 ft) (FCI)	5 m (16.4 ft), 10 m (32.8 ft), and 15 m (49.2 ft). Some studies staggered devices on parallel lines to increase visual density and distribute loading equally.

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.
† See Table 6.10 for study details and sources.

SAMPLE

TABLE 6.10: Representative studies for Swan-Flight Diverters (SFDs).

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
White spirals (SFD), 30 cm (11.8 in) diameter/ spacing: 10 m (32.8 ft)	Spain/various species including cranes, storks, and bustards	Various size distribution and transmission lines	–	Effective at reducing collisions	Roig-Soles and Navazo-Lopez 1997
White polypropylene spirals, 1 m (3.3 ft) long, 30 cm (11.8 in) maximum diameter/spacing: 10 m (32.8 ft); staggered on 2 shield wires for a visual effect of 5-m (16.4-ft) intervals	Spain/cranes	Transmission, 380 kV and 132 kV Distribution, 13 kV	–	Small sample size did not permit specific species evaluation. Reduced mortality for common cranes. The reduction in actual versus predicted mortality for all birds was 81%	Janss and Ferrer 1998
Yellow and gray SFD/spacing was not provided	Indiana/ waterfowl	Transmission, 345 kV	–	Reduced collisions by 37.5% on marked lines compared to unmarked lines	Crowder 2000
Yellow SFD/ spacing: 15.2 m (50 ft); staggered on parallel wires for a visual effect of 7.6-m (25-ft) spacing	Wisconsin/ trumpeter swans (*Cygnus buccinator*)	Distribution, 23.9 kV	–	Eliminated collisions completely	Rasmussen 2001, cited in Hunting 2002
Red SFD, 32 cm (12.6 in) for the gripping section and 17.5 cm (6.9 in) for the outside diameter of the central spiral/spacing: 5-m (16.4-ft) intervals on shield wire	England/ mute swans (*Cygnus olor*)	Transmission, 132 kV	–	Reduced collisions	Frost 2008
Gray SFD/ spacing: 4.6 m (15 ft); staggered on 3 phase conductors	California/ waterfowl	Distribution	Birds exhibited greater reactive distances	Reduced waterfowl collisions, but not coot collisions (coots fly at night)	Ventana Wildlife Society 2009
Large spirals, 35 cm (13.8 in) diameter, 1 m (3.3 ft) long/ spacing was not provided	Spain/various species including bustards, storks, and doves	Distribution and transmission	–	Reduced collisions overall after line marking (9.6%)	Barrientos et al. 2012

SAMPLE



ESKOM 2009

FIGURE 6.15: Examples of suspended devices (swinging and fixed).

SUSPENDED DEVICES (SWINGING, FLAPPING, AND FIXED)

There are several types of suspended devices including general designs and branded designs (e.g., FireFly™ and BirdMark BM-AG), which are discussed separately on page 95 and page 96. They have a clamp that attaches to the power line so that the device can move in the wind. Some are designed to swing, flap, and spin, while others, for use in high wind locations, are nearly immobile but do allow some motion. Some have reflective and glow-in-the-dark properties.

General Designs

Suspended devices have a polycarbonate, UV stabilized, plastic flapper (swinging or fixed) connected to a clamp that attaches to the power line (Figure 6.15). The movement and reflectivity of the device enhances the visibility of the line. Suspended devices are available in many colors and shapes with panels that reflect visible and UV light and glow. They can be attached to distribution phase conductors up to 40 kV and to shield wires up to a diameter of 1.9 cm (0.75 in) (Table 6.11 and Table 6.12).

SAMPLE

TABLE 6.11: Spacing and positioning for general designs of suspended devices.*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
Swinging or fixed device	5 m (16.4 ft), staggered (Eskom)	Staggering devices on parallel lines is recommended. The general spacing rule is 10 to 15 m (32.8 to 49.2 ft) (Preformed Line Products).	–

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.

TABLE 6.12: Representative studies for general designs of suspended devices.

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
Swinging or fixed device (specifications and spacing not provided)	South Africa/ bustards and cranes	Distribution, 22 kV Transmission, up to 440 kV	– –	Reduced collisions More effective than the BFD	van Rooyen 2000; Anderson 2001; McCann 2001
Yellow fiberglass swinging plate, 30.5 x 30.5 cm, (12 × 12 in) with a black stripe/ spacing: 20 to 30 m (65.6 to 98.4 ft) on shield wires or center phase conductor	Colorado/ sandhill cranes and waterfowl	Distribution, 7.2 kV Transmission, 69 kV to 115 kV	Birds reacted earlier and flew higher over marked lines than unmarked lines	63% reduction in mortality rates overall, but there was considerable seasonal variation. Over 30% of collisions in fall occurred at night.	Brown and Drewien 1995

FireFly™

There are several types of FireFlys, two of which (the FireFly FF and the FireFly HW) are designed as suspended devices (Figure 6.16). FireFlys have a strong spring-loaded clamp that attaches to the line so that the device can swing. The device increases the line profile slightly, but its motion and reflectivity attract attention and alert birds of the line's presence.

The FireFly FF has an acrylic plastic tag that measures 9 cm × 15 cm (3.5 in × 6 in), is 3 mm (0.13 in) thick, and is covered with yellow and orange reflective tape and photo-reactive coatings. They are UV light stabilized and constructed to be highly reflective during the day. According to the manufacturer they glow for up to 10 to 12 hours after sunset. They are attached to the clamp by swivels so they swing and spin in the wind.

The FireFly HW is similar in size to the FireFly FF but the HW model's plastic tag does not swivel and is designed to withstand higher, sustained winds. The manufacturer claims similar effectiveness. Results from installation in a high raptor use area on a new power line in central California have shown these devices to be effective without any damage to the line or failure of the devices (M. Schriner, pers. comm.).

FireFlys have been attached 4.6 to 15.2 m (15 to 50 ft) apart. For lines with parallel shield wires, they can be staggered so that the device density appears greater, e.g., when spaced at 12.2 m (40 ft) on each shield wire and staggered, they appear to be 6.1 m (20 ft) apart (Table 6.13 and Table 6.14).

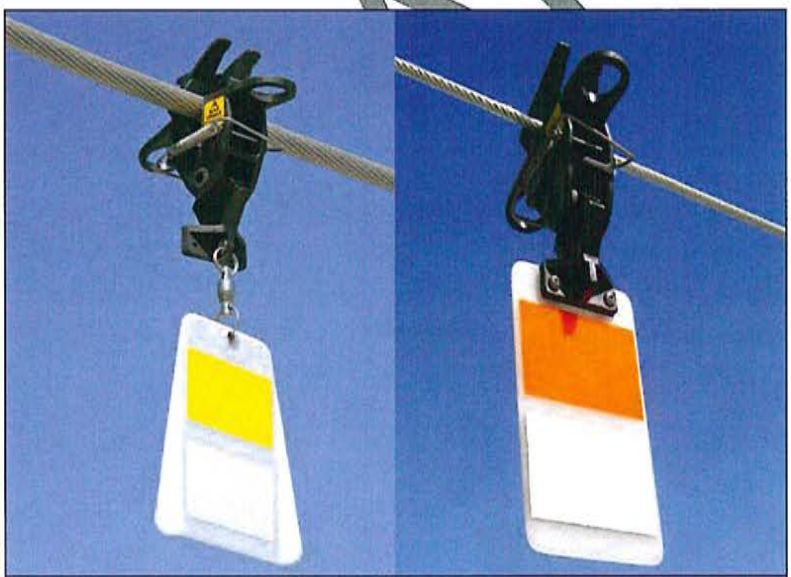

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FIGURE 6.16: The FireFly™ FF (left) has a swinging tag for use in light winds and the FireFly™ HW (right) has a fixed tag to withstand higher, sustained winds.

SAMPLE

TABLE 6.13: Spacing and positioning for FireFlys.*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies†
FireFly™	15.2 m (50 ft) spacing, staggered on alternating wires (PacifiCorp)	Recommendations depend on the tower height: 4.6 m (15 ft) apart for towers less than 30.5 m (100 ft) and 9.1 m (30 ft) apart for towers that are greater than 30.5 m (100 ft) tall (Birdbusters).	5 to 12 m (16.4 to 39.3 ft) apart. Some studies staggered devices on parallel lines to either increase visual density or distribute loading equally.

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.
† See Table 6.14 for study details and sources.

TABLE 6.14: Representative studies for FireFlys.

Description/Spacing	Location/ Species	Power Line Characteristics	Effectiveness		Reference
			Behavioral Avoidance	Reduction in Collisions	
FireFly™, 9 cm × 15 cm (3.5 in × 6 in), 3 mm (0.13 in) thick, luminescent strip, spinning swivel, contrasting reflective colors on opposite sides/spacing: 5 m (16.4 ft); staggered on conductors	California/ sandhill crane, song birds, other species	Distribution, 12 kV	No changes in flight height or reaction distance	60% reduction in collision frequency on marked lines, collision frequency also decreased on adjacent spans	Yee 2008
FireFly™, acrylic plastic tag measures 9 cm × 15 cm (3.5 in × 6 in), 3 mm (0.13 in) thick, yellow and orange reflective tape and photo-reactive coatings/ spacing: 12-m (39.3-ft) intervals	Nebraska/ sandhill cranes	Transmission, 69 kV	Cranes reacted more quickly (mainly by gradually gaining altitude) to avoid the marked line than they did to unmarked lines	Reduced collisions by half	Murphy et al. 2009

SAMPLE

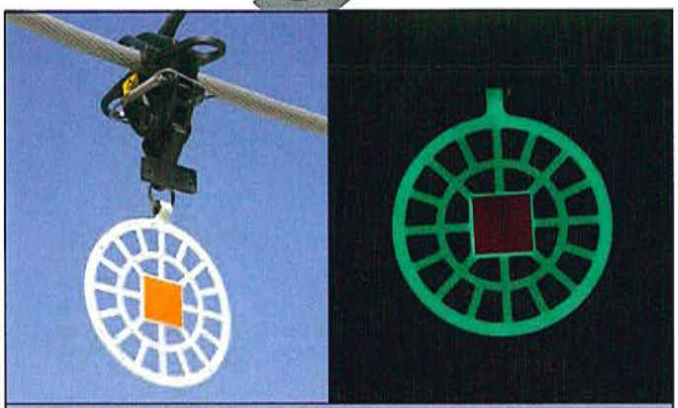

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FIGURE 6.17: BirdMark BM-AG (After Glow) in daylight (left) and darkness (right).

BirdMark BM-AG (After Glow)

The BirdMark BM-AG (After Glow) has a perforated swinging disk that spins and flutters (Figure 6.17). This device is 29.21 cm (11.5 in) long with a 13.33 cm (5.25 in) diameter disk with a reflective center. The BirdMark BM-AG is designed with a strong spring-loaded clamp that attaches to wires up to a diameter of 6.4 cm (2.5 in). The reflective disks glow for up to 10 hours after sunset and are available in orange, white, and red.

The manufacturer recommends 4.6 m (15 ft) spacing (Table 6.15). The movement of the device adds to the visibility of the line.

TABLE 6.15: Spacing and positioning for BirdMark BM-AG.*

Device	Utility Industry Practices	Manufacturer Recommendations	Spacing Lengths Used in Experimental Studies
BirdMark BM-AG	–	4.6 m (15 ft) (P&R Technologies)	No scientific studies on the BirdMark BM-AG were found.

* Actual spacing depends on engineering requirements, manufacturer specifications, species involved, and site-specific conditions.

Considerations for Suspended Devices

- In some of the earlier versions, there were problems with the device shifting (van Rooyen 2000).
- Depending upon the location, suspended devices can be targets for irresponsible shooters.
- The devices can be installed and removed from the ground or bucket truck with a hot stick. Two people are required for installation unless a special tool is used; homemade tools have worked better than some manufactured tools (S. Liguori, pers. comm.). New manufactured tools are being made and tested.
- Corona effects can occur depending upon the voltage (see *Corona Effects*, page 84).
- Installation cost increases with line height and in areas that are difficult to access such as river and lake crossings.
- Swivels have failed prematurely in high wind locations.

DEVICES AVAILABLE IN OTHER COUNTRIES

The following devices are not distributed in the United States at this time (2012).

Baliza Avifauna

The Baliza Avifauna is manufactured in Spain by Saprem. It is a variation of hanging strips that consists of two black neoprene crossed bands (measuring 6 cm × 28 cm [2.4 in × 11 in]). Some versions have a phosphorescent stripe.

Janss and Ferrer (1998) describe a similar device (with crossed bands measuring 5 cm × 35 cm [1.9 in × 13.8 in]) that was staggered on the conductors every 24 m (78.7 ft) (a visual effect of 12 m [39.3 ft] intervals). The device consisted of two black neoprene crossed bands slightly shorter than the com-

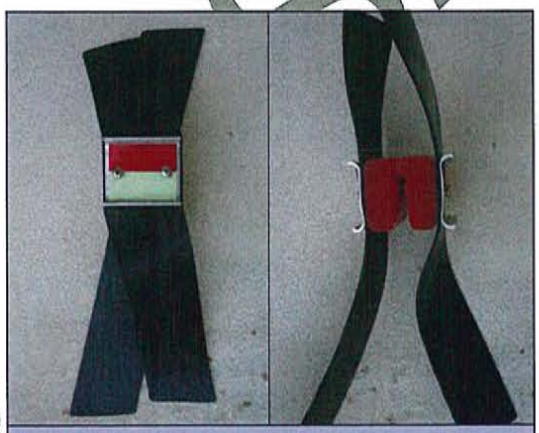

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FIGURE 6.18: Hanging strips of neoprene, such as this Spanish-made Baliza Avifauna, are being used as line marking devices in Europe and South Africa.

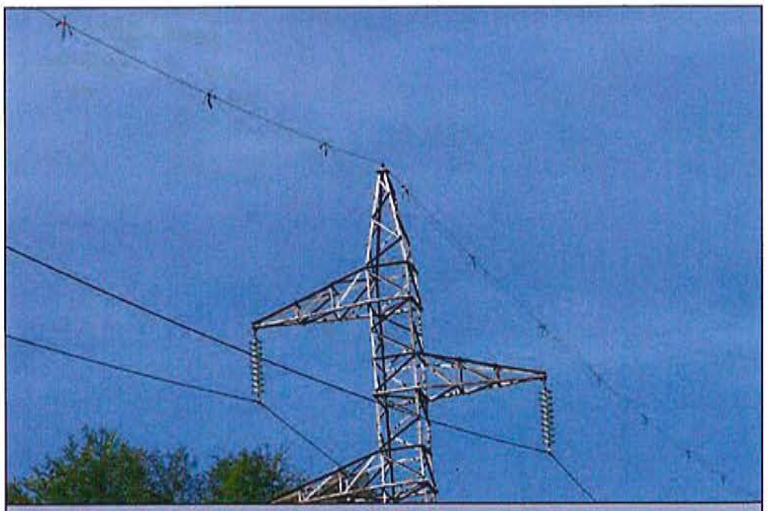

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FIGURE 6.19: Baliza Avifauna installed on a power line in Europe.

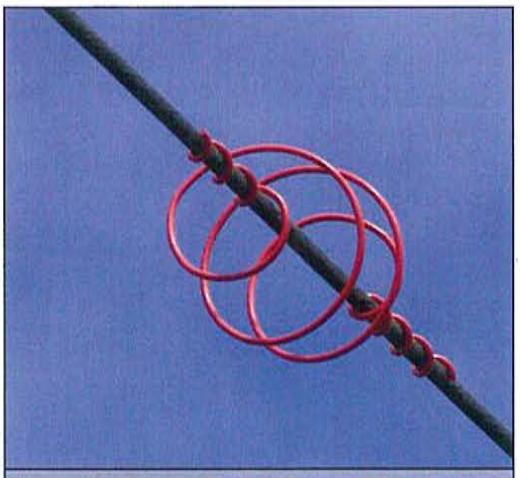

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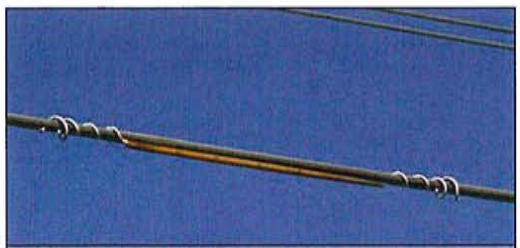
FIGURE 6.20: The Avifaune Spiral is commonly used in France and other parts of Europe.



© DR/RTE

FIGURE 6.21: Avifaune Spirals installed.



© MACE TECHNOLOGIES

FIGURE 6.22: The Mace Bird Lite is a spiral device with a central fluorescent tube that is illuminated by the ambient electrical field.

mercially available strips. Janss and Ferrer (1998) found the device reduced collisions by 76% on transmission (380 kV and 132 kV) and distribution (13 kV) lines. The device pictured here is widely used in Europe and South Africa.

Avifaune Spiral

The Avifaune Spiral is used in France and other parts of Europe. These are preformed PVC similar to the SFDs described previously. Avifaune Spirals are 91 cm (36 in) long and have two 36-cm (14-in) spirals in the middle. They are produced in two UV light protected colors: red and white. French researchers recommend alternating the colors. Raevel and Tombal (1991) indicate that the color combination is effective in variable light conditions on transmission lines. Avifaune Spirals have been used on phase conductors and shield wires with a recommended spacing of 7 to 10 m (23 to 32.8 ft).

Mace Bird Lite

The Mace Bird Lite is a spiral vibration damper with a fluorescent light attached inside a plastic tube. The light is energized by a phase conductor's electrical field and can be seen at night. These were designed specifically for 132-kV lines, but it should be possible to use them with other voltages. Although no precise scientific data are available on its effectiveness, this technology has been successfully used in Botswana and South Africa (Eskom 2003) in reducing flamingo collisions (Eskom Transmission 2009). The potential issue of the light attracting birds to a line was not addressed.

RIBE Bird Flight Diverter Fittings

RIBE bird flight diverter fittings are available in two versions: a swinging rectangular tag and a series of 10 alternating black-and-white, rigid plastic pieces that swing on a rod attached at both ends to a shield wire or phase conductor.

PREVIEW



© RIBE

FIGURE 6.23: The RIBE line marking device is available as a swinging triangular tag or as a series of black-and-white, rigid plastic pieces that swing (pictured).

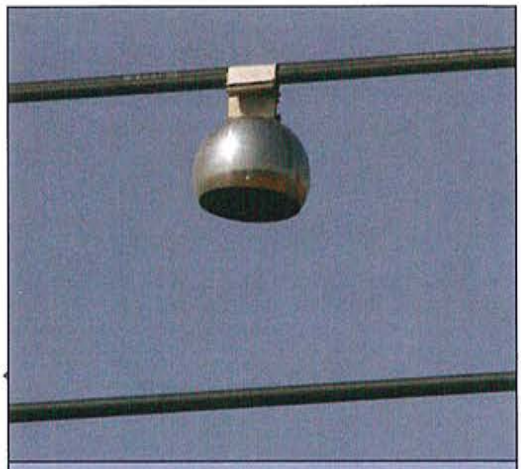


FIGURE 6.24: The Inotec BFD 88, a South African device, is a reflective stainless steel sphere reported to be visible from all angles and in low-light conditions.

© INOTEC

According to the manufacturer, results from a three-year field trial on the Bernbrug-Susigke 110-kV line in South Africa showed that these are effective at reducing bird collisions with power lines when compared to lines without diverters. The information suggests that closer spacing (20 m versus 40 m [65.6 ft versus 131.2 ft] apart) is more effective. However no description of the study design nor specific data was provided.

Inotec BFD 88

The Inotec BFD 88 is a relatively new device with characteristics of both suspended devices and spheres. It is a reflective stainless steel sphere, 7 cm (2.8 in) in diameter, attached to a metal spiral, which is attached to the wire. When installed they appear as small metal spheres suspended from the wire.

This device is made of 316-grade stainless steel and is naturally reflective and corrosion resistant. The crimp is made from marine-grade aluminum, a highly durable adhesive, and conductive rubber. According to the manufacturer, the clamp does not come into contact with the phase conductor, so there is no chance of galvanic cell reaction or mechanical damage to the power line. The stainless steel sphere does not sway and cannot touch the power line.

Eskom Transmission (2009) indicates that these metal spheres are visibly superior to colored (red, yellow, white, or black) objects in low light, especially at dawn and dusk when birds are flying between roosting and feeding areas. The spherical shape reflects available light and is claimed to be visible from all directions including above or below the diverter. When viewed during low-light conditions, the device is visible against dark backgrounds such as the ground, trees, or high ground. It is also visible against bright clouds when viewed from below (Eskom Transmission 2009).

The diverter can be attached while a line is energized and installed from the ground with a hot stick. Because of the spherical design, it does not display corona. It was developed in South Africa for use on shield wires and phase conductors up to 88 kV, and no radio interference was detected up to 88 kV.

SAMPLE

PLASTIC TUBES

Archibald (1987) reported that yellow plastic tubes placed on power lines near Hokkaido, Japan, in 1982 reduced mortality of red-crowned cranes (*Grus japonensis*). Plastic tubes along with various versions of ribbons, however, are not durable enough for use.

LARGE DIAMETER WIRE

OVERSIZED SHIELD WIRE FOR TRANSMISSION LINES

A limited study compared the use of an oversized shield wire with a conventional shield wire (Brown et al. 1987; Miller 1990). The oversized wire was 2.52 cm (1 in) in diameter, or 2.6 times greater than standard shield wire (0.95 cm [0.4 in]). Researchers found that there was no significant difference between these wires. Other studies have identified the conventional, small-diameter shield wire as the highest risk wire for collisions with transmission lines (e.g., Savereno et al. 1996), which suggests that diameter and distance visibility are factors involved in collision risk. The use of larger-diameter shield wire is considerably more expensive. Though anecdotal reports suggest larger diameter shield wire is effective, studies of its effectiveness are needed before it can be recommended for reducing collision risk.

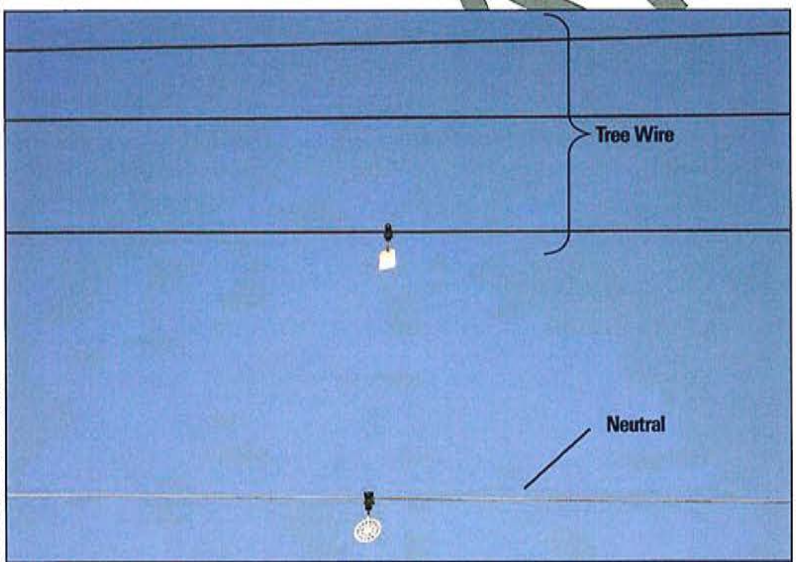


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FIGURE 6.25: Tree wire on all three phases of a distribution line marked with suspended devices.

TREE WIRE TO PREVENT COLLISION-ELECTROCUTIONS ON DISTRIBUTION LINES

Tree wire is a type of insulated phase conductor used on distribution lines to provide protection from momentary contact with tree branches, which would otherwise cause an electric arc (Figure 6.25, Figure 6.26, and Figure 6.27). The insulation is also sufficient[17] to protect birds from collision-electrocutions, which are caused by phase-to-phase contact when large birds, such as eagles and swans, brush phase conductors while flying between them. The electric arc created in collision-electrocutions can kill multiple birds in a flock, even if only one bird makes phase-to-phase contact. Because tree wire can prevent collision-electrocutions, it has even been used in some open areas for rebuilt and new distribution lines (M. Walters, pers. comm.).

Tree wire may also be an effective means of reducing collision incidence because the insulated covering increases the diameter of the wire, making the line more visible. However, no scientific studies were found to verify this.

Retrofitting a line with tree wire is usually only a consideration when outages are caused by tree branches. It would be unusual to retrofit an existing line with tree wire to prevent collisions because line marking devices are more cost effective. However, when a distribution line is being upgraded or a new line is being built, tree wire may be a cost-effective option when used for the center

[17] The insulation on tree wire is not considered protective for human safety.

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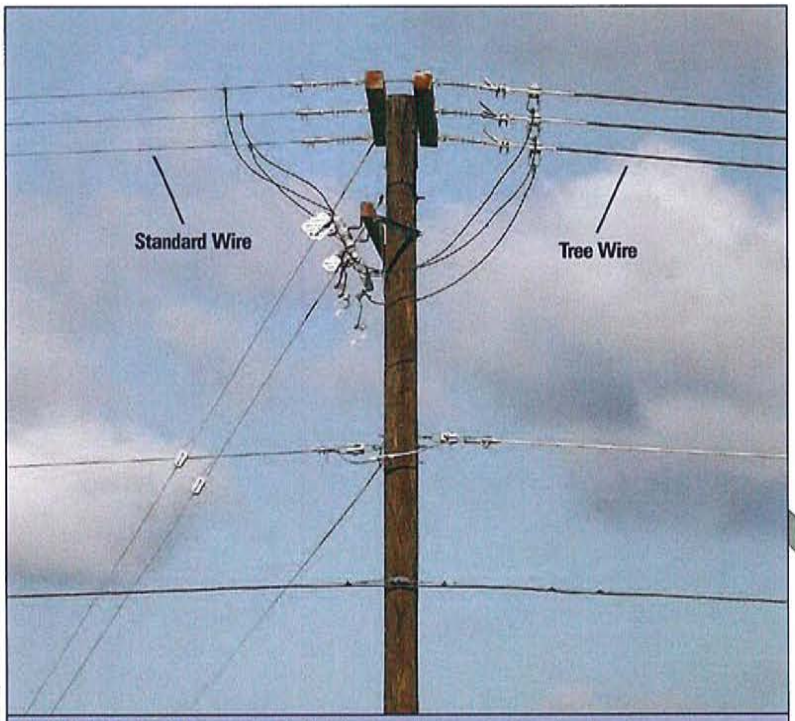

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FIGURE 6.26: Tree wire (right of pole) and standard wire (left of pole) on a distribution line.



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FIGURE 6.27: Collision-electrocutions cause an electrical short, like this one caused by tree branches, and can kill two or three birds in a flock even if only one bird makes phase-to-phase contact.

phase. The difference in cost (2011 $) between tree wire (336ACSR TW= $0.89 per 30.5 cm [12 in]) and standard wire (397KCM = $0.77 per 30.5 cm [12 in]) is approximately $0.12 per 30.5 cm (12 in) or $1,900 per 1.6 km (1 mi) for a standard three-phase distribution feeder. Tree wire is also heavier than standard wire and may require higher class poles, more poles (1 to 2 per 1.6 km [1 mi]), and possibly additional guying. The average lifespan of tree wire is 40 years. The advantages to tree wire are that it reduces the risk of collision-electrocution at mid-span for flying birds, reduces the risk of electrocution for perching birds, and reduces the maintenance requirements usually associated with suspended devices.

Unpublished observations show that tree wire used in conjunction with line marking devices, such as the FireFly™ and/or Bird-Mark BM-AG, is effective at reducing collision-electrocutions and collisions for trumpeter swans (*Cygnus buccinator*), waterfowl, and raptors (M. Walters, pers. comm.). When rebuilding lines already equipped with flight diverters, the diverters are reinstalled on the new tree wire lines. The increased visibility of tree wire reduces the risk, which is further reduced by installing FireFlys (M. Walters, pers. comm.).

In the Chimacum Valley, Washington, from 2000 to 2007, an eight-span lateral line averaged three bird-caused outages per year due to swan and waterfowl collisions, including 10 swan mortalities in 2006 alone. In 2007, the line was modified with tree wire to prevent collision-electrocutions and with FireFlys to reduce collision risk. No swan mortalities or outages have occurred since the line was modified in spite of increasing swan populations and their continued use of this flight corridor. The landowner reported that the swan flight path is much higher over the lines since these modifications were made (M. Walters, pers. comm).

PREVIOUS VIEW

At another site in western Washington's Skagit Valley, five swan mortalities occurred on a single-phase line in the winter of 2008–2009, and others had been documented in previous years. The line was rebuilt in a three-phase configuration during the summer of 2009, which included tree wire on the center phase along with alternating FireFly™ and BirdMark BM-AG devices on all three phase conductors. In the following winter season, no mortalities or outages occurred, although swan populations continue to increase. Between 1,000 and 2,000 swans forage in this area throughout the winter (M. Walters, pers. comm.).

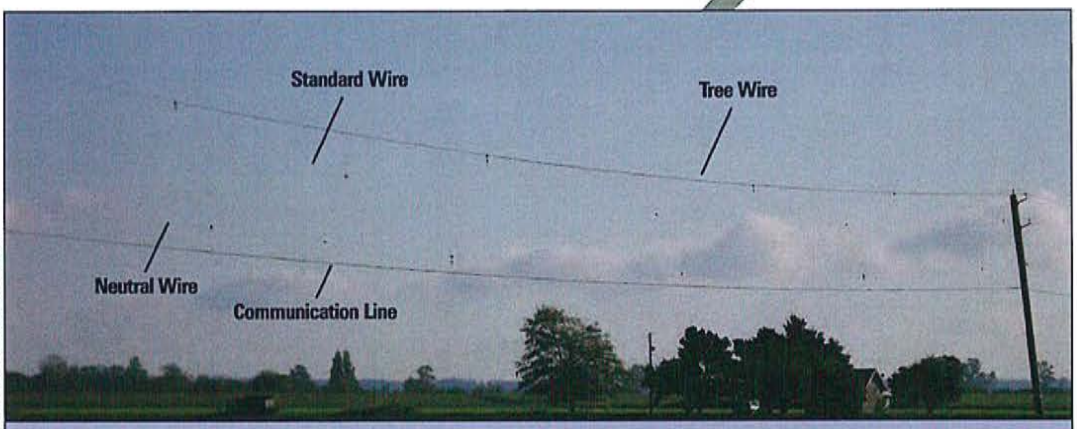

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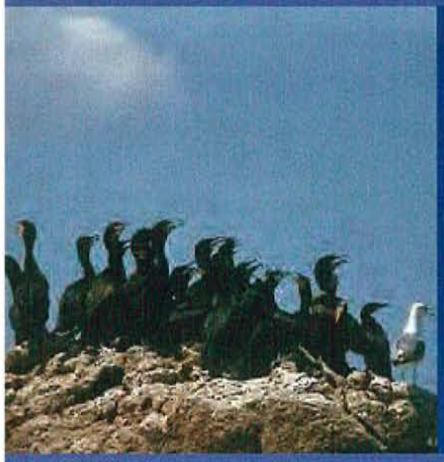
FIGURE 6.28: Tree wire on the top phase conductor of a two-phase distribution line (vertical configuration) with line marking devices.

SAMPLE



CHAPTER 7

Avian Protection Plans

IN THIS CHAPTER

- Overview of Avian Protection Plans
- Components of an Avian Protection Plan
- Creating and Implementing an Avian Protection Plan

An Avian Protection Plan is a voluntary, utility-specific plan that provides a framework for reducing bird mortalities, documenting utility actions, and improving service reliability. In 2005, the U.S. Fish and Wildlife Service and the Avian Power Line Interaction Committee jointly published Avian Protection Plan Guidelines to provide utilities with resources and guidance for developing Avian Protection Plans. This chapter is based on those guidelines.

OVERVIEW OF AVIAN PROTECTION PLANS

An Avian Protection Plan (APP) is a utility-specific program for reducing the operational and avian risks that result from avian interactions with electric utility facilities. In 2005, the Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service (USFWS) announced their jointly developed Avian Protection Plan Guidelines (*Guidelines*) that are intended to help utilities manage their avian/power line issues. The *Guidelines* offer resources for developing APPs and provide a toolbox from which utilities may select and tailor APP components to fit their needs. An APP should provide the framework necessary for developing a program to reduce bird mortalities, document utility actions, and improve service reliability. The APP components are summarized in this section. The complete version of the *Guidelines* can be obtained from either the APLIC (www.aplic.org) or USFWS (www.fws.gov) websites.

An APP represents a utility's commitment to reducing its avian impacts. Since they are created by a utility, APPs are more easily modified to address newly developing or unforeseen problems. Despite the fact that APPs are generally initiated by utilities, a cooperative dialog between the utility and the USFWS is encouraged during development and implementation. This sets the tenor for those conversations that will inevitably follow as the APP is implemented and refined over time.

Implementing the *Guidelines* will reduce avian collision and electrocution risks. An APP represents responsible environmental practices to all stakeholders, and a utility that creates an APP to address its specific avian issues can benefit through regulatory compliance, reliability improvements, potential long-term cost savings, and positive recognition from regulators, employees, and customers.

PREVIOUS VIEW

COMPONENTS OF AN AVIAN PROTECTION PLAN

Although each utility's APP will be different, the overall goal of reducing avian mortality is the same. The *Guidelines* provide a framework along with principles and examples to help a utility craft an APP to best fit its needs. Because of utility-specific circumstances, some of the *Guidelines*' elements may not be applicable. The *Guidelines* present a comprehensive overview of the elements that should be considered in an APP. The APP should also be a "living document" that is modified over time to improve its effectiveness. Some or all of the following elements may be implemented:

- Corporate policy
- Training
- Permit compliance
- Construction design standards
- Nest management
- Avian reporting system
- Risk assessment methodology
- Mortality reduction measures
- Avian enhancement options
- Quality control
- Public awareness
- Key resources

Details on the nature of these elements and how they may be developed by a utility are discussed on the following pages.

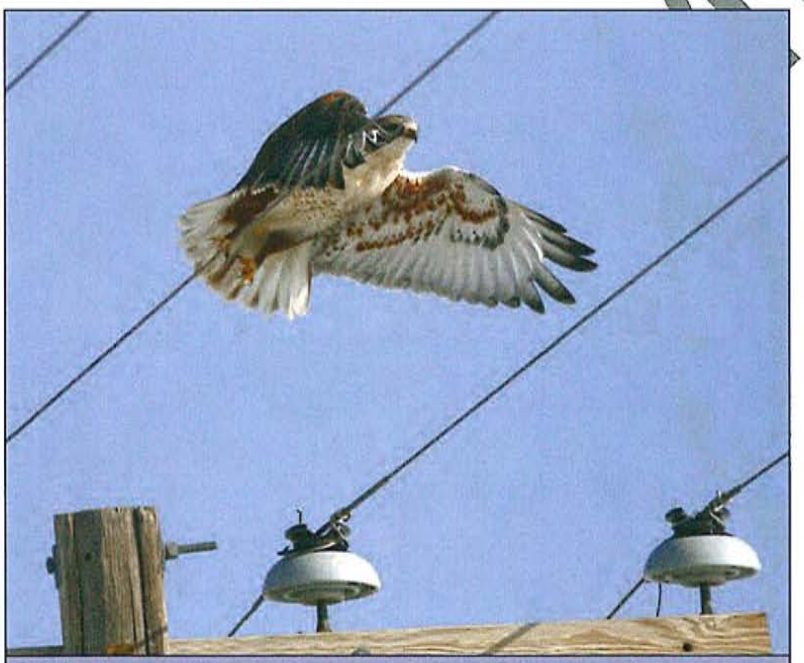


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FIGURE 7.1: Utility employee training should include the reasons and methods for reporting bird mortalities, nest management protocols, proper disposal of carcasses, applicable regulations, and the consequences of non-compliance.

CORPORATE POLICY

An APP usually includes a statement that balances the company's commitment to minimizing its impact on migratory birds, complying with bird-protection regulations, and providing reliable, cost-effective electrical service. To do this, it will comply with all necessary permits, monitor avian mortality incidents, and make reasonable efforts to construct and alter infrastructure to reduce the incidence of avian mortality.

TRAINING

Training is an integral component of an APP. Workshops and short courses on avian/power line interactions are provided by APLIC (www.aplic.org) and Edison Electric Institute (EEI) (www.eei.org). A two-hour overview of avian electrocutions and collisions intended for training use is also available to APLIC members through the APLIC website as part of the APP toolbox. Each company will have its own approach to training. All appropriate utility personnel, including managers, supervisors, line crews, engineering, dispatch, design personnel, and vegetation management personnel should be trained in avian issues. This training should encompass the reasons, needs, and methods for reporting avian mortalities, following nest management protocols, disposing of carcasses, complying with applicable

SAMPLE

regulations, and understanding the potential consequences of non-compliance. Supplemental training also may be appropriate when there are changes in regulations, personnel, permit conditions, construction standards, bird protection materials, or internal policies.

PERMIT COMPLIANCE

Each utility developing an APP should familiarize itself with the different avian regulations and permit types and should work with wildlife agencies to determine whether permits are required for operational activities that may affect protected avian species (see Chapter 3). An APP should discuss how this is done and identify company permits. Particular attention should be given to activities that may require special purpose or related permits, including but not limited to nest relocation, temporary possession, depredation, salvage or disposal, scientific collection, and miscellaneous. State permits may also be required to manage protected bird nests or for temporary possession of nests, birds, or their parts.

CONSTRUCTION DESIGN STANDARDS

To improve system reliability, avian interactions should be considered when siting and designing new facilities and when operating and maintaining existing facilities. For those reasons the accepted standards for both new construction and retrofitting for risk minimization should be included in an APP. Companies can either rely upon the recommendations in APLIC documents for electrocutions and collisions or develop their own standards that meet or exceed these guidelines.

An APP may indicate that all new or rebuilt lines in identified avian-use areas or potential problem areas be built to current standards for minimizing electrocutions and collisions. Employing avian-safe construction standards in such areas will reduce future legal and public relations problems and will enhance service reliability.

NEST MANAGEMENT

An APP may include procedures for managing nests on utility structures and in power line rights-of-way (ROW). This could include procedures for handling problem nests (ones that need to be relocated or removed) as well as for creating safe nest sites. These procedures should be explained to company employees during training to ensure uniform treatment of avian nest issues and compliance with regulations or permits related to nest management. For more detailed guidance regarding nest management, see *Suggested Practices for Avian Protection on Power Lines* (APLIC 2006).

AVIAN REPORTING SYSTEM

An avian reporting system is used for documenting bird injuries, fatalities, and nest management activities. This system should be described in the APP and designed to meet the needs of the utility and applicable avian permit reporting requirements. The reporting system should be compatible with a utility's other data management and analysis programs so this information can be effectively collected and recorded. The system could be based on paper forms or may be an internal web-based program. The information collected should be used to help a utility conduct risk assessments of avian problem areas and high risk structures or lines. To protect birds and minimize outages, these data can be prioritized for corrective actions. Avian information collected by a utility should be maintained internally. Reporting is required as a condition of the USFWS permit for direct *take* of birds or their nests (see Chapter 3).

The USFWS Office of Law Enforcement also maintains a voluntary, internet-based Bird Fatality/Injury Reporting Program.[18]

[18] The USFWS (2012) has been internally referring to this as the Bird Information and Mortality Reporting System. The title on the web page may assume this title as well (A. Manville pers. comm.).

SAMPLE

This program provides a clearinghouse of useful information for the electric utility industry to mitigate the impacts of energy delivery systems on birds and to address specific bird/power line problems on an incident-specific basis (USFWS 2009b). This database was designed to collect information about bird collisions and electrocutions to help with preventing future bird/power line incidents. It is also intended for utilities to see which structures pose a greater risk than others and under what conditions they occur. Utilities can establish a password-protected account with this voluntary program, and privacy and confidentiality are protected including several exemptions from the Freedom of Information Act (FOIA). The data collected include the characteristics of the fatality or injury, location, configuration of the equipment, environmental conditions, etc. To date (2012), at least 33 electric utilities have been voluntarily reporting through this program.

RISK ASSESSMENT METHODOLOGY

A utility can cost-effectively reduce avian mortalities by focusing its efforts on the areas of greatest risk. Therefore, an APP should include a method for evaluating and prioritizing the risks that a company's operations pose to migratory birds. A risk assessment will often begin with a review of available data that address areas of high avian use, avian mortality, problem nests, established flyways, migration corridors, concentration and staging areas, other preferred habitats, prey populations, perch availability, effectiveness of existing procedures, remedial actions, and other factors that can increase avian interactions with utility facilities. The avian reporting system discussed in the previous section is an integral component of this risk assessment, as is the use of avian experts, birders, and biologists who can provide additional information on avian distribution. A risk assessment can be used to develop models that will enable a company to use biological and electrical design information to choose an optimal route during corridor and ROW siting and to prioritize existing poles and lines most in need of modification. A risk assessment may also provide data about the various causes of avian mortality as well as the benefits birds receive from utility structures. For more discussion on avian risk assessment, see Chapter 5.

MORTALITY REDUCTION MEASURES

As a part of an APP, a mortality reduction process is described. A utility can use the results of an avian risk assessment to focus its efforts on areas of concern, ensure that its responses are not out of proportion to the risks presented to protected birds, and determine whether avian mortality reduction plans need to be implemented.

Mortality reduction plans may use strategies that include preventive, reactive, and proactive measures that focus on issues, risks, and reliability commitments facing a utility. The following are examples of how this multi-faceted approach may be used.

- **Preventive:** Construct all new or rebuilt lines in high avian-use areas to avian-safe standards. Apply collision minimization measures for new construction in high risk areas. Ensure that the APP is in compliance with applicable laws, regulations, and permits.
- **Reactive:** Document bird mortalities and problem nests, conduct assessment of problems, and apply remedial measures where appropriate. Notify resource agencies in accordance with the utility's permits and policies.
- **Proactive:** Provide resources and training to improve employees' knowledge and awareness. Partner with organizations that conduct research on effects of bird interactions with power lines. Evaluate risks of existing lines in high avian-use areas and prioritize structures or lines for retrofitting or mitigation according to their risk level.

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A successful APP and mortality reduction plan requires management support as well as the following:

- Assessment of facilities to identify risks
- Allocation of resources
- Standards for new or retrofit construction
- Budget for operation and maintenance and capital investment
- System for tracking remedial actions and associated costs
- Timely implementation of remedial measures
- Positive working relationships with agencies

An APP should be reviewed annually in the context of risk assessment and modified as appropriate, ideally with wildlife agency input.

AVIAN ENHANCEMENT OPTIONS

In addition to reducing avian mortality risk, an APP also may include descriptions of opportunities for a utility to enhance avian populations or habitat. These opportunities may include installing nest platforms, managing habitats to benefit migratory birds, or working with agencies or organizations in these efforts. Where feasible, new ideas and methods for protecting migratory birds should be encouraged and explored.

There are also opportunities to collaborate with agencies or organizations and to educate the public about the company's APP and its partnerships. USFWS and state wildlife agencies, as well as other experts, can be consulted for recommendations on habitat enhancement projects. Nest box construction, maintenance, and monitoring can be done in conjunction with volunteers, such as Boy Scouts, Girl Scouts, and avian/wildlife conservation organizations.

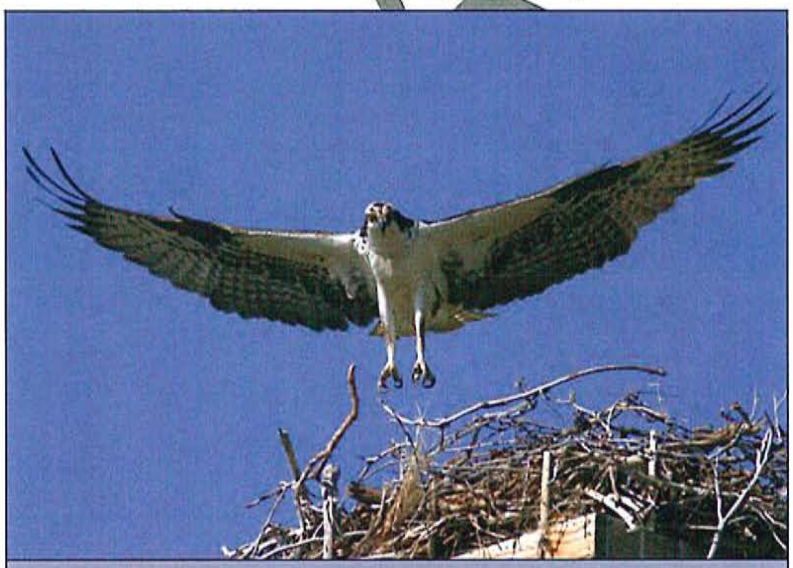

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FIGURE 7.2: An Avian Protection Plan may include opportunities to enhance avian populations or habitat with nesting structures, habitat restoration, or other projects.

QUALITY CONTROL

A quality control mechanism can and should be incorporated into an APP to evaluate the effectiveness of a company's avian protection procedures. Some examples of quality control include the following:

- Effectiveness of remedial actions in reducing avian mortality
- Effectiveness of avian protection devices as well as their ease of application and durability
- Mortality reporting procedures to ensure that discoveries of avian mortalities are properly documented
- Response to avian mortalities to ensure that appropriate and timely actions are taken
- Compliance with company policy to ensure that personnel are consistently following company procedures for avian-safe construction, mortality reporting, nest management, training, etc.
- Public and agency feedback and opinions on system reliability and avian protection

The quality control component of an APP is a continuous process that is used to ensure that a company's APP is accomplishing what

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it is intended to do. Information gathered during assessments of existing practices should be used to improve the effectiveness and timeliness of avian protection efforts, which, in turn, can help to reduce costs associated with such efforts.

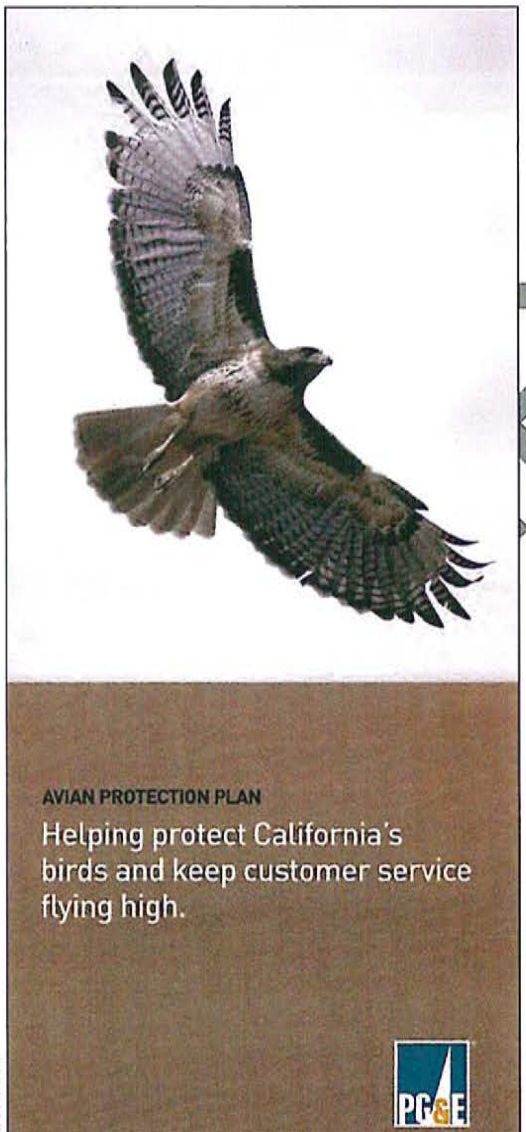

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FIGURE 7.3: Raising public awareness about avian collisions and the utility's commitment to avian protection can increase support for an Avian Protection Plan.

PUBLIC AWARENESS

An APP may include a method for educating the public about avian collision issues, the company's avian protection program, and its successes in avian protection. A public awareness program can be an integral part of an APP and can be used to enhance public awareness and support for a company's APP. Public participation allows stakeholders such as government agencies, tribes, non-profit organizations, wildlife rehabilitators, and other interested parties an opportunity to provide input to the decision-making process, enabling all parties to work openly and collaboratively towards recommendations that can be effectively implemented. This collaboration often leads to improved relationships within the community and to more efficient and positive projects (see Chapter 5). The relationships developed through this process may also encourage the public to report bird mortalities and encourage them to seek assistance for birds that have been injured in power line-related accidents.

Communicating an APP can be accomplished through a variety of public outreach tools, including fact sheets, newsletters, brochures, videos, websites, public workshops, short courses, special training sessions, and speaker bureau presentations. These tools can also be used to record the success of an APP, thereby documenting the utility and electric industry's efforts to reduce avian mortalities. The goal of these outreach efforts is to convey to the public that electric utilities are responsible environmental stewards working cooperatively with wildlife agencies towards reducing avian mortalities while continuing to provide safe, reliable, and affordable electricity to their customers.

Many utilities have examples of their environmental stewardship and of the innovative ways they have reduced environmental impacts through their business decisions. A company's efforts to minimize avian mortalities should

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be shared with the public and resource agencies. For more information, see *Public Participation* in Chapter 5.

KEY RESOURCES

An APP should identify the key resources that address avian protection issues. Key resources include utility personnel and external contacts. This would include a list of experts who may be called upon to help resolve avian-caused problems. Experts could include company specialists, consultants, state and federal resource agents, university faculty, or other biologists. Internal personnel may include representatives from environmental, engineering, operations and maintenance, standards, procurement, outage management, etc. Engineers may find that company personnel such as environmental specialists (or biologists) can help find creative solutions to avian interaction problems. An understanding of avian behavior can also influence how and when avian protection should be provided. An APP that connects biologists with utility decision-makers may reduce bird mortality and improve system reliability.

Members of organizations like APLIC can help with workshops, materials, and contacts. External resources may include biologists and law enforcement agents from wildlife agencies, avian specialists from NGOs or universities, wildlife rehabilitators, and industry consultants. Utility industry resources include APLIC, EEI, Electric Power Research Institute, Institute of Electrical and Electronics Engineers, National Rural Electric Cooperative Association, and the Rural Utilities Service. Contact information and websites for a number of resources are available in the *Guidelines* (see www.aplic.org).

CREATING AND IMPLEMENTING AN AVIAN PROTECTION PLAN

Integrating an APP into an electric utility's operations will help the utility meet demands for reliable, cost-efficient, and environmentally compatible power delivery. A utility that creates and manages an APP will quickly become familiar with the avian-related science, engineering, and laws. It will also need to satisfy utility employees, utility customers, investors, and other stakeholders.

The ease of creating and implementing an APP will depend on a utility's size, the location of its transmission and distribution system, the range of avian species in the service area, and the frequency of bird/power line interactions. The extent of bird/power line interactions may not be realized until several years into a fully implemented reporting program. Thus, APP implementation and operation is a long-term commitment and a process of continual evaluation and improvement.

Depending on the company's culture, the rate of adoption may vary. An APP may be the first species-oriented environmental compliance initiative to which utility employees are exposed. High-profile endorsements by corporate officers and managers can facilitate a program's implementation. Some larger utilities have effectively linked APP compliance with financial incentives, similar to more common budget, schedule, and safety incentives. Compliance with an APP will reduce utility costs in the long term through improved reliability and reduced regulatory risk.

Creating and implementing an APP will be more successful if all the affected departments within the utility also support it. An effective way to build a broad consensus during APP preparation is to form a team within the utility that includes representatives from standards, engineering, environmental services, vegetation management, construction, operations and maintenance, public relations, customer service, and other departments that will be impacted by the APP. Considerable input and assistance from team members are needed to understand how APP implementation will

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FIGURE 7.4: Integrating an Avian Protection Plan into an electric utility's operations will help the utility meet demands for reliable, cost-efficient, and environmentally compatible power delivery while protecting and enhancing bird populations.

best fit the operations of each department. Solutions to reduce avian mortality can be developed that are responsive to the work requirements of each functional unit. In this manner, individuals from each department will feel invested in the mortality reduction solutions they helped develop and will have an interest in assuring APP effectiveness.

Beyond developing and communicating a corporate APP policy, the most important component of an APP is a consistent and mandatory reporting process. An electronic or paper form of documenting bird/power line conflicts (e.g., time, place, equipment) becomes the foundation for appropriate corrective action—both to correct unsafe situations and to build a dataset to guide future engineering/construction needs. Managing data for these purposes, as well as for meeting any state and federal agency reporting requirements, is an important function of APP administration. Using GIS technology to track and report bird mortalities, remedial actions, outages, and avian risks enables a utility to identify problems and to track the effectiveness of its APP.

Use of existing processes and systems (e.g., outage reporting, environmental review, asset management, and accounting) will help control costs of developing and implementing an APP. Whether an APP is driven by an environmental, engineering, or operations department, cooperation will be necessary across all departments to reduce actual and potential avian/power line conflicts. As with any project, better planning yields better results. The goals of an APP are a measurable decrease in avian/power line injuries and mortalities and an increase in electric service reliability—ultimately benefiting the birds, the utility, its customers, the regulators, and the affected public.

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APPENDIX A

Literature Cited and Bibliography

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APPENDIX B

Designing Site-Specific Studies for Collision Monitoring

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With any study design for collision monitoring it is important that the resulting data can be compared to similar studies (see *Variability of Reported Mortality Rates* in Chapter 4 and *Effectiveness of Designs* in Chapter 6). The information in this appendix will help you design site-specific study methods that produce useful and comparable results. Table B.1 summarizes the considerations and issues presented in this appendix.

TABLE B.1: Summary of considerations and issues for designing site-specific collision monitoring.

Considerations for Site-Specific Collision Monitoring	Issues Related to Estimating Mortality Rates
Behavioral Monitoring • Bird density • Evaluation criteria • Estimating bird flight height • Radar observation and detection • Metrics • Study segments	Equations for Calculating Mortality Rate • Accuracy • Variability in methods
Mortality Monitoring • Differences in sampling design • Questions to ask • Data to record • Remote sensing	Sampling Biases • Crippling loss • Searcher efficiency • Scavenger removal • Habitat differences

CONSIDERATIONS FOR SITE-SPECIFIC COLLISION MONITORING

BEHAVIORAL MONITORING SURVEYS

The most direct way to determine how collisions are occurring is to observe behavior as birds are approaching, crossing, or colliding with power lines. Behavioral monitoring is used to characterize the birds' reaction to lines by giving each reaction a behavioral avoidance value. In line modification studies, behavioral monitoring can be used to measure the effectiveness of line marking devices.

Bird Density

Past studies (e.g., Bevanger 1999; Janss 2000) have counted collisions per flyby (observed collisions per number of birds flying by a line). With high bird density, counting collisions per flyby is feasible. But with low bird density, counting flybys is not practical because so few observations can be made, even over an extended period of time. Direct observation can be especially time consuming with low bird density or intermittent high bird density. Observations may also be restricted by poor visibility due to weather or time of day. In such cases, the most feasible method may be to conduct mortality monitoring to estimate collisions (see *Mortality Monitoring Surveys* on page 141). Bird collisions with power lines can also be detected with remote sensing devices (see *Remote Sensing* on page 142), although they do not yield behavioral and species data.

Evaluation Criteria

A study's behavioral criteria may include the type of reaction to lines, distance from the line when the reaction occurred, and height above the line when crossing. Because estimates are provided by different observers, all observers must be trained and given time to practice before the study begins, and the same observers should be used throughout the study when possible to minimize observer bias. Records of approach, crossing, and departure heights should be kept. If behavioral avoidance is observed, the reaction to and distance from the line should be recorded. The following are possible reaction categories and definitions:

- No reaction—Birds maintain constant altitude and unaltered flight
- Swerve and over—Birds turn from course, flying up and over line
- Swerve and under—Birds turn from course, flying down and under line
- Over and swerve—Birds flying over line swerve immediately after crossing the lines
- Turn and leave—Birds turn and retreat from the line after approaching within 50 meters (m) (164 feet [ft]) of the line
- Collision and fly—Birds in flight hit a line but keep flying outside of the transect boundaries
- Collision and fall—Birds in flight hit a line and drop within the study transect (the specific line should be noted in the comments section)
- Land on line—Birds land on line or pole

Estimating Bird Flight Height

Bird flight altitude information should be estimated relative to the structure height and the height of phase conductors, neutral wires, and shield wires. Height classes will vary depending on the type of power line (e.g., conductor arrangement, voltage) and the species studied. Figure B.1 provides an example of altitude classes for transmission lines. Since power lines will vary in design, site-specific altitude criteria should be developed.

The manner of recording flight altitude should be modified according to line configuration and the species studied. If the wires are in the same horizontal plane, then the area included in the study is above and below the line for a certain number of meters (feet). If the wires are in a vertical configuration, then the area observed is above and below the multiple planes including the shield wire and a distribution underbuild if present. If the structure type is an H-frame, then the obser-

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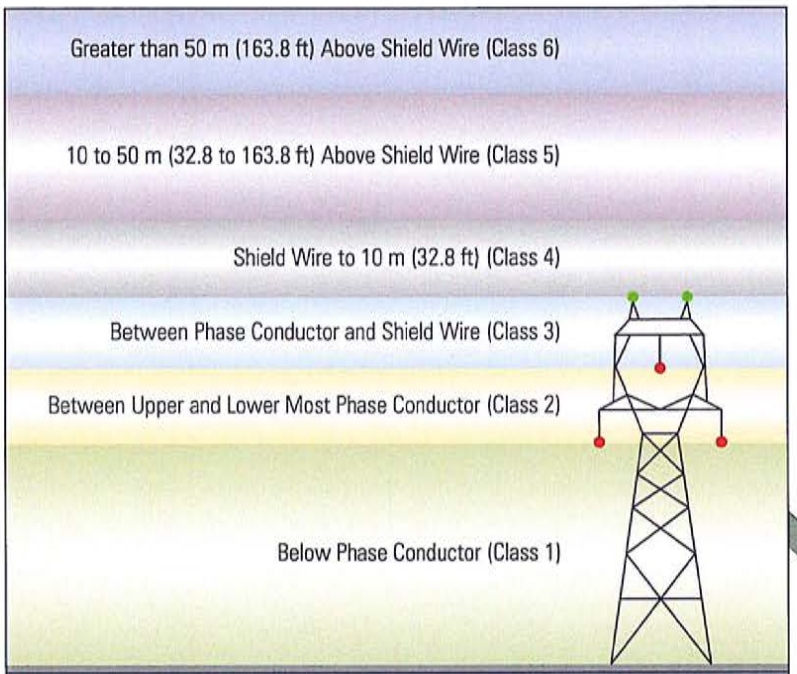

FIGURE B.1: Classes used to describe birds' approach, crossing, and departure altitudes in collision studies on transmission lines (after James and Haak 1979).

vational box might be different than if the tower is steel lattice or a V-shape supported by guy wires. The size of the line structure may warrant extending the observational area farther from the poles (i.e., begin recording at 30.5 m (100 ft) away from a distribution single pole, but 152.4 m (500 ft) from a steel lattice transmission tower) in order to account for reaction times related to the size of the structure and the height and arrangement of the lines.

Bird flight height can be estimated and measured in various ways with varying degrees of expense, effort, accuracy, and efficiency. Visual categorization, rangefinders, and radar systems can all collect data on the flight height and each approach has its advantages and disadvantages (see *Radar Observation and Detection* on page 140). When choosing which techniques to use, the following must be considered: project goals, species identification and concentration, migration data, and project budget. For example, if the major bird migration occurs in spring, data needs to be collected for a sufficient period in the spring to characterize bird movement and behavior. If you need to estimate the overall impacts of the mortality to the local bird population, you will need an understanding of that population in the area surrounding the study site throughout its seasonal fluctuations including breeding, migration, and wintering.

One of the simplest field techniques for estimating flight height is to visually categorize height, such as above the lines, below the lines, etc. This approach only requires a known reference point in the field. Survey flags and reaction zones can help observers estimate the distance from the line and the section of the line as they record behavioral avoidance. For example, survey flags can be placed 5 m (16.4 ft), 5 to 25 m (16.4 to 82 ft), and >25 m (>82 ft) from the line (Brown and Drewien 1995). This technique works well in terrestrial situations and eliminates the need for a rangefinder. In another approach, a reaction zone of 200 m (656.2 ft) on each side of a 500-kV transmission line has been used (Willdan Associates 1981, 1982).

This approach can be expanded by using visual estimation in conjunction with electronic rangefinders, which are used to measure the height of reference structures in the field. Electronic rangefinders come equipped with a laser and built in clinometers, which measure straight line distance to the bird and the angle of the measurement above horizontal. The measurements can be used to estimate an object's (bird's) height above ground. Height is calculated as:

SIN([Angle[1]])*[Distance to Object] = Flight height

[1] if calculating in Excel use the radian function to convert degree units into radians so the number will be compatible with the SIN function

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Once the heights are known for several tall objects in the area, bird flight heights can be estimated. This approach can be further expanded by directly measuring the flight heights of birds using an electronic rangefinder. This approach can be effective if birds are in close range and are big and reflective enough to bounce a signal back to the rangefinder. Other factors that affect successful measuring of flight height using the rangefinder include:

- Distance of the observer to the bird (shorter distances reflect better signals)
- Size of the bird (larger birds reflect the laser better than smaller birds)
- Reflectivity of the bird (white birds reflect the signal better than dark birds; Klimentjew et al. 2010; M. Schriner, pers. comm.)

A limitation of measuring bird flight height directly is that it is difficult to record multiple heights simultaneously. In areas where bird passage rates are high, multiple observers, digital tape recorders, or video cameras may be needed to adequately capture multiple measurements of flight height.

Radar Observation and Detection

Although the use of radar in power line studies is not common, it is a useful tool for characterizing bird movements. Two types of radar, Nexrad and portable radar, have been used in bird studies to collect data on nocturnal movements and broad front migrations, which may be missed by field observations. Nexrad radar (Next-Generation Radar) is a network of Doppler weather radars operated by the National Weather Service. Nexrad radar has the advantage of being able to collect data on the density of targets within an area and examine the temporal variation in target activity over many years. Portable radars are smaller and include systems such as modified marine, pencil beam tracking, and other specialized radar systems. Portable radar collects data on flight height, direction, and speed of targets and can distinguish different size classes of targets which provides some level of certainty as to what is being detected (e.g., songbirds versus herons).

Despite the unique information that radar can collect, it does have limitations. Nexrad cannot distinguish between birds, bats, and insects, and the height of airspace that is surveyed is dependent on the distance from the Nexrad station. Portable radar detects targets (e.g., birds, bats, insects, weather, etc.) in flight and can classify them by size and speed and movement patterns (R. Larkin, pers. comm.). Software filters can help refine target specificity by removing weather images, leaving images of desired targets. While size classes can be used to indicate species groups to some extent, distinguishing between species groups that are of similar size is not possible. Ground clutter, visual obstructions, and inclement weather can also limit the ability of radar to detect objects at a distance. The longer the distance between radar and subject, the more likely ground clutter will interfere. Finally, the cost of radar systems can be high, which limits their applicability.

Metrics

Metrics used in behavioral observations of collisions are generally expressed as the number of observed collisions per number of birds flying by a line (flybys), often expressed as a percentage. For example, Meyer (1978, cited in Bevanger 1998) observed the number of collisions to be 0.003% to 0.07% of flybys for waders and gulls. Janss and Ferrer (2000) reported collisions per flyby as 3.93×10^{-5} for the common crane (*Grus grus*) and 6.34×10^{-3} for the great bustard (*Otis tarda*).

Study Segments

It is essential that study segments represent the line as a whole (unless there is a need to identify high risk areas), that test and control segments be of comparable length, and that

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they have as much environmental homogeneity as possible. Variability will be reduced by including an adequate number of test and control segments. Contiguous segments are convenient but not essential. Koops and de Jong (1982) marked alternating spans, and Brown and Drewien (1995) marked alternate 0.8-kilometer (km) (0.5-mile [mi]) segments of eight different test lines. The length of study segments may vary according to bird density, seasonal use, habitat type, size of the power line, etc. However, in line modification studies it is important that test and control segments are separated sufficiently so control segments are not affected by the presence of markers on the test segments. Thus, when evaluating markers on small distribution lines that have short spans (pole to pole distance), each test and control segment should consist of several spans. Barrientos et al. (2011) provides recommendations on reasons for standardizing segment length.

MORTALITY MONITORING SURVEYS

The most common way to determine if collisions have occurred is to survey the power line right-of-way (ROW) for dead and injured birds and attempt to identify the cause of injury or death. Mortality monitoring surveys provide a more accurate assessment of collision mortality.

Differences in Sampling Design

There are numerous monitoring approaches and each has different strengths and weaknesses (e.g., APLIC 1994; Bevanger 1999; Hunting 2002). Mortality surveys conducted through 2011 generally differ in sampling design including:

- Segment selection
- Lengths of lines sampled
- Width of the area sampled
- Duration and intensity of the study
- Seasonal sampling

The fact that all these considerations are not routinely included leads to difficulty in comparing studies (Hunting 2002; Barrientos et al. 2011). Typically the sampling biases (i.e., searcher efficiency, crippling loss, scavenger removal, and habitat differences; see *Sampling Biases* on page 143), which need to be accounted for to correct the estimated mortality rates, are not implemented systematically or in a manner that is consistent with the expected monitoring program survey designs. In addition, because of sampling uncertainty, a variety of statistical methods are applied to estimate the actual number of birds affected based on the number of birds found.

Site-specific study designs and correction factors need to be developed for mortality monitoring to account for these variables. Bevanger (1999) concluded that, given the site-specific factors and local conditions (e.g., biological, environmental, and engineering) that influence collision and mortality estimation, it is not expedient to develop a set of standard study design methods or use general correction factors. Barrientos et al. (2011) presented three recommendations for conducting line marking device effectiveness studies that also apply to mortality monitoring:

1. Collecting data on carcass counts and flight frequency for the same length of time and at the same time of the year at marked and unmarked wire segments
2. Studying marked (test segment) and unmarked (control segment) lines in areas with similar vegetation and topography, with similar lengths of time spent searching for carcasses, and with transects of equal lengths and widths
3. Standardizing the timing of carcass searches and search area widths

For search area width, searches should cover the width of ROW with reference to the height of the power line (James and Haak 1979; Raevel and Tombal 1991) and the zone in which carcasses are expected to fall.

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Questions to Ask

The study design phase should focus on the questions being asked, the data needed to answer these questions, and the appropriate methods, including duration and intensity, to provide those data. A series of hierarchical questions that need to be considered may include the following:

1. Are collision injuries and/or mortalities occurring?
2. What species of birds are involved? Are they protected species?
3. Where along the power line are the birds colliding?
4. When are they being killed?
5. Under what circumstances (e.g., weather, time of day) are they being killed?
6. What biological, environmental, and engineering factors appear to be important in influencing collisions?
7. What line modification actions can be taken to reduce these collisions?

Questions 1 and 2 are the simplest to answer if the carcasses are detected. Many of the past studies have focused on answering the first two questions and sometimes 3 and 4. More recent studies have attempted to address questions 5, 6, and 7. There is a tendency to focus on sampling worst-case situations or locations where high numbers of collisions have occurred as opposed to sampling representative locations along a given power line to understand the overall collision risk. Although results from worst-case situations may skew general mortality risk, determining this information is still important because it provides data needed for reducing risk.

Data to Record

For each bird found, the following information should be gathered when possible:

- Location of the carcass in proximity to the power line (e.g., GPS position)
- Species
- Sex
- Age: adult or juvenile
- Date or approximate time of death
- Physical injuries and conditions (e.g., broken bones, lacerations, abrasions, blood, discolorations, gunshot wounds, decomposition, feather spots, feeding by scavengers)
- Probable cause of death
- Necropsy[19]

Environmental conditions should also be recorded, especially visibility, wind speed and direction, weather events, avian habitats, as well as the type and abundance of bird species in the study area.

Remote Sensing

An alternative to directly observing bird collisions is to use a Bird Strike Indicator (BSI). BSI is a vibration sensing and recording tool that is fitted to a power line to detect collisions with that line. It is especially useful for monitoring collisions in low-light or no-light conditions. However, BSI does not identify what species struck the line; mortality monitoring or field observations would be required to determine this. See Chapter 5 for a discussion on the BSI.

[19] In the United States, the possession of any protected migratory bird will require a Special Purpose or Scientific Collecting permit (see Chapter 3), unless otherwise instructed by an agent of U.S. Fish and Wildlife Service Office of Law Enforcement.

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ISSUES RELATED TO ESTIMATING MORTALITY RATES

EQUATIONS FOR CALCULATING MORTALITY RATE

Accuracy

Few mathematical equations for estimating mortality have been tested for accuracy using experimentally designed, rigorous field studies (Bevanger 1999). Furthermore, there are no agreed upon methods that link the equation to the type of field trials necessary for site-specific calculation of mortality, nor are methods for incorporating uncertainty often provided.

These issues are not unique to power lines. Similar uncertainty is found in calculating actual mortality from estimates of bird carcasses collected from wind turbine collisions, building window collisions, pesticide application, and avian diseases. Although the causes of mortality are different, the ability to find bird carcasses in the field is affected by the same sampling biases (i.e., crippling loss, searcher efficiency, scavenger removal, and habitat differences; see discussion on this page). Huso (2011) evaluated the accuracy and precision of mortality estimators for power lines and other structures and proposed one that improves reliability. This limitation in calculating mortality rates is also presently being investigated by the wind industry, U.S. Fish and Wildlife Service, U.S. Geological Survey, and others. The California Energy Commission (CEC) is funding a controlled field study through the California Wind Energy Association strictly looking at the mathematical relationships of scavenger removal and searcher efficiency as they relate to calculating actual mortality rates. The study report should be available in 2012 (J. Newman, pers. comm.).

Variability in Methods

While designing a study, the most recent literature on mortality rate calculations should be reviewed before selecting a particular method. Bevanger (1999) and Hunting (2002) provide an excellent review of collision mortality for power lines. A mortality rate of the number of carcasses/distance of line surveyed/time period is the most commonly used metric found in the literature. However, the search area (i.e., estimated annual mortality/hectare/kilometer [/acre/mile]) also needs to be included (Hunting 2002).

Finally, as mentioned earlier, there is great variability in monitoring methods, which prevents useful comparison of mortality rates and effectiveness of markers to reduce collisions.

SAMPLING BIASES

When conducting mortality monitoring, the mortality rate calculation must take a number of sampling biases into account, including the following:

- Crippling loss
- Searcher efficiency
- Scavenger removal
- Habitat differences

Crippling Loss Bias

The crippling loss bias occurs when birds strike a line and fall outside the search area or when injured birds move out of the search area and are not observed by searchers. Bevanger (1999) cites several studies that found 22% (Hiltunen 1953) to 50% (Renssen et al. 1975) to 74% (Beaulaurier 1981) of birds fatally injured in power line collisions move far enough away from the power line before dying that they are not found during carcass searches.

In Beaulaurier's (1981) study, crippling loss bias was defined as the percent of observed collisions in which birds continued flying out of the study area after the collision. Because she did not observe a collision during her study, she used an estimate of 74%—the average measure of crippling loss bias calculated by Meyer (1978) as 75% and James and Haak (1980) as 73%. These authors assume

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a worst-case estimate with all injured birds dying from their injuries. The estimates were also based on collisions with shield wires.

Because great time and effort are involved in monitoring flights and recording collisions, crippling loss bias estimates are extremely difficult to obtain and they are the least likely to be calculated in a study. Application of estimates from other studies is inappropriate, and, in fact, very misleading. Once again, the size of the bird may make a significant difference because of flight dynamics. A crane or swan that just tips a line is more likely to tumble to the ground and sustain fatal injuries than is a smaller, lighter bird that may be able to recover its flight mid-air and die later at some distance from the line (W. Brown, pers. comm.). Consequently, smaller birds might have a higher crippling loss bias than larger birds. This may need to be examined in future research.

Searcher Efficiency Bias

During carcass searches, some of the carcasses will be missed depending on several variables (e.g., number of observers, their skill and experience, and how the surveys are conducted). This is called searcher efficiency bias or searcher bias. Searcher bias is also influenced by vegetation type, height, and density, search pattern, presence of waterbodies, bird size, and other factors (Bevanger 1999; Erickson et al. 2005). Searcher bias in carcass detection must be carefully controlled (Bevanger 1999; Erickson et al. 2005). Searcher efficiency biases are specific to the site and the season. Bias needs to be determined while the mortality monitoring is taking place and not extrapolated from or to other locations, seasons, or studies (Bevanger 1999; Barrientos et al. 2011). APLIC (1994) and Bevanger (1999) give examples of the calculations for determining searcher bias. CEC is also studying searcher efficiency factors for calculating wind turbine-caused bird mortality.

The use of trained dogs in mortality monitoring studies can increase carcass recovery, particularly of small carcasses in dense vegetation (Homan et al. 2001; Anderson 1978; Rusz et al. 1986; Bevanger 1995, cited in Bevanger 1999). However, the availability of trained dogs is limited and their efficiency varies with individuals, seasons, weather conditions, vegetation structure, breed, length of use, and level of fatigue.

Scavenger Removal Bias

Scavengers may remove carcasses before a search is completed, which results in underestimating mortality. Scavenging rates are very important to include in mortality rate estimation (Bevanger 1999; Rivera-Milan et al. 2004; Erickson et al. 2005; Gehring et al. 2009). Bevanger (1999) gives an example of the calculation. Scavenging rate varies by habitat, season, time of day, scavenger type, bird size, bird species, etc. (Bevanger 1999; Erickson et al. 2005). Evidence of seasonal variation in scavenging rates in United Kingdom farmland is presented by Prosser et al. (2008).

In some cases scavenging can be a quick process, occurring in a matter of minutes depending on the scavenger species as well as the bird species involved. A review of the scavenging studies from various mortality monitoring studies (including power lines, communication towers, wind turbines, pesticide application, and bird disease) indicates that the majority of scavenging takes place within a short period of time after death for many species. For example, preliminary results of a scavenging removal study at one communication tower location on the Alaska Peninsula suggest that carcass removal from scavenging is as high as 50% removal per day (P. Flint, USGS pers. comm.; E. Lance, USFWS pers. comm.; USFWS 2007 unpubl. Data, cited in Manville 2007a); scavenged carcasses included eiders, waterfowl, and shorebirds,

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among others. This degree of scavenging is consistent with what Herbert Stoddard (Crawford and Engstrom 2001) found in a 29-year study of a communication tower in Florida where about 92% of carcasses were removed by scavengers within 24 hours. Peterson et al. (2001) reported that in British Columbia, Canada, 52/54 poisoned waterfowl carcasses were discovered by avian scavengers within 72 hours. Kostecke et al. (2001) reported carcasses scavenged mostly by skunks with 66% of carcasses scavenged within five days in a South Dakota study. Erickson et al. (2005) cites a number of case studies with average carcass persistence times ranging from less than one to 28 days. In other cases it can be longer (Brown and Drewien 1995). They found that crane carcasses sometimes remained for as much as a year after death and that no crane carcasses were removed by scavengers during the removal studies. Likewise, large bird carcasses (e.g., raptors, pelicans) may persist for extended periods (several months to 32 months) without scavenger removal (S. Liguori, pers. comm.). Raevel and Tombal (1991) and others have noted that removal bias varies with the size of the birds (i.e., smaller birds usually disappear more quickly and more frequently). Consequently, the effects of size and perhaps species must be included in calculations of removal bias for a study. In controlled studies where a known number of carcasses were placed in the field showed that many carcasses were removed within a short period time, e.g. days; however, even small birds can persist in the field for long periods of time as they become desiccated and less preferred for scavenging.

Scavenger removal bias is site-specific and needs to be determined when the mortality monitoring is taking place rather than extrapolating it from other locations, seasons, or studies (Bevanger 1999). Scavengers can quickly learn where carcasses or injured birds are readily available, suggesting the need to update these bias correction factors throughout the study, as needed, to account for learning behavior.

Habitat Differences Bias

Habitat bias is used to account for unsearchable areas. Some portions of a study area may not be searchable because of water, bogs, dense vegetation, or topography. Researchers should not extrapolate beyond the area sampled because the rate of collision may vary with habitat type. Habitat bias should be used only in situations where unsearchable habitat is finely interspersed with searchable habitat and where researchers can demonstrate that the numbers of birds found in searchable and unsearchable habitats are similar.

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APPENDIX C

Glossary

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adult
A bird that has acquired its final plumage.

aspect ratio
Aspect ratio is the wing breadth divided by wing length. A low aspect ratio generally correlates with relatively thin wings and high aspect ratio with relatively wide wings.

avian-safe
A power pole configuration designed to minimize avian electrocution risk.

circuit (multiple)
A configuration that supports more than one circuit.

circuit (single)
A conductor or system of conductors through which an electric current is intended to flow. The circuit is energized at a specified voltage.

conductivity
The capacity to transmit electrical energy.

conductor
The material (usually copper or aluminum)—usually in the form of a wire, cable, or bus bar—suitable for carrying an electric current (AC, DC, and shield); a material that offers little resistance to the flow of electricity.

conductor gallop
Also known as galloping. The high-amplitude, low-frequency oscillation of overhead power lines often due to wind. The movement of the wires occurs most commonly in the vertical plane, although horizontal or rotational motion is also possible. Galloping can cause power lines to slap together, which results in outages and damage to the lines and equipment. Icing conditions, wind velocity, and conductor tension are some of the factors that interact to cause galloping.

configuration
The arrangement of parts or equipment. A distribution configuration would include the necessary arrangement of crossarms, braces, insulators, etc. to support one or more electrical circuits.

conspecific
Members of the same species.

corona
A process by which current in a conductor with a high potential ionizes the air surrounding it to create a plasma. The ions generated eventually pass charge to nearby areas of lower potential or recombine to form neutral gas molecules.

corridor
The broad area between the origin and termination of a new line, within which the potential routes lie. The area in which a new line's routing alternatives are proposed and evaluated before the final route is determined.

corvid
Birds belonging to the family Corvidae; includes crows, ravens, magpies, and jays.

crossarm
A horizontal supporting member used to support electrical conductors and equipment for the purpose of distributing electrical energy. Usually made of wood, fiberglass, or steel, and manufactured in various lengths.

current
A movement or flow of electricity passing through a conductor. Current is measured in amperes.

distribution line
Lower-voltage wires, energized at voltages from 2.4 kV to 60 kV, and used to distribute electricity to residential, industrial, and commercial customers, i.e., end users.

facility
As used in this manual, this term refers to all the equipment, wires, structures (e.g., poles and towers), etc., that are involved in carrying electricity.

fault
A power disturbance that interrupts the quality of electrical supply. A fault can have a variety of causes including fires, ice storms, lightning, animal collisions/electrocutions, or equipment failures. Also known as arc, short circuit, or flash.

flappers
Suspended collision reduction devices that clamp to and hang from a line and swing and spin in the wind. There are variations on this theme that have little or no motion, which are used when high winds cause moving parts to wear rapidly.

flaring
A sudden panic avoidance reaction to power lines, in which birds ascend almost vertically with rapid wing beats or fold their wings and fall down and backwards away from the obstacle.

fledgling
A bird that has recently learned to fly and left the nest, but may still be dependent on its parents for food.

ground
Material that conducts electricity and makes an electrical connection with the earth.

ground rod
Normally a copper-clad steel rod or galvanized steel rod, driven into the ground so that the necessary parts of a facility can be physically connected to ground potential.

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grounding conductor
A conductor used to ground the shield and neutral wires. Grounding conductors may be copper-clad, solid copper, or stranded galvanized wires and are attached to the structure. Sometimes also called a down wire. When steel structures are used the structure becomes the grounding conductor.

guy
Secures the upright position of a pole and offsets physical loads imposed by conductors, wind, ice, etc. Guys are normally attached to anchors that are securely placed in the ground.

immature
All plumages other than adult.

juvenile
(Plumage)—first plumage of a bird.
(Bird)—a bird in its first year of life.

Kilovolt (kV)
1,000 volts

latticework
The combination of steel members connected together to make complete structures, such as transmission towers or substation structures.

lightning arrester
An electrical protection device used to divert the energy of lightning strikes to the earth.

lightning days
Lightning or thunderstorm days. A day with one or more lightning storms would be classified as a lightning day.

maneuvering
Any change in flight behavior, height, or direction, and in this context, in response to obstacles such as power lines.

necropsy
Postmortem examination of wildlife often used to determine cause of death.

nestling
A young bird that has not yet reached sufficient size and maturity to leave the nest.

neutral wire
A non-energized conductor that carries the primary current back to its substation. The neutral is at ground potential (i.e., it grounds a distribution power line system).

outage
Event that occurs when the energy source is cut off from the load.

overhead ground wire
See shield wire.

phase conductor
An energized power line that carries alternating current electricity.

phase-to-ground
The contact of an energized conductor to ground potential. A bird can cause a phase-to-ground fault when fleshy parts of its body touch an energized phase and ground simultaneously.

phase-to-phase
The contact of two energized conductors. Birds can cause a phase-to-phase fault when the fleshy part of their wings or other body parts contact two energized conductors of different phases at the same time.

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pole

1. A vertical structure used to support electrical conductors and equipment for the purpose of transporting electrical energy. It can be made of wood, fiberglass, concrete, or steel and manufactured in various heights.

2. DC transmission lines use bundled conductors also known as poles, which refers to the positively and negatively charged conductors in a DC design.

power generation facility
The location where electricity is generated, which may be a power plant, station, wind turbines, solar farm, or hydro-electric dam, among others.

power line
A line made of conductive material that transmits electricity from its source to its point of use.

ramping
A contemplated maneuver frequently seen in wading birds approaching a power line at or below conductor levels. During their approach waders swerve and continue parallel to the power line until sufficient altitude is reached for crossing. Ramping is most frequently observed on clear days with moderate winds and apparently allows birds to assess and negotiate the power line before crossing.

raptor
Bird of prey. Raptors are members of the orders Falconiformes (diurnal raptors) and Strigiformes (owls). Raptors have a sharp hooked bill and sharp talons used for killing and eating prey.

rebuild
The act of upgrading an existing line by replacing its wires and/or structures.

reliability
The percentage of time a line is delivering uninterrupted electricity.

reroute
The act of removing an existing line from the original right-of-way and rebuilding it along another route that will avoid the interactions encountered in the original route.

retrofit
The modification of an existing electrical power line structure to make it avian-safe.

right-of-way (ROW)
The strip of land that has been acquired by an agreement between two or more parties for the purpose of constructing and maintaining a utility easement. The width of right-of-way required by each voltage level is generally dictated by state statutes and the National Electrical Safety Code (NESC) and is a function of span length, the conductor height above ground, and the conductor's low point of sag.

route
The pathway on which a right-of-way will be cleared and the new line constructed.

sailing
Crossing of conductors and shield wires with wings set. Most frequently seen in birds flying through or close to the conductor-shield wire complex.

SAMPLE

separation
The physical distance between energized conductors or between energized and non-energized conductors.

shield wire
Also called static wire or overhead ground wire. A conductor that provides a path to ground for static electricity. Lightning is its most common source of static electricity. Since lightning follows pathways to ground, the shield wire protects phase (AC) and pole (DC) conductors from lightning strikes.

shortstopping
Wintering in more northerly latitudes than has been historic for the species.

siting
The process of identifying the points in the electrical system that need new lines of connection to deliver electricity to growing or new demand centers.

span
The pole-to-pole or tower-to-tower distance of a power line.

static wire
See **shield wire**.

structure
A pole or lattice assembly that supports electrical conductors and equipment for the transmission or distribution of electricity.

subadult
Stage of a bird between juvenile and adult.

substation
A transitional point (where voltage is increased or decreased) in transmission and distribution systems.

transmission line
Power line that delivers electricity from its source over long distances to substations where the voltage is reduced for distribution. Transmission voltages range from 60 to 765 kV in the United States.

trust resource
Wildlife held in the public trust and managed and protected by federal and state agencies. These trust agencies are designated by statute and regulations as responsible for upholding the protection, conservation, and management of these resources.

underbuild
Refers to a circuit that is placed on the same pole but underneath another circuit of a higher voltage. The lower circuit is often referred to as the underbuilt circuit.

volt
The measure of electrical potential.

voltage
Electromotive force can be expressed in volts. Power lines are rated and categorized by voltage.

SAMPLE

voltage rating

The voltage rating of a transmission line depends on the utility's existing transmission system voltages, interconnections with other utilities, potential delivery points, and the amount of power that must be transmitted to meet load requirements. As voltages increase, the amount of power that can be transmitted increases. Various line-design parameters such as conductor size and configuration, spacing, and the number of conductors per phase (bundling) allow for increased transmission capability. Transmission voltages for carrying energy long distances are generally in the 115- to 765-kV range in North America.

wing loading

Wing loading is a bird's mass divided by its wing surface area. High wing loading describes a bird that is heavy relative to its wing area. Low wing loading describes a bird that is light relative to its wing area.

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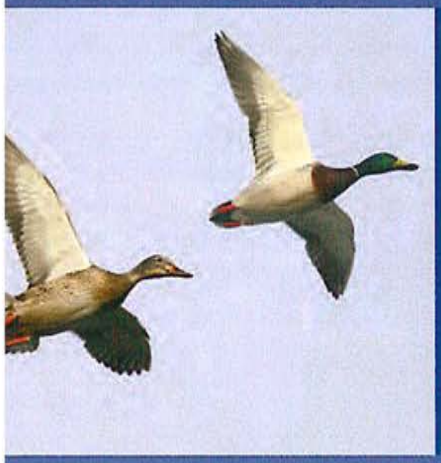

APPENDIX D

Acronyms

AC	Alternating Current
ACP	Advanced Conservation Practice
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
AWBP	Aransas-Wood Buffalo Population (whooping cranes)
BAMS	Bird Activity Monitoring System
BFD	Bird-Flight™ Diverter
BGEPA	Bald and Golden Eagle Protection Act (United States)
BSI	Bird Strike Indicator
CAP	Citizens Advisory Panel
CEC	California Energy Commission
cm	centimeter
CFR	Code of Federal Regulations (United States)
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DC	Direct Current
EEI	Edison Electric Institute
EPRI	Electric Power Research Institute
ESA	Endangered Species Act (United States)
FAA	Federal Aviation Administration
ft	feet
GIS	Geographic Information Systems
GPS	Global Positioning System
HCP	Habitat Conservation Plan
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
in	inch
ITP	Incidental Take Permit
km	kilometer
kV	kilovolt
m	meter
mi	mile
MBCA	Migratory Birds Convention Act (Canada)
MBTA	Migratory Bird Treaty Act (United States)
MOU	Memorandum of Understanding
NESC	National Electrical Safety Code
NMFS	National Marine Fisheries Service (United States)
NRECA	National Rural Electric Cooperative Association
PVC	Polyvinyl Chloride
ROW	Right-of-Way (singular), Rights-of-Way (plural)
SARA	Species at Risk Act (Canada)
SFD	Swan-Flight™ Diverter
SVD	Spiral Vibration Damper

SAMPLE

USEPA	U.S. Environmental Protection Agency	USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service	UV	Ultraviolet
		V	Volt

SAMPLE



APPENDIX E

Resources

SAMPLE

BIRD IDENTIFICATION AND NATURAL HISTORY

All About Birds
Cornell Lab of Ornithology
Includes bird identification information and bird songs.
www.allaboutbirds.org/Page.aspx?pid=1189

Birds of North America
Cornell Lab of Ornithology
Comprehensive reference covering the life histories of North America's breeding birds.
http://bna.birds.cornell.edu/bna

Tools for Learning About Birds
USGS Patuxent Wildlife Research Center
Includes bird pictures and songs.
www.mbr-pwrc.usgs.gov/bbs/ident.html

Bird Identification Pages
Idaho Museum of Natural History
Includes a visual key with silhouettes.
http://imnh.isu.edu/digitalatlas/bio/birds/main/birdid.htm

Florida Bird Sounds
Florida Museum of Natural History
www.flmnh.ufl.edu/birds/sounds.htm

BIRD DATABASES AND CONSERVATION INFORMATION

Migratory Bird Program
USFWS Division of Migratory Birds
Resources and regulations for the conservation and management of migratory birds.
www.fws.gov/migratorybirds

Migratory Bird Treaty Act (MBTA)
USFWS Division of Migratory Birds
www.fws.gov/laws/lawsdigest/migtrea.html

Bald and Golden Eagle Protection Act (BGEPA)
USFWS Division of Migratory Birds
www.fws.gov/laws/lawsdigest/baldegl.html

Endangered Species Act of 1973 (ESA)
USFWS Division of Migratory Birds
www.fws.gov/laws/lawsdigest/esact.html

Endangered Species Consultation Handbook (1998)
USFWS and NMFS
Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act.
www.fws.gov/midwest/endangered/section7/index.html

North American Waterfowl Management Plan
USFWS Division of Bird Habitat Conservation
Includes waterfowl status reports.
www.fws.gov/birdhabitat/NAWMP/index.shtm

Bird Conservation Initiatives
U.S. Environmental Protection Agency
Portal to major United States bird conservation plans and organizations.
www.epa.gov/owow/birds/bird.html

Conservation Plans, Databases, Strategies, and Assessments
Partners in Flight—U.S.
www.partnersinflight.org

North American Landbird Conservation Plan (2004)
Partners in Flight
www.pwrc.usgs.gov/pif/cont_plan

U.S. Shorebird Conservation Plan (2001)
USFWS
www.fws.gov/shorebirdplan

North American Waterbird Conservation Plan (2002)
Waterbird Conservation for the Americas
www.pwrc.usgs.gov/nacwcp/nawcp.html

Migratory Birds (Canada)
Environment Canada
Conservation, monitoring and reporting, and regulations for Canadian migratory birds.
www.ec.gc.ca/nature/default.asp?lang=En&n=FDF836EF-I

Migratory Birds Convention Act and Regulations (Canada)
Environment Canada
Polices, regulations, and list of birds protected in Canada under the MBCA.
www.ec.gc.ca/nature/default.asp?lang=En&n=7CEBB77D-I

Species at Risk Public Registry (Canada)
Government of Canada
Information and regulations for at-risk species in Canada.
www.sararegistry.gc.ca/default_e.cfm

Committee on the Status of Endangered Wildlife in Canada
Committee of experts that assesses wildlife species in danger of disappearing.
www.cosewic.gc.ca/eng/sct5/index_e.cfm

North American Bird Conservation Initiative
Bird Studies Canada
Describes and maps the North American bird conservation regions.
www.bsc-eoc.org/nabci.html

Christmas Bird Counts
National Audubon Society
Annual "snapshot" of North American bird populations over many decades. Because of issues with detection and database limitations, this database should only be used for indications of species presence and season of use.
http://birds.audubon.org/christmas-bird-count

eBird
Audubon and Cornell Lab of Ornithology
International database of bird observations with graphs and range maps. Because of issues with detection and database limitations, this database should only be used for indications of species presence and season of use.
http://ebird.org/content/ebird

Avian Knowledge Network (AKN)
Downloadable version of the eBird reference dataset for the Western Hemisphere.
www.avianknowledge.net/content

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National Biological Information Infrastructure: Bird Conservation
USGS Biological Informatics Program
Portal to maps, data, and bird conservation procedures for conservation of bird populations and their habitats in North America.
www.nbii.gov/portal/server.pt/community/bird_conservation/460

Ornithological Information System (ORNIS)
National Science Foundation
Data from collections of a network of museum and academic partners.
www.ornisnet.org

North American Breeding Bird Survey
U.S. Geological Survey
Data since 1966 on the status and trends of North American bird populations. Because of issues with detection and database limitations, this database should only be used for indications of species presence and season of use.
www.pwrc.usgs.gov/BBS

Landbird Population Estimates Database
Partners in Flight/Rocky Mountain Bird Observatory
Based on the Breeding Bird Survey data of the 1990s.
www.rmbo.org/pif_db/laped/default.aspx

Raptor Information System
U.S. Geological Survey
Keyword catalog of over 32,000 references on the biology and management of raptors.
http://ris.wr.usgs.gov

BIRD/ENERGY PROGRAMS AND AVIAN PROTECTION PLANNING

Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006
Avian Power Line Interaction Committee
www.aplic.org/documents.php

Avian Protection Plan Guidelines 2005
Avian Power Line Interaction Committee and USFWS
www.aplic.org/uploads/files/2634/APPguidelines_final-draft_Aprl2005.pdf

Short Courses and Workshops on Avian-Power Line Interactions
Avian Power Line Interaction Committee
www.aplic.org (see Upcoming Events)

California Energy Commission
www.energy.ca.gov/index.html

On-Line Annotated Bibliography of Avian Interactions with Utility Structures
California Energy Commission
www.energy.ca.gov/research/environmental/avian_bibliography

Right-of-Way Siting, Vegetation Management, and Avian Issues—Program 57
Electric Power Research Institute
http://portfolio.epri.com/ProgramTab.aspx?sId=ENV&rId=134&pId=5117

Conserving Birds and Their Habitats on Department of Defense Lands
U.S. Department of Defense and Partners in Flight
Includes a variety of resources such as bird conservation maps and avian protection planning guidelines.
www.dodpif.org

Materials on Bird-Power Line Interactions for Electric Utilities and their Employees
New Mexico Avian Protection Working Group
http://nmavianprotection.org//resources.html

Wildlife and Energy Programme
Endangered Wildlife Trust
www.ewt.org.za/WHATWEDO/OurProgrammes/WildlifeEnergyProgramme.aspx

SAMPLE

HIGH VOLTAGE DIRECT CURRENT (HVDC) TRANSMISSION SYSTEMS

Technology Information, Resource Library, and Student/Teacher Education
Clean Line Energy Partners
www.cleanlineenergy.com

AVIAN HEALTH, MORTALITY, AND CARCASS IDENTIFICATION

National Wildlife Health Center
U.S. Geological Survey
www.nwhc.usgs.gov

Field Manual of Wildlife Diseases, General Field Procedures and Diseases of Birds
U.S. Geological Survey
www.nwhc.usgs.gov/publications/field_manual

Wildlife Health Bulletin #06-02: Wild bird mortality reporting
U.S. Geological Survey
www.nwhc.usgs.gov/publications/wildlife_health_bulletins/WHB_06_02.jsp

Avian Necropsy Manual for Biologists in Remote Refuges
U.S. Geological Survey
http://www.nwhc.usgs.gov/publications/necropsy_manuals/index.jsp

Causes of Mortality in Common Loons
U.S. Geological Survey
www.nwhc.usgs.gov/publications/documents/92JCF.CLE01.pdf

Field Guide to Raptor Remains
California Energy Commission
www.energy.ca.gov/index.html

Wing and Tail Image Collection (Useful for Carcass Identification)
University of Puget Sound
www.pugetsound.edu/academics/academic-resources/slater-museum/biodiversity-resources/birds/wing-image-collection

PUBLIC PARTICIPATION RESOURCES

Introduction to Public Participation
Edison Electric Institute
Practical information for working with the public as a partner.
www2.eei.org/products_and_services/descriptions_and_access/intro_pub_partic.htm

Bird Education Network
Council for Environmental Education
Coalition developing a national strategy for bird education.
www.birdeducation.org

Flying Wild
Council for Environmental Education
Classroom bird education resources.
www.flyingwild.org

International Migratory Bird Day
Environment for the Americas
Annual event focusing on migratory birds of the Americas.
www.birdday.org

Project BEAK (Bird Education and Awareness for Kids)
Nebraska Partnership for All-Bird Conservation, Nebraska Environmental Trust, Nebraska Game and Fish Commission, U.S. Environmental Protection Agency
Exemplary bird education program.
http://projectbeak.org

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National Wildlife Refuge System
U.S. Fish and Wildlife Service
552 refuges, many of which focus on bird conservation and public outreach.
www.fws.gov/refuges

FUNDING ORGANIZATIONS

Avian Power Line Interaction Committee
APLIC funds research projects that further the knowledge of avian/power line interactions, including causes and solutions to avian mortalities due to power line electrocutions and collisions.
www.aplic.org/proposals.php

California Energy Commission
CEC funds various programs; see their website for a complete list.
www.energy.ca.gov/contracts/index.html

Electric Power Research Institute
EPRI funds research and development through competitive selection of contractors.
http://my.epri.com
(see About EPRI and Contractor Resources)

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Edison Electric Institute

Power by Association®

Avian Power Line Interaction Committee

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

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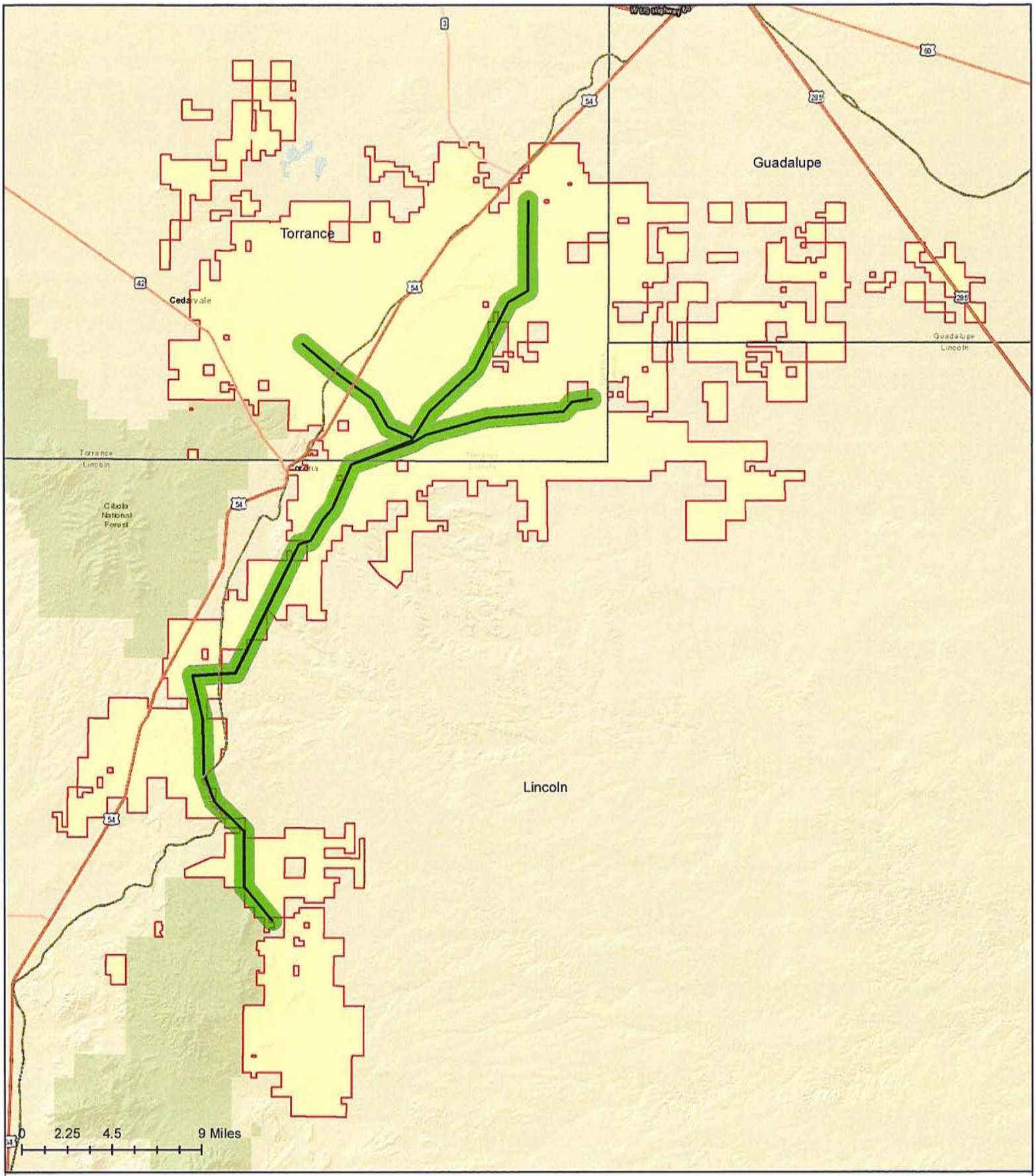

Original Corona Gen-Tie System
Original Corona Gen-Tie Corridor
Corona Wind Project Area

PREVIOUSLY APPROVED CORONA WIND PROJECTS

Pattern Development

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12/11/2019

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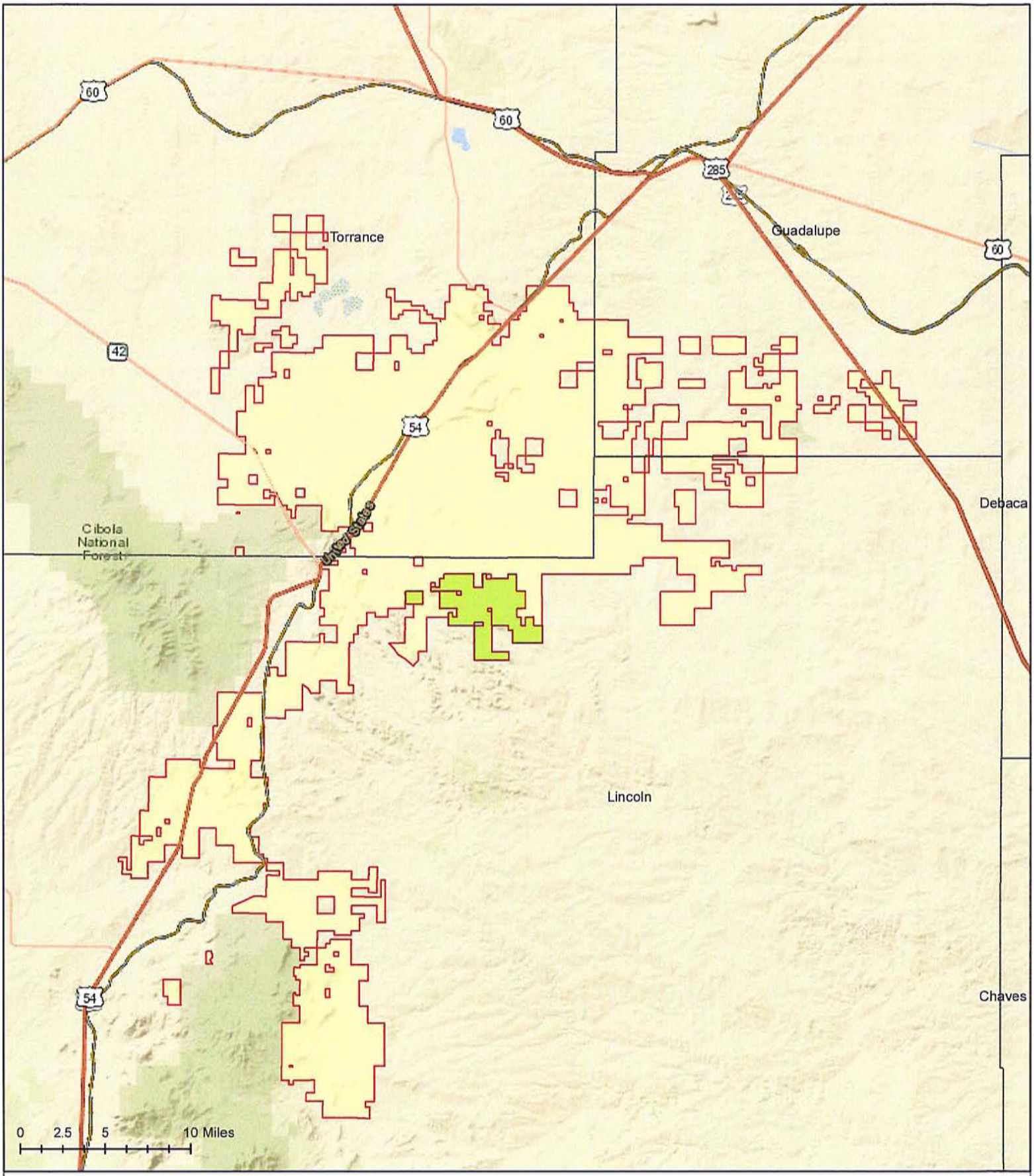

Corona Wind Project Area
Corona Wind Update

CORONA WIND PROJECT UPDATE

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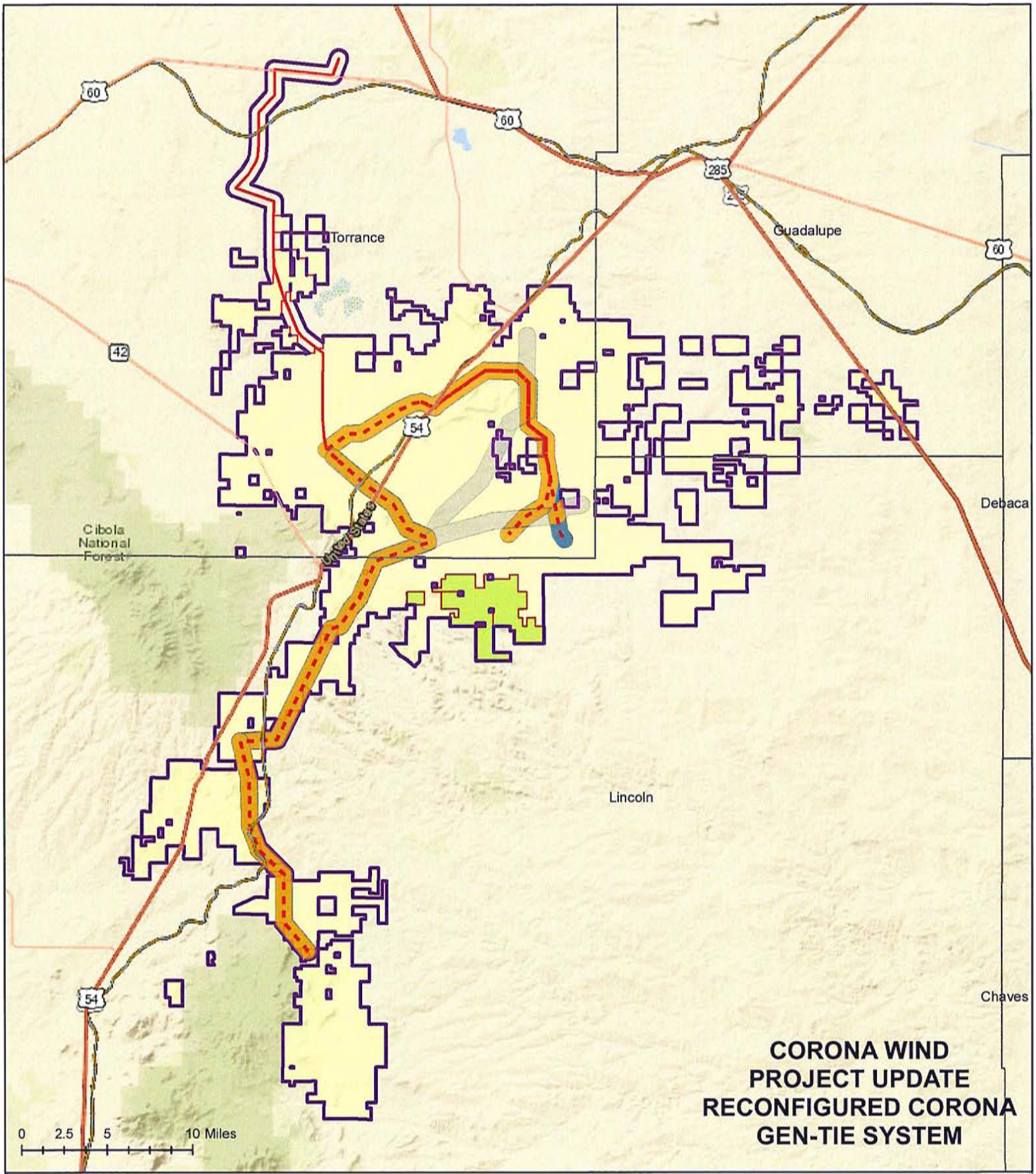

CORONA WIND PROJECT UPDATE RECONFIGURED CORONA GEN-TIE SYSTEM

- Extended Corona Gen-Tie System
- Reconfigured Corona Gen-Tie System
- Removed Corona Gen-Tie Corridor
- Reconfigured Corona Gen-Tie System Corridor
- Reconfigured Corona Gen-Tie System Corridor Option B
- Updated Corona Wind Project
- Corona Wind Project
- Corona Wind Update

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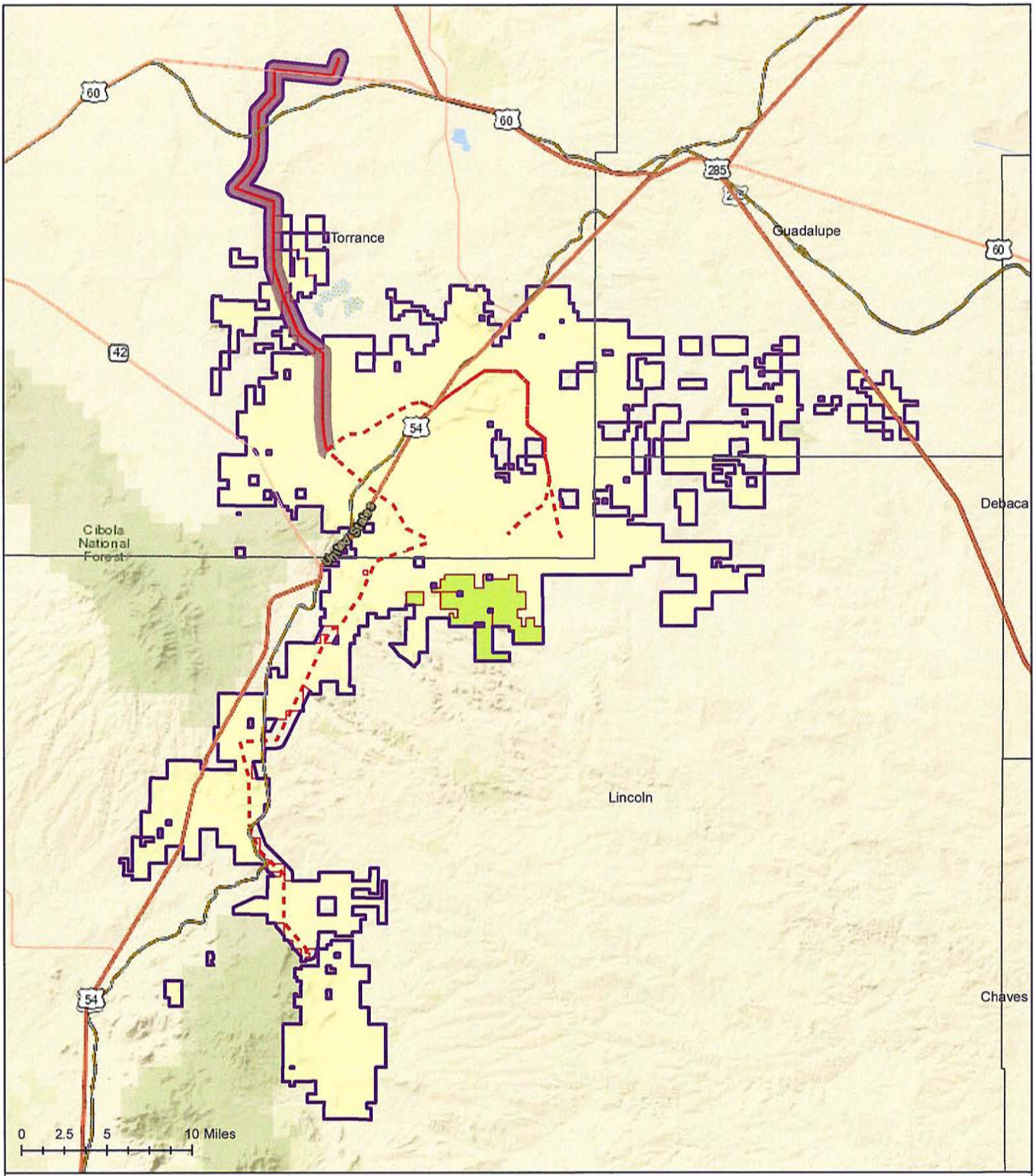

Extended Corona Gen-Tie System
Reconfigured Corona Gen-Tie System
Updated Corona Wind Project Area
Extended Corona Gen-Tie System Corridor
Corona Wind Project Area
Corona Wind Update

CORONA WIND PROJECT UPDATE EXTENDED CORONA GEN-TIE SYSTEM

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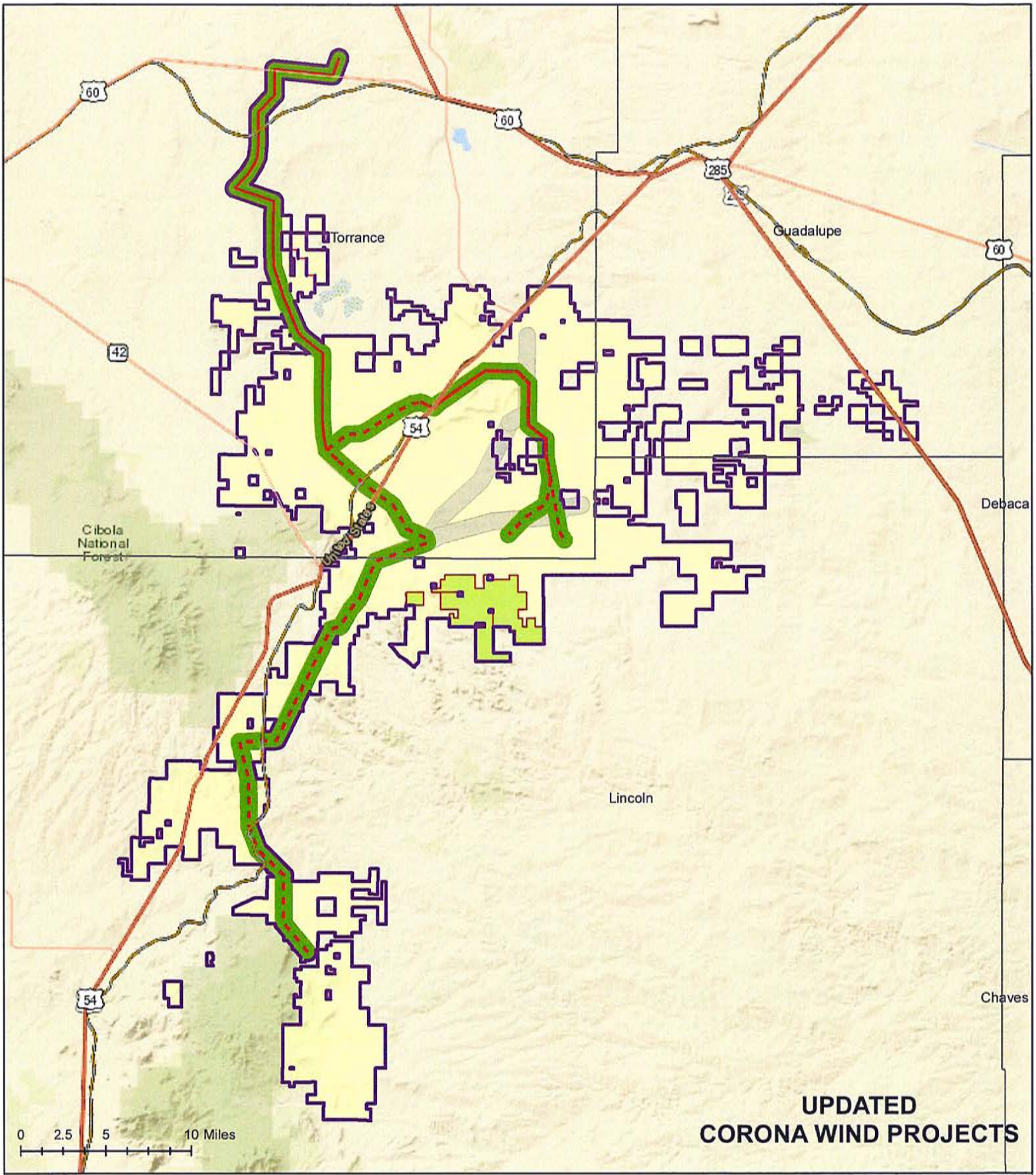

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Reconfigured Corona Gen-Tie System
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Updated Corona Gen-Tie System Corridor
Removed Corona Gen-Tie Corridor
Corona Wind Project Area
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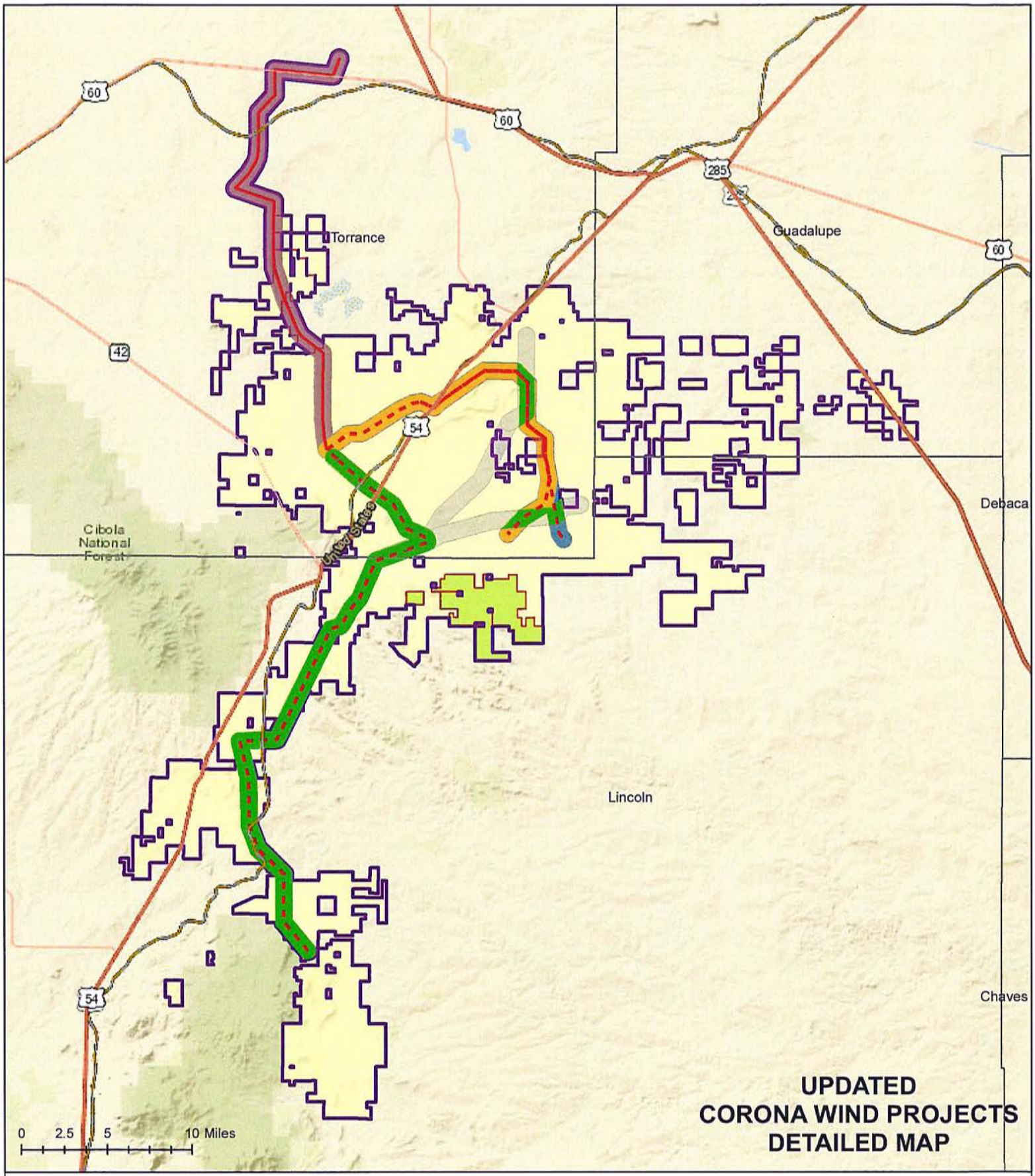

UPDATED CORONA WIND PROJECTS DETAILED MAP

- Extended Corona Gen-Tie System
- Reconfigured Corona Gen-Tie System
- Remaining Original Corona Gen-Tie System Corridor
- Removed Corona Gen-Tie Corridor
- Extended Corona Gen-Tie System Corridor
- Reconfigured Corona Gen-Tie System Corridor
- Reconfigured Corona Gen-Tie System Corridor Option B
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- Corona Wind Project
- Corona Wind Update

Pattern Development

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BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

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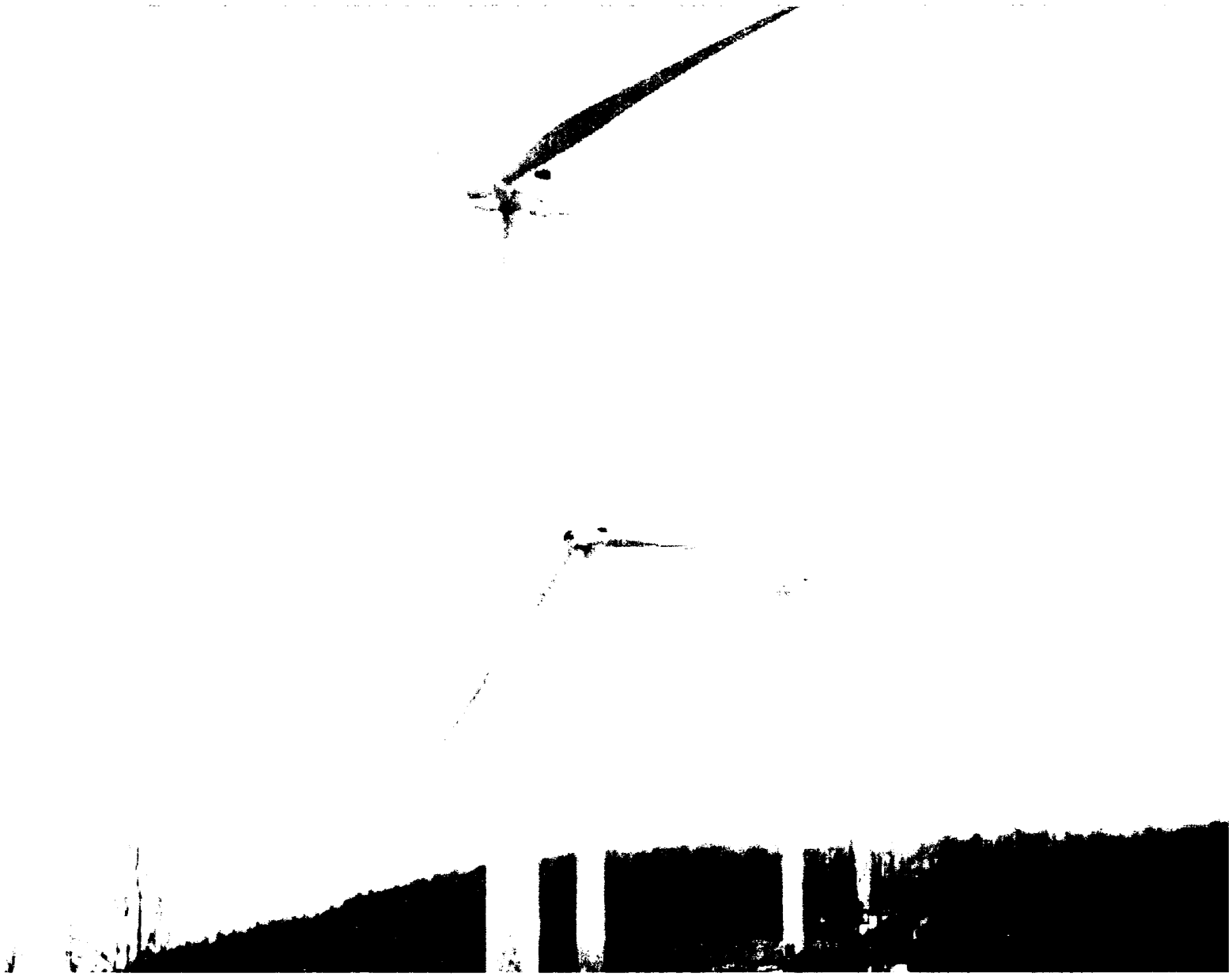

Cover Photo:

Wind Turbine. Photo by Stefanie Stavrakas, USFWS

OMB Control No, 1018-0148
Expiration Date: 12/31/2014

U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines

March 23, 2012

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The U.S. Fish and Wildlife Service (Service) would like to recognize and thank the Wind Turbine Guidelines Advisory Committee for its dedication and preparation of its Recommendations. The Recommendations have served as the basis from which the Service's team worked to develop the Service's Land-Based Wind Energy Guidelines. The Service also recognizes the tireless efforts of the Headquarters, Regional and Field Office staff that helped to review and update these Guidelines.

Paperwork Reduction Act Statement: The Land-Based Wind Energy Guidelines contain reporting and recordkeeping requirements that require Office of Management and Budget approval in accordance with the Paperwork Reduction Act of 1995. Your response is voluntary. We collect this information in order to provide technical assistance related to addressing wildlife conservation concerns at all stages of land-based wind energy development. For each response, we estimate the time necessary to provide the information as follows:

Tier 1 – 83 hours
Tier 2 – 375 hours
Tier 3 – 2,880 hours
Tier 4 – 2,550 hours
Tier 5 – 2,400 hours

The above estimates include time for reviewing instructions, gathering and maintaining data, and preparing and transmitting reports. Send comments regarding these estimates or any other aspect of the requirements to the Service Information Collection Clearance Officer, U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, MS 2042-PDM, Arlington, VA 22203.

We may not conduct and you are not required to respond to a collection of information unless it displays a currently valid OMB control number.

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Executive Summary

As the Nation shifts to renewable energy production to supplant the need for carbon-based fuel, wind energy will be an important source of power. As wind energy production increases, both developers and wildlife agencies have recognized the need for a system to evaluate and address the potential negative impacts of wind energy projects on species of concern. These voluntary Guidelines provide a structured, scientific process for addressing wildlife conservation concerns at all stages of land-based wind energy development. They also promote effective communication among wind energy developers and federal, state, and local conservation agencies and tribes. When used in concert with appropriate regulatory tools, the Guidelines form the best practical approach for conserving species of concern. The Guidelines have been developed by the Interior Department's U.S. Fish and Wildlife Service (Service) working with the Wind Turbine Guidelines Advisory Committee. They replace interim voluntary guidance published by the Service in 2003.

The Guidelines discuss various risks to "species of concern" from wind energy projects, including collisions with wind turbines and associated infrastructure; loss and degradation of habitat from turbines and infrastructure; fragmentation of large habitat blocks into smaller segments that may not support sensitive species; displacement and behavioral changes; and indirect effects such as increased predator populations or introduction of invasive plants. The Guidelines assist developers in identifying species of concern that may potentially be affected by their proposed project, including migratory birds; bats; bald and golden eagles and other birds of prey; prairie and sage grouse; and listed, proposed, or candidate endangered and threatened species. Wind energy development in some areas may be precluded by federal law; other areas may be inappropriate for development because they have been recognized as having high wildlife value based on their ecological rarity and intactness.

The Guidelines use a "tiered approach" for assessing potential adverse effects to species of concern and their habitats. The tiered approach is an iterative decision-making process for collecting information in increasing detail; quantifying the possible risks of proposed wind energy projects to species of concern and their habitats; and evaluating those risks to make siting, construction, and operation decisions. During the pre-construction tiers (Tiers 1, 2, and 3), developers are working to identify, avoid and minimize risks to species of concern. During post-construction tiers (Tiers 4 and 5), developers are assessing whether actions taken in earlier tiers to avoid and minimize impacts are successfully achieving the goals and, when necessary, taking additional steps to compensate for impacts. Subsequent tiers refine and build upon issues raised and efforts undertaken in previous tiers. Each tier offers a set of questions to help the developer evaluate the potential risk associated with developing a project at the given location.

Briefly, the tiers address:

- Tier 1 – Preliminary site evaluation (landscape-scale screening of possible project sites)
- Tier 2 – Site characterization (broad characterization of one or more potential project sites)
- Tier 3 – Field studies to document site wildlife and habitat and predict project impacts
- Tier 4 – Post-construction studies to estimate impacts[1]
- Tier 5 – Other post-construction studies and research

The tiered approach provides the opportunity for evaluation and decision-making at each stage, enabling a developer to abandon or proceed with project development, or to collect additional information if required. This approach does not require that every tier, or every element within each tier, be implemented for every project. The Service anticipates that many distributed or community facilities will not need to follow the Guidelines beyond Tiers 1 and 2. Instead, the tiered approach allows efficient use of developer and wildlife agency resources with increasing levels of effort.

If sufficient data are available at a particular tier, the following outcomes are possible:

1. The project proceeds to the next tier in the development process without additional data collection.
2. The project proceeds to the next tier in the development process with additional data collection.
3. An action or combination of actions, such as project

[1] The Service anticipates these studies will include fatality monitoring as well as studies to evaluate habitat impacts.

modification, mitigation, or specific post-construction monitoring, is indicated.

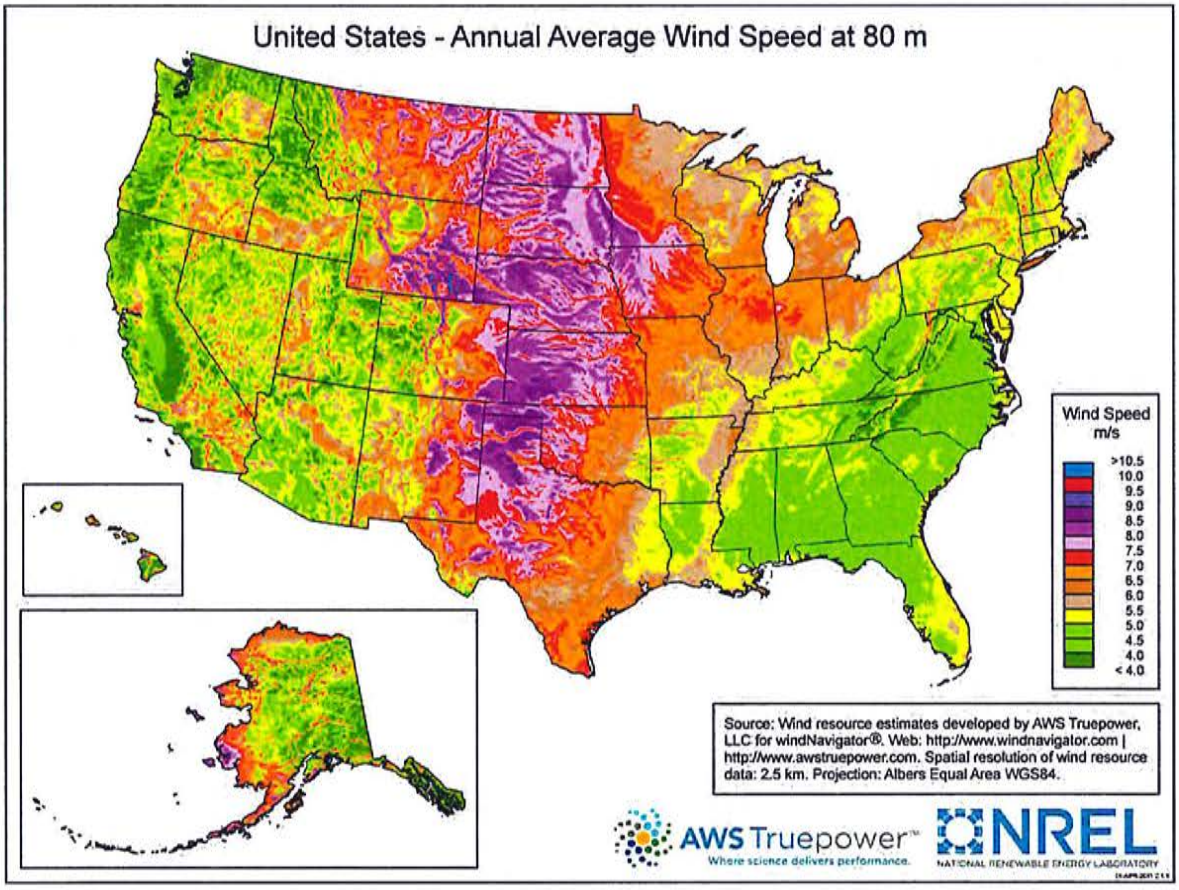
4. The project site is abandoned because the risk is considered unacceptable.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to modify the project, proceed with the project, or abandon the project.

The most important thing a developer can do is to consult with the Service as early as possible in the development of a wind energy project. Early consultation offers the greatest opportunity for avoiding areas where development is precluded or where wildlife impacts are likely to be high and difficult or costly to remedy or mitigate at a later stage. By consulting early, project developers can also incorporate appropriate wildlife conservation measures and monitoring into their decisions about project siting, design, and operation.

Adherence to the Guidelines is voluntary and does not relieve any individual, company, or agency of the responsibility to comply with laws and regulations. However, if a violation occurs the Service will consider a developer's documented efforts to communicate with the Service and adhere to the Guidelines. The Guidelines include a Communications Protocol which provides guidance to both developers and Service personnel regarding appropriate communication and documentation.

The Guidelines also provide Best Management Practices for site development, construction, retrofitting, repowering, and decommissioning. For additional reference, a glossary of terms and list of literature cited are included in the appendices.



Wind Resource Map. Credit: NREL



Chapter 1 - General Overview

The mission of the U.S. Fish and Wildlife Service (Service) is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. As part of this, the Service implements statutes including the Endangered Species Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act. These statutes prohibit taking of federally listed species, migratory birds, and eagles unless otherwise authorized.

Recent studies have documented that wind energy facilities can kill birds and bats. Mortality rates in fatalities per nameplate MW per year vary among facilities and regions. Studies have indicated that relatively low raptor (e.g., hawks, eagles) fatality rates exist at most modern wind energy developments with the exception of some facilities in California and Wyoming. Turbine-related bat deaths have been reported at each wind facility to date. Generally, studies in the West have reported lower rates of bat fatalities than facilities in the East. There is still much uncertainty regarding geographic distribution and causes of bat fatalities (NWCC 2010).

These Guidelines are intended to:

(1) Promote compliance with relevant wildlife laws and regulations;

(2) Encourage scientifically rigorous survey, monitoring, assessment, and research designs proportionate to the risk to species of concern;

(3) Produce potentially comparable data across the Nation;

(4) Mitigate, including avoid, minimize, and compensate for potential adverse effects on species of concern and their habitats; and,

(5) Improve the ability to predict and resolve effects locally, regionally, and nationally.

As the United States moves to expand wind energy production, it also must maintain and protect the Nation's wildlife and their habitats, which wind energy production can negatively affect. As with all responsible energy development, wind energy projects should adhere to high standards for environmental protection. With proper diligence paid to siting, operations, and management of projects, it is possible to mitigate for adverse effects to wildlife, and their habitats. This is best accomplished when the wind energy project developer communicates as early as possible with the Service and other stakeholders. Such early communication allows for the greatest range of development and mitigation options. The following website contains contact information for the Service Regional and Field offices as well as State wildlife agencies: http://www.fws.gov/offices/statelinks.html.

In response to increasing wind energy development in the United States, the Service released a set of voluntary, interim guidelines for reducing adverse effects to fish and wildlife resources from wind energy projects for public comment in July 2003. After the Service reviewed the public comments, the Secretary of the Interior (Secretary) established a Federal Advisory Committee[2] to provide recommendations to revise the guidelines related to land-based wind energy facilities. In March 2007, the U.S. Department of the Interior established the Wind Turbine Guidelines Advisory Committee (the Committee). The Committee submitted its final Recommended Guidelines (Recommendations) to the Secretary on March 4, 2010. The Service used the Recommendations to develop its Land-Based Wind Energy Guidelines.

The Service encourages project proponents to use the process described in these voluntary Land-based Wind Energy Guidelines (Guidelines) to address risks to species of concern. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will form the best practical approach for conservation of species of concern.

Statutory Authorities

These Guidelines are not intended nor shall they be construed to limit or preclude the Service from exercising its authority under any law, statute, or regulation, or from conducting enforcement action against any individual, company, or agency. They are not meant to relieve any individual, company, or agency of its obligations to comply with any applicable federal, state,

[2] Committee membership, from 2008 to 2011, has included: Taber Allison, Massachusetts Audubon; Dick Anderson, California Energy Commission; Ed Arnett, Bat Conservation International; Michael Azeka, AES Wind Generation; Thomas Bancroft, National Audubon; Kathy Boydston, Texas Parks and Wildlife Department; René Braud, EDP Renewables; Scott Darling, Vermont Fish and Wildlife Department; Michael Daulton, National Audubon; Aimee Delach, Defenders of Wildlife; Karen Douglas, California Energy Commission; Sam Enfield, MAP Royalty; Greg Hueckel, Washington Department of Fish and Wildlife; Jeri Lawrence, Blackfeet Nation; Steve Lindenberg, U.S. Department of Energy; Andy Linehan, Iberdrola Renewables; Rob Manes, The Nature Conservancy, Kansas; Winifred Perkins, NextEra Energy Resources; Steven Quarles, Crowell & Moring; Rich Rayhill, Ridgeline Energy; Robert Robel, Kansas State University; Keith Sexson, Association of Fish and Wildlife Agencies; Mark Sinclair, Clean Energy States Alliance; David Stout, U.S. Fish and Wildlife Service; Patrick Traylor, Hogan Lovells.

tribal, or local laws, statutes, or regulations. The Guidelines do not prevent the Service from referring violations of law for enforcement when a company has not followed the Guidelines.

Ultimately it is the responsibility of those involved with the planning, design, construction, operation, maintenance, and decommissioning of wind projects to conduct relevant wildlife and habitat evaluation and determine, which, if any, species may be affected. The results of these analyses will inform all efforts to achieve compliance with the appropriate jurisdictional statutes. Project proponents are responsible for complying with applicable state and local laws.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) is the cornerstone of migratory bird conservation and protection in the United States. The MBTA implements four treaties that provide for international protection of migratory birds. It is a strict liability statute, meaning that proof of intent, knowledge, or negligence is not an element of an MBTA violation. The statute's language is clear that actions resulting in a "taking" or possession (permanent or temporary) of a protected species, in the absence of a Service permit or regulatory authorization, are a violation of the MBTA.

The MBTA states, "Unless and except as permitted by regulations ... it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill ... possess, offer for sale, sell ... purchase ... ship, export, import ... transport or cause to be transported ... any migratory bird, any part, nest, or eggs of any such bird .... [The Act] prohibits the taking, killing, possession, transportation, import and export of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior." 16 U.S.C. 703. The word "take" is defined by regulation as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." 50 CFR 10.12.

The MBTA provides criminal penalties for persons who commit any of the acts prohibited by the statute in section 703 on any of the species protected by the statute. See 16 U.S.C. 707. The Service maintains a list of all species protected by the MBTA at 50 CFR 10.13. This list includes over one thousand species of migratory birds, including eagles and other raptors, waterfowl, shorebirds, seabirds, wading birds, and passerines. The MBTA does not protect introduced species such as the house (English) sparrow, European starling, rock dove (pigeon), Eurasian collared-dove, and non-migratory upland game birds. The Service maintains a list of introduced species not protected by the Act. See 70 Fed. Reg. 12,710 (Mar. 15, 2005).

Bald and Golden Eagle Protection Act

Under authority of the Bald and Golden Eagle Protection Act (BGEPA), 16 U.S.C. 668–668d, bald eagles and golden eagles are afforded additional legal protection. BGEPA prohibits the take, sale, purchase, barter, offer of sale, purchase, or barter, transport, export or import, at any time or in any manner of any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. 16 U.S.C. 668. BGEPA also defines take to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb," 16 U.S.C. 668c, and includes criminal and civil penalties for violating the statute. See 16 U.S.C. 668. The Service further defined the term "disturb" as agitating or bothering an eagle to a degree that causes, or is likely to cause, injury, or either a decrease in productivity or nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior. 50 CFR 22.3. BGEPA authorizes the Service to permit the take of eagles for certain purposes and under certain circumstances, including scientific or exhibition purposes, religious purposes of Indian tribes, and the protection of wildlife, agricultural, or other interests, so long as that take is compatible with the preservation of eagles. 16 U.S.C. 668a.

In 2009, the Service promulgated a final rule on two new permit regulations that, for the first time, specifically authorize the incidental take of eagles and eagle nests in certain situations under BGEPA. See 50 CFR 22.26 & 22.27. The permits authorize limited, non-purposeful (incidental) take of bald and golden eagles; authorizing individuals, companies, government agencies (including tribal governments), and other organizations to disturb or otherwise take eagles in the course of conducting lawful activities such as operating utilities and airports.



Bald Eagle, Credit: USFWS

Removal of active eagle nests would usually be allowed only when it is necessary to protect human safety or the eagles. Removal of inactive nests can be authorized when necessary to ensure public health and safety, when a nest is built on a human-engineered structure rendering it inoperable, and when removal is necessary to protect an interest in a particular locality, but only if the take or mitigation for the take will provide a clear and substantial benefit to eagles.

To facilitate issuance of permits under these new regulations, the Service has drafted Eagle Conservation Plan (ECP) Guidance. The ECP Guidance is compatible with these Land-Based Wind Energy Guidelines. The Guidelines guide developers through the process of project development and operation. If eagles are identified as a potential risk at a project site, developers are strongly encouraged to refer to the ECP Guidance. The ECP Guidance describes specific actions that are recommended to comply with the regulatory requirements in BGEPA for an eagle take permit, as described in 50 CFR 22.26 and 22.27. The ECP Guidance provides a national framework for assessing and mitigating risk specific to eagles through development of ECPs and issuance of programmatic incidental takes of eagles at wind turbine facilities. The Service will make its final ECP Guidance available to the public through its website.

Endangered Species Act

The Endangered Species Act (16 U.S.C. 1531–1544; ESA) was enacted by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The ESA directs the Service to identify and protect these endangered and threatened species and their critical habitat, and to provide a means to conserve their ecosystems. To this end, federal agencies are directed to utilize their authorities to conserve listed species, and ensure that their actions



Indiana bat. Credit: USFWS

are not likely to jeopardize the continued existence of these species or destroy or adversely modify their critical habitat. Federal agencies are encouraged to do the same with respect to "candidate" species that may be listed in the near future. The law is administered by the Service and the Commerce Department's National Marine Fisheries Service (NMFS). For information regarding species protected under the ESA, see: http://www.fws.gov/endangered/.

The Service has primary responsibility for terrestrial and freshwater species, while NMFS generally has responsibility for marine species. These two agencies work with other agencies to plan or modify federal projects so that they will have minimal impact on listed species and their habitats. Protection of species is also achieved through partnerships with the states, through federal financial assistance and a system of incentives available to encourage state participation. The Service also works with private landowners, providing financial and technical assistance for management actions on their lands to benefit both listed and non-listed species.

Section 9 of the ESA makes it unlawful for a person to "take" a listed species. Take is defined as "... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." 16 U.S.C. 1532(19). The terms harass and harm are further defined in our regulations. See 50 CFR 17.3. However, the Service may authorize "incidental take" (take that occurs as a result of an otherwise legal activity) in two ways.

Take of federally listed species incidental to a lawful activity may be authorized through formal consultation under section 7(a)(2) of the ESA, whenever a federal agency, federal funding, or a federal permit is involved. Otherwise, a person may seek an incidental take permit under section 10(a)(1)(B) of the ESA upon completion of a satisfactory habitat conservation plan (HCP) for listed species. Developers not receiving federal funding or authorization should contact the Service to obtain an incidental take permit if a wind



Utility-Scale Wind turbine with an anemometer tower in the background. Credit: University of Minnesota College of Science and Engineering

energy project is likely to result in take of listed threatened or endangered wildlife species. For more information regarding formal consultation and the requirements of obtaining HCPs, please see the Endangered Species Consultation Handbook at http://www.fws.gov/endangered/esa-library/index.html#consultations and the Service's HCP website, http://www.fws.gov/endangered/what-we-do/hcp-overview.html.

Implementation of the Guidelines

Because these Guidelines are voluntary, the Service encourages developers to use them as soon as possible after publication. To receive the considerations discussed on page 6 regarding enforcement priorities, a wind energy project would fall into one of three general categories relative to timing and implementation:

- For projects initiated after publication, the developer has applied the Guidelines, including the tiered approach, through site selection, design, construction, operation and post-operation phases of the project, and has communicated and shared information with the Service and considered its advice.
- For projects initiated prior to publication, the developer should consider where they are in the planning process relative to the appropriate tier and inform the Service of what actions they will take to apply the Guidelines.
- For projects operating at the time of publication, the developer should confer with the Service regarding the appropriate period of fatality monitoring consistent with Tier 4, communicate and share information with the Service on monitoring results, and consider Tier 5 studies and mitigation options where appropriate.

Projects that are already under development or are in operation are not expected to start over or return to the beginning of a specific tier. Instead, these projects should implement those portions of the Guidelines relevant to the current phases of the project per the bullets above.

The Service is aware that it will take time for Service staff and other personnel, including wind energy developers and their biologists, to develop expertise in the implementation of these Guidelines. Service staff and many staff associated with the wind energy industry have been involved with developing these Guidelines. Therefore, they have a working knowledge of the Guidelines. To further refine their training, the Service will make every effort to offer an in-depth course within 6 months of the final Guidelines being published.

The Communications Protocol on page 5 provides guidance to Service staff and developers in the exchange of information and recommendations at each tier in the process. Although the advice of the Service is not binding, a developer should review such advice, and either accept or reject it. If they reject it, they should contemporaneously document with reasoned justification why they did so. Although the Guidelines leave decisions up to the developer, the Service retains authority to evaluate whether developer efforts to mitigate impacts are sufficient, to determine significance, and to refer for prosecution any unlawful take that it believes to be reasonably related to lack of incorporation of Service recommendations or insufficient adherence with the Guidelines.

Table 1. Suggested Communications Protocol
This table provides examples of potential communication opportunities between a wind energy project developer and the Service. Not all projects will follow all steps indicated below.

TIER	*Project Developer/Operator Role*	*Service Role*
Tier 1: Preliminary site evaluation	• Landscape level assessment of habitat for species of concern • Request data sources for existing information and literature	• Provide lists of data sources and references, if requested
Tier 2: Site characterization	• Assess potential presence of species of concern, including species of habitat fragmentation concern, likely to be on site • Assess potential presence of plant communities present on site that may provide habitat for species of concern • Assess potential presence of critical congregation areas for species of concern • One or more reconnaissance level site visit by biologist • Communicate results of site visits and other assessments with the Service • Provide general information about the size and location of the project to the Service	• Provide species lists, for species of concern, including species of habitat fragmentation concern, for general area, if available • Provide information regarding plant communities of concern, if available • Respond to information provided about findings of biologist from site visit • Identify initial concerns about site(s) based on available information • Inform lead federal agencies of communications with wind project developers
Tier 3: Field studies and impact prediction	• Discuss extent and design of field studies to conduct with the Service • Conduct biological studies • Communicate results of all studies to Service field office in a timely manner • Evaluate risk to species of concern from project construction and operation • Identify ways to mitigate potential direct and indirect impacts of building and operating the project	• Respond to requests to discuss field studies • Advise project proponent about studies to conduct and methods for conducting them • Communicate with project proponent(s) about results of field studies and risk assessments • Communicate with project proponents(s) ways to mitigate potential impacts of building and operating the project • Inform lead federal agencies of communications with wind project developers
Tier 4: Post construction studies to estimate impacts	• Discuss extent and design of post-construction studies to conduct with the Service • Conduct post-construction studies to assess fatalities and habitat-related impacts • Communicate results of all studies to Service field office in a timely manner • If necessary, discuss potential mitigation strategies with Service • Maintain appropriate records of data collected from studies	• Advise project operator on study design, including duration of studies to collect adequate information • Communicate with project operator about results of studies • Advise project operator of potential mitigation strategies, when appropriate
Tier 5: Other post-construction studies and research	• Communicate with the Service about the need for and design of other studies and research to conduct with the Service, when appropriate, particularly when impacts exceed predicted levels • Communicate with the Service about ways to evaluate cumulative impacts on species of concern, particularly species of habitat fragmentation concern • Conduct appropriate studies as needed • Communicate results of studies with the Service • Identify potential mitigation strategies to reduce impacts and discuss them with the Service	• Advise project proponents as to need for Tier 5 studies to address specific topics, including cumulative impacts, based on information collected in Tiers 3 and 4 • Advise project proponents of methods and metrics to use in Tier 5 studies • Communicate with project operator and consultants about results of Tier 5 studies • Advise project operator of potential mitigation strategies, when appropriate, based on Tier 5 studies

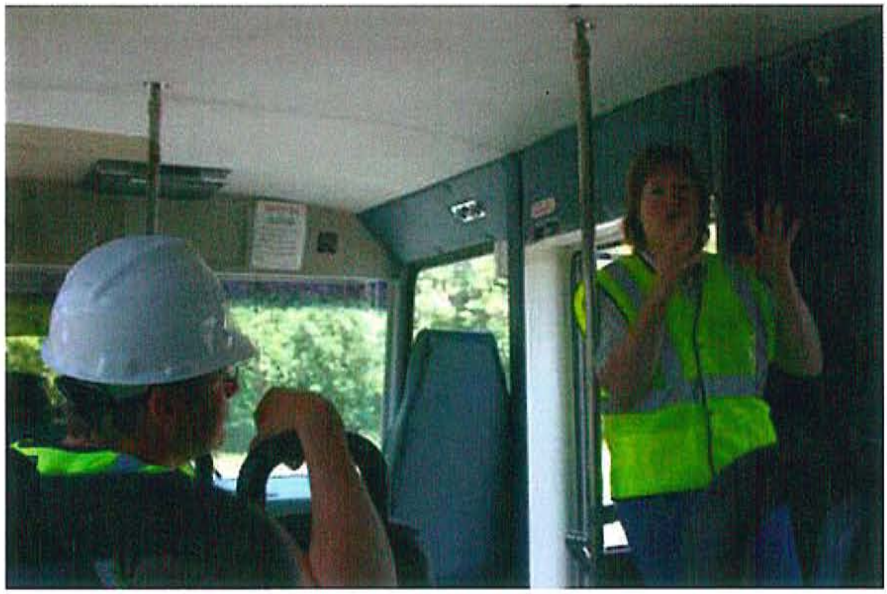
Consideration of the Guidelines in MBTA and BGEPA Enforcement

The Service urges voluntary adherence to the Guidelines and communication with the Service when planning and operating a facility. While it is not possible to absolve individuals or companies from MBTA or BGEPA liability, the Office of Law Enforcement focuses its resources on investigating and prosecuting those who take migratory birds without identifying and implementing reasonable and effective measures to avoid the take. The Service will regard a developer's or operator's adherence to these Guidelines, including communication with the Service, as appropriate means of identifying and implementing reasonable and effective measures to avoid the take of species protected under the MBTA and BGEPA.[3] The Chief of Law Enforcement or more senior official of the Service will make any decision whether to refer for prosecution any alleged take of such species, and will take such adherence and communication fully into account when exercising discretion with respect to such potential referral. Each developer or operator will be responsible for maintaining internal records sufficient to demonstrate adherence to the Guidelines and response to communications from the Service. Examples of these records could include: studies performed in the implementation of the tiered approach; an internal or external review or audit process; a bird and bat conservation strategy; or a wildlife management plan.

If a developer and operator are not the same entity, the Service expects the operator to maintain sufficient records to demonstrate adherence to the Guidelines.

Scope and Project Scale of the Guidelines

The Guidelines are designed for "utility-scale" land-based wind energy projects to reduce potential impacts to species of concern, regardless of whether they are proposed for private or public lands. A developer of a distributed or community scale wind project may find it useful to consider the general principles of the tiered approach to assess and reduce potential impacts to species of concern, including answering Tier 1 questions using publicly available information. In the vast majority of situations, appropriately sited small wind projects are not likely to pose significant risks to species of concern. Answering Tier 1 questions will assist a developer of distributed or community wind projects, as well as landowners, in assessing the need to further communicate with the Service, and precluding, in many cases, the need for full detailed pre-construction assessments or monitoring surveys typically called for in Tiers 2 and 3. If landowners or community/distributed wind developers encounter problems locating information about specific sites they can contact the Service and/or state wildlife agencies to determine potential risks to species of concern for their particular project.



Communication with Christy Johnson-Hughes. Credit: Rachel London, USFWS

The tiered approach is designed to lead to the appropriate amount of evaluation in proportion to the anticipated level of risk that a project may pose to species of concern and their habitats. Study plans and the duration and intensity of study efforts should be tailored specifically to the unique characteristics of each site and the corresponding potential for significant adverse impacts on species of concern and their habitats as determined through the tiered approach. This is why the tiered approach begins with an examination of the potential location of the project, not the size of the project. In all cases, study plans and selection of appropriate study methods and techniques may be tailored to the relative scale, location, and potential for significant adverse impacts of the proposed site.

The Service considers a "project" to include all phases of wind energy development, including, but not limited to, prospecting, site assessment, construction, operation, and decommissioning, as well as all associated infrastructure and interconnecting electrical lines. A "project site" is the land and airspace where development occurs

[3] With regard to eagles, this paragraph will only apply when a project is not likely to result in take. If Tiers 1, 2, and/or 3 identify a potential to take eagles, developers should consider developing an ECP and, if necessary, apply for a take permit

or is proposed to occur, including the turbine pads, roads, power distribution and transmission lines on or immediately adjacent to the site; buildings and related infrastructure, ditches, grades, culverts; and any changes or modifications made to the original site before development occurs. Project evaluations should consider all potential effects to species of concern, which includes species 1) protected by the MBTA, BGEPA, or ESA (including candidate species), designated by law, regulation or other formal process for protection and/or management by the relevant agency or other authority, or that have been shown to be significantly adversely affected by wind energy development; and 2) determined to be possibly affected by the project.

These Guidelines are not designed to address power transmission beyond the point of interconnection to the transmission system.

Service Review Period

The Service is committed to providing timely responses. Service Field Offices should typically respond to requests by a wind energy developer for information and consultation on proposed site locations (Tiers 1 and 2), pre- and post-construction study designs (Tiers 3 and 4), and proposed mitigation (Tier 3) within 60 calendar days. The request should be in writing to the Field Office and copied to the Regional Office with information about the proposed project, location(s) under consideration, and point of contact. The request should contain a description of the information needed from the Service. The Service will provide a response, even if it is to notify a developer of additional review time, within the 60 calendar day review period. If the Service does not respond within 60 calendar days of receipt of the document, then the developer can proceed through Tier 3 without waiting for Service input. If the Service provides comments at a later time, the developer should incorporate the comments if feasible. It is particularly important that if data from Tier 1-3 studies predict that the project is likely to produce significant adverse impacts on species of concern, the developer inform the Service of the actions it intends to implement to mitigate those impacts. If the Service cannot respond within 60 calendar days, this does not relieve developers from their MBTA, BGEPA, and ESA responsibilities.

The tiered approach allows a developer in certain limited circumstances to move directly from Tier 2 to construction (e.g., adequate survey data for the site exists). The developer should notify the Service of this decision and give the Service 60 calendar days to comment on the proposed project prior to initiating construction activities.

Introduction to the Decision Framework Using a Tiered Approach

The tiered approach provides a decision framework for collecting information in increasing detail to evaluate risk and make siting and operational decisions. It provides the opportunity for evaluation and decision-making at each tier, enabling a developer to proceed with or abandon project development, or to collect additional information if necessary. This approach does not require that every tier, or every element within each tier, be implemented for every project. Instead, it allows efficient use of developer and wildlife agency resources with increasing levels of effort until sufficient information and the desired precision is acquired for the risk assessment.

Figure 1 ("General Framework of Tiered Approach") illustrates the tiered approach, which consists of up to five iterative stages, or tiers:

- Tier 1 – Preliminary site evaluation (landscape-scale screening of possible project sites)
- Tier 2 – Site characterization (broad characterization of one or more potential project sites)
- Tier 3 – Field studies to document site wildlife and habitat and predict project impacts
- Tier 4 – Post-construction studies to estimate impacts[4]
- Tier 5 – Other post-construction studies and research

At each tier, potential issues associated with developing or operating a project are identified and questions formulated to guide the decision process. Chapters Two through Six outline the questions to be posed at each tier, and describe recommended methods and metrics for gathering the data needed to answer those questions.

The first three tiers correspond to the pre-construction evaluation phase of wind energy development. At each of the three tiers, the Guidelines provide questions that developers should answer, followed by recommended methods and metrics to use in answering the questions. Some questions are repeated at each tier, with successive tiers requiring a greater investment in data collection to answer certain questions. For example, while Tier 2 investigations may discover some existing information on federal or state-listed species and their use of the proposed development site, it may be necessary to collect empirical data in Tier 3 studies to determine the presence of federal or state-listed species.

Developers decide whether to proceed to the next tier. Timely communication and sharing of information will allow opportunities for the Service to provide, and developers to consider, technical advice. A developer should base the decision on the information obtained from adequately answering the questions in this tier, whether the methods used were appropriate for the site selected, and the resulting

[4] The Service anticipates these studies will include fatality monitoring as well as studies to evaluate habitat impacts.



Wind turbines in California. Credit: Rachel London, USFWS

assessment of risk posed to species of concern and their habitats.

If sufficient data are available at a particular tier, the following outcomes are possible:

1. The project proceeds to the next tier in the development process without additional data collection.

2. The project proceeds to the next tier in the development process with additional data collection.

3. An action or combination of actions, such as project modification, mitigation, or specific post-construction monitoring, is indicated.

4. The project site is abandoned because the risk is considered unacceptable.

If data are deemed insufficient at a tier, more intensive study is conducted in the subsequent tier until sufficient data are available to make a decision to modify the project, proceed with the project, or abandon the project.

The tiered approach used in these Guidelines embodies adaptive management by collecting increasingly detailed information that is used to make decisions about project design, construction, and operation as the developer progresses through the tiers. Adaptive management is an iterative learning process producing improved understanding and improved management over time (Williams et al 2007). DOI has determined that its resource agencies, and the natural resources they oversee, could benefit from adaptive management. Use of adaptive management in DOI is guided by the DOI Policy on Adaptive Management. DOI has adopted the National Research Council's 2004 definition of adaptive management, which states:

"Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders."

This definition gives special emphasis to uncertainty about management effects, iterative learning to reduce uncertainty, and improved management as a result of learning. The DOI Adaptive Management Technical Guide is located on the web at: www.doi.gov/initiatives/AdaptiveManagement/index.html.

Figure 1. General Framework of Tiered Approach

TIER 1

A. Species of concern known to be present?
   1. No .....proceed to Tier 2
   2. Unknown - Insufficient or inconclusive data .....proceed to Tier 2
   3. Yes.....abandon site or proceed to Tier 2

TIER 2

A. Probability of significant adverse impacts?
   1. Unknown - Insufficient or inconclusive data .....proceed to Tier 3
   2. Low.....proceed to obtain state and local permit (if required), design, and construction following BMPs
   3. Moderate .....proceed to Tier 3 and mitigate
   4. High, and:
      a. can be adequately mitigated...modify project and proceed to Tier 3
      b. cannot be adequately mitigated.....abandon project

TIER 3

A. Probability of significant adverse impacts?
   1. Low .....proceed to Tier 4
   2. Moderate to high, and:
      a. certainty regarding mitigation ..... proceed to Tier 4
      b. uncertainty regarding mitigation .....proceed to Tier 4
   3. High, and:
      a. can be adequately mitigated.....proceed to Tier 4
      b. cannot be adequately mitigated .....modify or abandon project

TIER 4a (See Table 2, pg 39)

A. Tier 3 studies indicate low probability of significant adverse impacts
   1. Documented fatalities are equal to or lower than predicted.....no further studies or mitigation needed
   2. Documented fatalities are higher than predicted, but not significant, and:
      a. comparable data are available that support findings of not significant.....no further studies needed
      b. comparable data not available to support findings of not significant.....additional year(s) of monitoring recommended
   3. Documented fatalities are higher than predicted and are significant.....communicate with Service

B. Tier 3 studies indicate moderate probability of significant adverse impacts
   1. Documented fatalities are lower than or no different predicted, and:
      a. are not significant and no ESA or BGEPA species are affected .....no further monitoring or mitigation needed
      b. are significant *OR* ESA or BGEPA species are affected .....communicate with Service
   2. Documented fatalities are greater than predicted and are likely to be significant *OR* ESA or BGEPA species are affected.....communicate with Service

C. Tier 3 studies indicate high probability of significant adverse impacts
   1. Documented fatalities are less than predicted and are not significant, and no ESA or BGEPA species are affected.....no further monitoring or mitigation needed
   2. Documented fatalities are less than predicted but are still significant, and no ESA or BGEPA species are affected.....further monitoring or mitigation needed
   3. Fatalities are equal to or greater than predicted and are significant OR ESA or BGEPA species are affected.....communicate with Service regarding additional mitigation

TIER 4b (See Table 3, pg. 42)

A. Species of habitat fragmentation concern potentially present?
   1. No.....no further studies needed
   2. Yes, and:
      a. Tier 3 studies do not confirm presence...no further studies needed
      b. Tier 3 studies confirm presence, but no significant adverse impacts predicted, and:
         i. Tier 4b studies confirm Tier 3 predictions.....no further studies or mitigation needed
         ii. Tier 4b studies indicate potentially significant adverse impacts .....Tier 5 studies and mitigation may be needed
      c. Tier 3 studies confirm presence, and significant adverse impacts predicted and mitigation plan is developed and implemented, and:
         i. Tier 4b studies determine mitigation is effective .....no further studies or mitigation needed
         ii. Tier 4b studies determine mitigation not effective.....further mitigation and, where appropriate, Tier 5 studies needed

Considering Risk in the Tiered Approach

In the context of these Guidelines, risk refers to the likelihood that adverse impacts will occur to individuals or populations of species of concern as a result of wind energy development and operation. Estimates of fatality risk can be used in a relative sense, allowing comparisons among projects, alternative development designs, and in the evaluation of potential risk to populations. Because there are relatively few methods available for direct estimation of risk, a weight-of-evidence approach is often used (Anderson et al. 1999). Until such time that reliable risk predictive models are developed regarding avian and bat fatality and wind energy projects, estimates of risk would typically be qualitative, but should be based upon quantitative site information.

For the purposes of these Guidelines, risk can also be defined in the context of populations, but that calculation is more complicated as it could involve estimating the reduction in population viability as indicated by demographic metrics such as growth rate, size of the population, or survivorship, either for local populations, metapopulations, or entire species. For most populations, risk cannot easily be reduced to a strict metric, especially in the absence of population viability models for most species. Consequently, estimating the quantitative risk to populations is usually beyond the scope of project studies due to the difficulties in evaluating these metrics, and therefore risk assessment will be qualitative.

Risk to habitat is a component of the evaluation of population risk. In this context, the estimated loss of habitat is evaluated in terms of the potential for population level effects (e.g., reduced survival or reproduction).

The assessment of risk should synthesize sufficient data collected at a project to estimate exposure and predict impact for individuals and their habitats for the species of concern, with what is known about the population status of these species, and in communication with the relevant wildlife agency and industry wildlife experts. Predicted risk of these impacts could provide useful information for determining appropriate mitigation measures if determined to be necessary. In practice in the tiered approach, risk assessments conducted in Tiers 1 and 2 require less information to reach a risk-based decision than those conducted at higher tiers.

Cumulative Impacts of Project Development

Cumulative impacts are the comprehensive effect on the environment that results from the incremental impact of a project when added to other past, present, and reasonably foreseeable future actions. Developers are encouraged to work closely with federal and state agencies early in the project planning process to access any existing information on the cumulative impacts of individual projects on species and habitats at risk, and to incorporate it into project development and any necessary wildlife studies. To achieve that goal, it is important that agencies and organizations take the following actions to improve cumulative impacts analysis:

- review the range of development-related significant adverse impacts;
- determine which species of concern or their habitats within the landscape are most at risk of significant adverse impacts from wind development in conjunction with other reasonably foreseeable significant adverse impacts; and
- make that data available for regional or landscape level analysis.

The magnitude and extent of the impact on a resource depend on whether the cumulative impacts exceed the capacity for resource sustainability and productivity.

For projects that require a federal permit, funding, or other federal nexus, the lead federal agency is required to include a cumulative impacts analysis in their National Environmental Policy Act (NEPA) review. The federal action agency coordinates with the developer to obtain the necessary information for the NEPA review and cumulative impacts analysis. To avoid project delays, federal and state agencies are encouraged to use existing wildlife data for the cumulative impacts analysis until improved data are available.

Where there is no federal nexus, individual developers are not expected to conduct their own cumulative impacts analysis. However, a cumulative impacts analysis would help developers and other stakeholders better understand the significance of potential impacts on species of concern and their habitats.

Other Federal Agencies

Other federal agencies, such as the Bureau of Land Management, National Park Service, U.S. Department of Agriculture Forest Service and Rural Utility Service, Federal Energy Regulatory Commission and Department of Energy are often interested in and involved with wind project developments. These agencies have a variety of expertise and authorities they implement. Wind project developers on public lands will have to comply with applicable regulations and policies of those agencies. State and local agencies and Tribes also have additional interests and knowledge. The Service recommends that, where appropriate, wind project developers contact these agencies early in the tiered process and work closely with them throughout project planning and development to assure that projects address issues of concern to those agencies. The definition of "species of concern" in these Guidelines includes species which are trust resources of States and of federal agencies (See Glossary). In those instances where a project may significantly affect State trust

resources, wind energy developers should work closely with appropriate State agencies.

Relationship to Other Guidelines

These Guidelines replace the Service's 2003 interim voluntary guidelines. The Service intends that these Guidelines, when used in concert with the appropriate regulatory tools, will form the best practical approach for conservation of species of concern. For instance, when developers find that a project may affect an endangered or threatened species, they should comply with Section 7 or 10 of the ESA to obtain incidental take authorization. Other federal, state, tribal and local governments may use these Guidelines to complement their efforts to address wind energy development/wildlife interactions. They are not intended to supplant existing regional or local guidance, or landscape-scale tools for conservation planning, but were developed to provide a means of improving consistency with the goals of the wildlife statutes that the Service is responsible for implementing. The Service will continue to work with states, tribes, and other local stakeholders on map-based tools, decision-support systems, and other products to help guide future development and conservation. Additionally, project proponents should utilize any relevant guidance of the appropriate jurisdictional entity, which will depend on the species and resources potentially affected by proposed development.



Pronghorn Antelope. Credit: Steve Hillebrand, USFWS

Chapter 2: Tier 1 – Preliminary Site Evaluation

For developers taking a first look at a broad geographic area, a preliminary evaluation of the general ecological context of a potential site or sites can serve as useful preparation for working with the federal, state, tribal, and/or local agencies. The Service is available to assist wind energy project developers to identify potential wildlife and habitat issues and should be contacted as early as possible in the company's planning process. With this internal screening process, the developer can begin to identify broad geographic areas of high sensitivity due to the presence of: 1) large blocks of intact native landscapes; 2) intact ecological communities; 3) fragmentation-sensitive species' habitats; or 4) other important landscape-scale wildlife values.

Tier 1 may be used in any of the following three ways:

1. To identify regions where wind energy development poses significant risks to species of concern or their habitats, including the fragmentation of large-scale habitats and threats to regional populations of federal- or state-listed species.

2. To "screen" a landscape or set of multiple potential sites to avoid those with the highest habitat values.

3. To begin to determine if a single identified potential site poses serious risk to species of concern or their habitats.

Tier 1 can offer early guidance about the sensitivity of the site within a larger landscape context; it can help direct development away from sites that will be associated with additional study need, greater mitigation requirements, and uncertainty; or it can identify those sensitive resources that will need to be studied further to determine if the site can be developed without significant adverse impacts to the species of concern or local population(s). This may facilitate discussions with the federal, state, tribal, and/or local agencies in a region being considered for development. In some cases, Tier 1 studies could reveal serious concerns indicating that a site should not be developed.

Developers of distributed or community scale wind projects are typically considering limited geographic areas to install turbines. Therefore, they would not likely consider broad geographic areas. Nevertheless, they should consider the presence of habitats or species of concern before siting projects.

Development in some areas may be precluded by federal law. This designation is separate from a determination through the tiered approach that an area is not appropriate for development due to feasibility, ecological reasons, or other issues. Developers are encouraged to visit Service and other publicly available databases or other available information during Tier 1 or Tier 2 to see if a potential wind energy area is precluded from development by federal law. Some areas may be protected from development through state or local laws or ordinances, and the appropriate agency should be contacted accordingly. Service field offices are available to answer questions where they are knowledgeable, guide developers to databases, and refer developers to other agency contacts.

Some areas may be inappropriate for large scale development because they have been recognized according to scientifically credible information as having high wildlife value, based solely on their ecological rarity and intactness (e.g., Audubon Important Bird Areas, The Nature Conservancy portfolio sites, state wildlife action plan priority habitats). It is important to identify such areas through the tiered approach, as reflected in Tier 1, Question 2 below. Many of North America's native landscapes are greatly diminished, with some existing at less than 10 percent of their pre-settlement occurrence.



Attwater's prairie chicken. Credit: Gary Halvorsen, USFWS

Herbaceous scrub-shrub steppe in the Pacific Northwest and old growth forest in the Northeast represent such diminished native resources. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Developers should collaborate with such entities specifically about such areas in the vicinity of a prospective project site.

Tier 1 Questions

Questions at each tier help determine potential environmental risks at the landscape scale for Tier 1 and project scale for Tiers 2 and 3. Suggested questions to be considered for Tier 1 include:

1. **Are there species of concern present on the potential site(s), or is habitat (including designated critical habitat) present for these species?**

2. **Does the landscape contain areas where development is precluded by law or areas designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: federally-designated critical habitat; high-priority conservation areas for non-government organizations (NGOs); or other local, state, regional, federal, tribal, or international categorizations.**

3. **Are there known critical areas of wildlife congregation, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

4. **Are there large areas of intact habitat with the potential for fragmentation, with respect to species of habitat fragmentation concern needing large contiguous blocks of habitat?**

Tier 1 Methods and Metrics

Developers who choose to conduct Tier 1 investigations would generally be able to utilize existing public or other readily available landscape-level maps and databases from sources such as federal, state, or tribal wildlife or natural heritage programs, the academic community, conservation organizations, or the developers' or consultants' own information. The Service recommends that developers conduct a review of the publicly available data. The analysis of available sites in the region of interest will be based on a blend of the information available in published and unpublished reports, wildlife range distribution maps, and other such sources. The developer should check with the Service Field Office for data specific to wind energy development and wildlife at the landscape scale in Tier 1.

Tier 1 Decision Points

The objective of the Tier 1 process is to help the developer identify a site or sites to consider further for wind energy development. Possible outcomes of this internal screening process include the following:

1. One or more sites are found within the area of investigation where the answer to each of the above Tier 1 questions is "no," indicating a low probability of significant adverse impact to wildlife. The developer proceeds to Tier 2 investigations and characterization of the site or sites, answering the Tier 2 questions with site-specific data to confirm the validity of the preliminary indications of low potential for significant adverse impact.

2. If a developer answers "yes" to one or more of the Tier 1 questions, they should proceed to Tier 2 to further assess the probability of significant adverse impacts to wildlife. A developer may consider abandoning the area or identifying possible means by which the project can be modified to avoid or minimize potential significant adverse impacts.

3. The data available in the sources described above are insufficient to answer one or more of the Tier 1 questions. The developer proceeds to Tier 2, with a specific emphasis on collecting the data necessary to answer the Tier 2 questions, which are inclusive of those asked at Tier 1.

Chapter 3: Tier 2 – Site Characterization

At this stage, the developer has narrowed consideration down to specific sites, and additional data may be necessary to systematically and comprehensively characterize a potential site in terms of the risk wind energy development would pose to species of concern and their habitats. In the case where a site or sites have been selected without the Tier 1 preliminary evaluation of the general ecological context, Tier 2 becomes the first stage in the site selection process. The developer will address the questions asked in Tier 1; if addressing the Tier 1 questions here, the developer will evaluate the site within a landscape context. However, a distinguishing feature of Tier 2 studies is that they focus on site-specific information and should include at least one visit by a knowledgeable biologist to the prospective site(s). Because Tier 2 studies are preliminary, normally one reconnaissance level site visit will be adequate as a "ground-truth" of available information. Notwithstanding, if key issues are identified that relate to varying conditions and/or seasons, Tier 2 studies should include enough site visits during the appropriate times of the year to adequately assess these issues for the prospective site(s).

If the results of the site assessment indicate that one or more species of concern are present, a developer should consider applicable regulatory or other agency processes for addressing them. For instance, if migratory birds and bats are likely to experience significant adverse impacts by a wind project at the proposed site, a developer should identify and document possible actions that will avoid or compensate for those impacts. Such actions might include, but not be limited to, altering locations of turbines or turbine arrays, operational changes, or compensatory mitigation. As soon as a developer anticipates that a wind energy project is likely to result in a take of bald or golden eagles, a developer should prepare an ECP and, if necessary, apply for a programmatic take permit. As soon as a developer realizes endangered or threatened species are present and likely to be affected by a wind project located there, a federal agency should consult with the Service under Section 7(a)(2) of the ESA if the project has a federal nexus or the developer should apply for a section 10(a)(1)(B) incidental take permit if there is not a federal nexus, and incidental take of listed wildlife is anticipated. State, tribal, and local jurisdictions may have additional permitting requirements.

Developers of distributed or community scale wind projects are typically considering limited geographic areas to install turbines. Therefore, they would likely be familiar with conditions at the site where they are considering installing a turbine. Nevertheless, they should do preliminary site evaluations to determine the presence of habitats or species of concern before siting projects.

Tier 2 Questions

Questions suggested for Tier 2 can be answered using credible, publicly available information that includes published studies, technical reports, databases, and information from agencies, local conservation organizations, and/or local experts. Developers or consultants working on their behalf should contact the federal, state, tribal, and local agencies that have jurisdiction or management authority and responsibility over the potential project.

1. **Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?**

2. **Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information? Examples of designated areas include, but are not limited to: federally-designated critical habitat;**



Open landscape with wind turbines. Credit: NREL

high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

3. **Are there plant communities of concern present or likely to be present at the site(s)?**

4. **Are there known critical areas of congregation of species of concern, including, but not limited to: maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?**

5. **Using best available scientific information has the developer or relevant federal, state, tribal, and/or local agency identified the potential presence of a population of a species of habitat fragmentation concern?**

6. **Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?**

7. **Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?**

Tier 2 Methods and Metrics

Obtaining answers to Tier 2 questions will involve a more thorough review of the existing site-specific information than in Tier 1. Tier 2 site characterizations studies will generally contain three elements:

1. A review of existing information, including existing published or available literature and databases and maps of topography, land use and land cover, potential wetlands, wildlife, habitat, and sensitive plant distribution. If agencies have documented potential habitat for species of habitat fragmentation concern, this information can help with the analysis.

2. Contact with agencies and organizations that have relevant scientific information to further help identify if there are bird, bat or other wildlife issues. The Service recommends that the developer make contact with federal, state, tribal, and local agencies that have jurisdiction or management authority over the project or information about the potentially affected resources. In addition, because key NGOs and relevant local groups are often valuable sources of relevant local environmental information, the Service recommends that developers contact key NGOs, even if confidentiality concerns preclude the developer from identifying specific project location information at this stage. These contacts also provide an opportunity to identify other potential issues and data not already identified by the developer.

3. One or more reconnaissance level site visits by a wildlife biologist to evaluate current vegetation/habitat coverage and land management/use. Current habitat and land use practices will be noted to help in determining the baseline against which potential impacts from the project would be evaluated. The vegetation/habitat will be used for identifying potential bird and bat resources occurring at the site and the potential presence of, or suitable habitat for, species of concern. Vegetation types or habitats will be noted and evaluated against available information such as land use/land cover mapping. Any sensitive resources located during the site visit will be noted and mapped or digital location data recorded for future reference. Any individuals or signs of species of concern observed during the site visit will be noted. If land access agreements are not in place, access to the site will be limited to public roads.

Specific resources that can help answer each Tier 2 question include:

1. **Are known species of concern present on the proposed site, or is habitat (including designated critical habitat) present for these species?**

   Information review and agency contact: locations of state and federally listed, proposed and candidate species and species of concern are frequently documented in state and federal wildlife databases. Examples include published literature such as: Natural Heritage Databases, State Wildlife Action Plans, NGOs publications, and developer and consultant information, or can be obtained by contacting these entities.

   Site Visit: To the extent practicable, the site visit(s) should evaluate the suitability of habitat at the site for species identified and the likelihood of the project to adversely affect the species of concern that may be present.

2. **Does the landscape contain areas where development is precluded by law or designated as sensitive according to scientifically credible information?** Examples of designated areas include, but are not limited to: federally-designated critical habitat; high-priority conservation areas for NGOs; or other local, state, regional, federal, tribal, or international categorizations.

   Information review and agency contact such as: maps of political and administrative boundaries; National Wetland Inventory data files; USGS National Land Cover data maps; state, federal and tribal agency data on areas that have been designated to preclude development, including wind energy development; State Wildlife Action Plans; State Land and Water Resource Plans; Natural Heritage databases; scientifically credible information provided by NGO and local



Tall grass prairie. Credit: Amy Thornburg, USFWS

resources; and the additional resources listed in Appendix C: Sources of Information Pertaining to Methods to Assess Impacts to Wildlife of this document, or through contact of agencies and NGOs, to determine the presence of high priority habitats for species of concern or conservation areas.

Site Visit: To the extent practicable, the site visit(s) should characterize and evaluate the uniqueness of the site vegetation relative to surrounding areas.

3. Are plant communities of concern present or likely to be present at the site(s)?

Information review and agency contact such as: Natural Heritage Data of state rankings (S1, S2, S3) or globally (G1, G2, G3) ranked rare plant communities.

Site Visit: To the extent practicable, the site visit should evaluate the topography, physiographic features and uniqueness of the site vegetation in relation to the surrounding region. If plant communities of concern are present, developers should also assess in Tier 3 whether the proposed project poses risk of significant adverse impacts and opportunities for mitigation.

4. Are there known critical areas of wildlife congregation, including, but not limited to, maternity roosts, hibernacula, staging areas, winter ranges, nesting sites, migration stopovers or corridors, leks, or other areas of seasonal importance?

Information review and agency contact such as: existing databases, State Wildlife Action Plan, Natural Heritage Data, and NGO and agency information regarding the presence of Important Bird Areas, migration corridors or stopovers, leks, bat hibernacula or maternity roosts, or game winter ranges at the site and in the surrounding area.

Site Visit: To the extent practicable, the site visit should, during appropriate times to adequately assess these issues for prospective site(s), evaluate the topography, physiographic features and uniqueness of the site in relation to the surrounding region to assess the potential for the project area to concentrate resident or migratory birds and bats.

5. Using best available scientific information, has the relevant federal, state, tribal, and/or local agency determined the potential presence of a population of a species of habitat fragmentation concern?

If not, the developer need not assess impacts of the proposed project on habitat fragmentation.

Habitat fragmentation is defined as the separation of a block of habitat for a species into segments, such that the genetic or demographic viability of the populations surviving in the remaining habitat segments is reduced; and risk, in this case, is defined as the probability that this fragmentation will occur as a result of the project. Site clearing, access roads, transmission lines and turbine tower arrays remove habitat and displace some species

of wildlife, and may fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding and foraging.

Consequences of isolating local populations of some species include decreased reproductive success, reduced genetic diversity, and increased susceptibility to chance events (e.g. disease and natural disasters), which may lead to extirpation or local extinctions. In addition to displacement, development of wind energy infrastructure may result in additional loss of habitat for some species due to "edge effects" resulting from the break-up of continuous stands of similar vegetation resulting in an interface (edge) between two or more types of vegetation. The extent of edge effects will vary by species and may result in adverse impacts from such effects as a greater susceptibility to colonization by invasive species, increased risk of predation, and competing species favoring landscapes with a mosaic of vegetation.

Site Visit: If the answer to Tier 2 Question 5 is yes, developers should use the general framework for evaluating habitat fragmentation at a project site in Tier 2 outlined below. Developers and the Service may use this method to analyze the impacts of habitat fragmentation at wind development project sites on species of habitat fragmentation concern. Service field offices may be able to provide the available information on habitat types, quality and intactness. Developers may use this information in combination with site-specific information on the potential habitats to be impacted by a potential development and how they will be impacted.

<u>General Framework for Evaluating Habitat Fragmentation at a Project Site (Tier 2)</u>

A. The developer should define the study area. The study area should not only include the project site for the proposed project, but be based on the distribution of habitat for the local population of the species of habitat fragmentation concern.

B. The developer should analyze the current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.

   i. Use recent aerial and remote imagery to determine distinct habitat patches, or boundaries, within the study area, and the extent of existing habitat fragmenting features (e.g., highways).

   ii. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:

   - High quality: little or no apparent fragmentation of intact habitat
   - Medium quality: intact habitat exhibiting some recent disturbance activity
   - Low quality: Extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

C. The developer should determine potential changes in quality and spatial configuration of the habitat in the study area if development were to proceed as proposed using existing site information.

D. The developer should provide the collective information from steps A-C for all potential developments to the Service for use in assessing whether the habitat impacts, including habitat fragmentation, are likely to affect population viability of the potentially affected species of habitat fragmentation concern.

6. **Which species of birds and bats, especially those known to be at risk by wind energy facilities, are likely to use the proposed site based on an assessment of site attributes?**

   Information review and agency contact: existing published information and databases from NGOs and federal and state resource agencies regarding the potential presence of:

   - Raptors: species potentially present by season
   - Prairie grouse and sage grouse: species potentially present by season and location of known leks
   - Other birds: species potentially present by season that may be at risk of collision or adverse impacts to habitat, including loss, displacement and fragmentation
   - Bats: species likely to be impacted by wind energy facilities and likely to occur on or migrate through the site

   Site Visit: To the extent practicable, the site visit(s) should identify landscape features or habitats that could be important to raptors, prairie grouse, and other birds that may be at risk of adverse impacts, and bats, including nesting and brood-rearing habitats, areas of high prey density, movement corridors and features such as ridges that may concentrate raptors. Raptors, prairie grouse, and other presence or sign of species of concern seen during the site visit should be noted, with species identification if possible.

7. **Is there a potential for significant adverse impacts to species of concern based on the answers to the questions above, and considering the design of the proposed project?**

The developer has assembled answers to the questions above and should make an initial evaluation of the probability of significant adverse impacts to species of concern and their habitats. The developer should make this evaluation based on assessments of the potential presence of species of concern and their habitats, potential presence of critical congregation areas for species of concern, and any site visits. The developer is encouraged to communicate the results of these assessments with the Service.

Tier 2 Decision Points

Possible outcomes of Tier 2 include the following:

1. The most likely outcome of Tier 2 is that the answer to one or more Tier 2 questions is inconclusive to address wildlife risk, either due to insufficient data to answer the question or because of uncertainty about what the answers indicate. The developer proceeds to Tier 3, formulating questions, methods, and assessment of potential mitigation measures based on issues raised in Tier 2 results.

2. Sufficient information is available to answer all Tier 2 questions, and the answer to each Tier 2 question indicates a low probability of significant adverse impact to wildlife (for example, infill or expansion of an existing facility where impacts have been low and Tier 2 results indicate that conditions are similar, therefore wildlife risk is low). The developer may then decide to proceed to obtain state and local permit (if required), design, and construction following best management practices (see Chapter 7: Best Management Practices).

3. Sufficient information is available to answer all Tier 2 questions, and the answer to each Tier 2 question indicates a moderate probability of significant adverse impacts to species of concern or their habitats. The developer should proceed to Tier 3 and identify measures to mitigate potential significant adverse impacts to species of concern.

4. The answers to one or more Tier 2 questions indicate a high probability of significant adverse impacts to species of concern or their habitats that:

   a) Cannot be adequately mitigated. The proposed site should be abandoned.

   b) Can be adequately mitigated. The developer should proceed to Tier 3 and identify measures to mitigate potential significant adverse impacts to species of concern or their habitats.



Greater sage grouse, Credit: Stephen Ting, USFWS

Chapter 4: Tier 3 – Field Studies to Document Site Wildlife and Habitat and Predict Project Impacts

Tier 3 is the first tier in which a developer would conduct quantitative and scientifically rigorous studies to assess the potential risk of the proposed project. Specifically, these studies provide pre-construction information to:

- Further evaluate a site for determining whether the wind energy project should be developed or abandoned
- Design and operate a site to avoid or minimize significant adverse impacts if a decision is made to develop
- Design compensatory mitigation measures if significant adverse habitat impacts cannot acceptably be avoided or minimized
- Determine duration and level of effort of post-construction monitoring. If warranted, provide the pre-construction component of post-construction studies necessary to estimate and evaluate impacts

At the beginning of Tier 3, a developer should communicate with the Service on the pre-construction studies. At the end of Tier 3, developers should communicate with the Service regarding the results of the Tier 3 studies and consider the Service's comments and recommendations prior to completing the Tier 3 decision process. The Service will provide written comments to a developer that identify concerns and recommendations to resolve the concerns based on study results and project development plans.

Not all Tier 3 studies will continue into Tiers 4 or 5. For example, surveys conducted in Tier 3 for species of concern may indicate one or more species are not present at the proposed project site, or siting decisions could be made in Tier 3 that remove identified concerns, thus removing the need for continued efforts in later tiers. Additional detail on the design issues for post-construction studies that begin in Tier 3 is provided in the discussion of methods and metrics in Tier 3.



Turkey vulture and wind turbine. Credit: Rachel London, USFWS

Tier 3 Questions

Tier 3 begins as the other tiers, with problem formulation: what additional studies are necessary to enable a decision as to whether the proposed project can proceed to construction or operation or should be abandoned? This step includes an evaluation of data gaps identified by Tier 2 studies as well as the gathering of data necessary to:

- Design a project to avoid or minimize predicted risk
- Evaluate predictions of impact and risk through post-construction comparisons of estimated impacts
- Identify compensatory mitigation measures, if appropriate, to offset significant adverse impacts that cannot be avoided or minimized

The problem formulation stage for Tier 3 also will include an assessment of which species identified in Tier 1 and/or Tier 2 will be studied further in the site risk assessment. This determination is based on analysis of existing data from Tier 1 and existing site-specific data and Project Site (see Glossary in Appendix A) visit(s) in Tier 2, and on the likelihood of presence and the degree of adverse impact to species or their habitat. If the habitat is suitable for a species needing further study and the site occurs within the historical range of the species, or is near the existing range of the species but presence has not been documented, additional field studies may be appropriate. Additional analyses should not be necessary if a species is unlikely to be present or is present but adverse impact is unlikely or of minor significance.

Tier 3 studies address many of the questions identified for Tiers 1 and 2, but Tier 3 studies differ because they attempt to quantify

the distribution, relative abundance, behavior, and site use of species of concern. Tier 3 data also attempt to estimate the extent that these factors expose these species to risk from the proposed wind energy facility. Therefore, in answering Tier 3 questions 1-3, developers should collect data sufficient to analyze and answer Tier 3 questions 4-6. High risk sites may warrant additional years of pre-construction studies. The duration and intensity of studies needed should be determined through communication with the Service.

If Tier 3 studies identify species of concern or important habitats, e.g., wetlands, which have specific regulatory processes and requirements, developers should work with appropriate state, tribal, or federal agencies to obtain required authorizations or permits.

Tier 3 studies should be designed to answer the following questions:

1. **Do field studies indicate that species of concern are present on or likely to use the proposed site?**

2. **Do field studies indicate the potential for significant adverse impacts on affected population of species of habitat fragmentation concern?**

3. **What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind energy project?**

4. **What are the potential risks of adverse impacts of the proposed wind energy project to individuals and local populations of species of concern and their habitats? (In the case of rare or endangered species, what are the possible impacts to such species and their habitats?)**

5. **How can developers mitigate identified significant adverse impacts?**

6. **Are there studies that should be initiated at this stage that would be continued in post-construction?**

The Service encourages the use of common methods and metrics in Tier 3 assessments for measuring wildlife activity and habitat features. Common methods and metrics provide great benefit over the long-term, allowing for comparisons among projects and for greater certainty regarding what will be asked of the developer for a specific project. Deviation from commonly used methods should be carefully considered, scientifically justifiable and discussed with federal, tribal, or state natural resource agencies, or other credible experts, as appropriate. It may be useful to consult other scientifically credible information sources.

Tier 3 studies will be designed to accommodate local and regional characteristics. The specific protocols by which common methods and metrics are implemented in Tier 3 studies depend on the question being addressed, the species or ecological communities being studied and the characteristics of the study sites. Federally-listed threatened and endangered species, eagles, and some other species of concern and their habitats, may have specific protocols required by local, state or federal agencies. The need for special surveys and mapping that address these species and situations should be discussed with the appropriate stakeholders.

In some instances, a single method will not adequately assess potential collision risk or habitat impact. For example, when there is concern about moderate or high risk to nocturnally active species, such as migrating passerines and local and migrating bats, a combination of remote sensing tools such as radar, and acoustic monitoring for bats and indirect inference from diurnal bird surveys during the migration period may be necessary. Answering questions about habitat use by songbirds may be accomplished by relatively small-scale observational studies, while answering the same question related to wide-ranging species such as prairie grouse and sage grouse may require more time-consuming surveys, perhaps including telemetry.

Because of the points raised above and the need for flexibility in application, the Guidelines do not make specific recommendations on protocol elements for Tier 3 studies. The peer-reviewed scientific literature (such as the articles cited throughout this section) contains numerous recently published reviews of methods for assessing bird and bat activity, and tools for assessing habitat and landscape level risk. Details on specific methods and protocols for recommended studies are or will be widely available and should be consulted by industry and agency professionals.

Many methods for assessing risk are components of active research involving collaborative efforts of public-private research partnerships with federal, state and tribal agencies, wind energy developers and NGOs interested in wind energy-wildlife interactions (e.g., Bats and Wind Energy Cooperative and the Grassland Shrub Steppe Species Cooperative). It is important to recognize the need to integrate the results of research that improves existing methods or describes new methodological developments, while acknowledging the value of utilizing common methods that are currently available.

The methods and metrics that may be appropriate for gathering data to answer Tier 3 questions are compiled and outlined in the Technical Resources section, page 26. These are not meant to be all inclusive and other methods and metrics are available, such as the NWCC Methods & Metrics document (Strickland et al. 2011) and others listed in Appendix C:



Avian Radar

Sources of Information Pertaining to Methods to Assess Impacts to Wildlife.

Each question should be considered in turn, followed by a discussion of the methods and their applicability.

1. **Do field studies indicate that species of concern are present on or likely to use the proposed site?**

In many situations, this question can be answered based on information accumulated in Tier 2. Specific presence/absence studies may not be necessary, and protocol development should focus on answering the remaining Tier 3 questions. Nevertheless, it may be necessary to conduct field studies to determine the presence, or likelihood of presence, when little information is available for a particular site. The level of effort normally contemplated for Tier 3 studies should detect common species and species that are relatively rare, but which visit a site regularly (e.g., every year). In the event a species of concern is very rare and only occasionally visits a site, a determination of "likely to occur" would be inferred from the habitat at the site and historical records of occurrence on or near the site.

State, federal and tribal agencies often require specific protocols be followed when species of concern are potentially present on a site. The methods and protocols for determining presence of species of concern at a site are normally established for each species and required by federal, state and tribal resource agencies. Surveys should sample the wind turbine sites and applicable disturbance area during seasons when species are most likely present. Normally, the methods and protocols by which they are applied also will include an estimate of relative abundance. Most presence/absence surveys should be done following a probabilistic sampling protocol to allow statistical extrapolation to the area and time of interest.

Determining the presence of diurnally or nocturnally active mammals, reptiles, amphibians, and other species of concern will typically be accomplished by following agency-required protocols. Most listed species have required protocols for detection (e.g., the black-footed ferret). State, tribal and federal agencies should be contacted regarding survey protocols for those species of concern. See Corn and Bury 1990, Olson et al. 1997, Bailey et al. 2004, Graeter et al. 2008 for examples of reptile and amphibian protocols, survey and analytical methods. See Tier 3 Study Design Considerations on page 24 for further details.

2. **Do field studies indicate the potential for significant adverse impacts on affected populations of species of habitat fragmentation concern?**

If Tier 2 studies indicate the presence of species of habitat fragmentation concern, but existing information did not allow for a complete analysis of potential impacts and decision-making, then additional studies and analyses should take place in Tier 3.

As in Tier 2, the particulars of the analysis will depend on the species of habitat fragmentation concern and how habitat block size and fragmentation are defined for the life cycles of that species, the likelihood that the project will adversely affect a local population of the species and the significance of these impacts to the viability of that population.

To assess habitat fragmentation in the project vicinity, developers should evaluate landscape characteristics of the proposed site prior to construction and determine the degree to which habitat for species of habitat fragmentation concern will be significantly altered by the presence of a wind energy facility.

A general framework for evaluating habitat fragmentation at a project site, following that described in Tier 2, is outlined on page 27. This framework should be used in those circumstances when the developer, or a relevant federal, state, tribal and/or other local agency determines the potential presence of a population of a species of habitat fragmentation concern that may be adversely affected by the project. Otherwise, the developer need not assess the impacts of the proposed project on habitat fragmentation. This method for analysis of habitat fragmentation at project sites must be adapted to the local population of the species of habitat fragmentation concern potentially affected by the proposed development.

3. **What is the distribution, relative abundance, behavior, and site use of species of concern identified in Tiers 1 or 2, and to what extent do these factors expose these species to risk from the proposed wind energy project?**

For those species of concern that are considered at risk of collisions or habitat impacts, the questions to be answered in Tier 3 include: where are they likely to occur (i.e., where is their habitat) within a project site or vicinity, when might they occur, and in what abundance. The spatial distribution of species at risk of collision can influence how a site is developed. This distribution should include the airspace for flying species with respect to the rotor-

swept zone. The abundance of a species and the spatial distribution of its habitat can be used to determine the relative risk of impact to species using the sites, and the absolute risk when compared to existing projects where similar information exists. Species abundance and habitat distribution can also be used in modeling risk factors.

Surveys for spatial distribution and relative abundance require coverage of the wind turbine sites and applicable site disturbance area, or a sample of the area using observational methods for the species of concern during the seasons of interest. As with presence/absence (see Tier 3, question 1, above) the methods used to determine distribution, abundance, and behavior may vary with the species and its ecology. Spatial distribution is determined by applying presence/absence or using surveys in a probabilistic manner over the entire area of interest. Suggested survey protocols for birds, bats, and other wildlife are found in the Technical Resources section on page 26.



Whooping crane. Credit: Ryan Hagerty, USFWS

4. **What are the potential risks of adverse impacts of the proposed wind energy project to individuals and local populations of species of concern and their habitats? (In the case of rare or endangered species, what are the possible impacts to such species and their habitats?)**

Methods used for estimating risk will vary with the species of concern. For example, estimating potential bird fatalities in Tier 3 may be accomplished by comparing exposure estimates (described earlier in estimates of bird use) at the proposed site with exposure estimates and fatalities at existing projects with similar characteristics (e.g., similar technology, landscape, and weather conditions). If models are used, they may provide an additional tool for estimating fatalities, and have been used in Australia (Organ and Meredith 2004), Europe (Chamberlin et al. 2006), and the United States (Madders and Whitfield 2006). As with other prediction tools, model predictions should be evaluated and compared with post-construction fatality data to validate the models. Models should be used as a subcomponent of a risk assessment based on the best available empirical data. A statistical model based on the relationship of pre-construction estimates of raptor abundance and post-construction raptor fatalities is described in Strickland et al. (2011) and promises to be a useful tool for risk assessment.

Collision risk to individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, relative abundance, behavior, weather conditions (e.g., wind, temperature) and site characteristics. Collision risk for an individual may be low regardless of abundance if its behavior does not place it within the rotor-swept zone. If individuals frequently occupy the rotor-swept zone but effectively avoid collisions, they are also at low risk of collision with a turbine (e.g., ravens). Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher risk of collisions with turbines regardless of abundance. For a given species (e.g., red-tailed hawk), increased abundance increases the likelihood that individuals will be killed by turbine strikes, although the risk to individuals will remain about the same. The risk to a population increases as the proportion of individuals in the population at risk to collision increases.

At some projects, bat fatalities are higher than bird fatalities, but the exposure risk of bats at these facilities is not fully understood (National Research Council (NRC) 2007). Horn et al. (2008) and Cryan (2008) hypothesize that bats are attracted to turbines, which, if true, would further complicate estimation

of exposure. Further research is required to determine if bats are attracted to turbines and if so, to evaluate 1) the influence on Tier 2 methods and predictions, and 2) if this increased individual risk translates into higher population-level impacts for bats.

The estimation of indirect impact risk requires an understanding of animal behavior in response to a project and its infrastructure, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid areas in proximity to turbines, roads and other components of the project. The amount of habitat that is lost to indirect impacts will be a function of the sensitivity of individuals to the project and to the activity levels associated with the project's operations. The population-level significance of this indirect impact will depend on the amount of habitat available to the affected population. If the indirect impacts include habitat fragmentation, then the risk to the demographic and genetic viability of the isolated animals is increased. Quantifying cause and effect may be very difficult, however.

5. How can developers mitigate identified significant adverse impacts?

Results of Tier 3 studies should provide a basis for identifying measures to mitigate significant adverse impacts predicted for species of concern. Information on wildlife use of the proposed area is most useful when designing a project to avoid or minimize significant adverse impacts. In cases of uncertainty with regard to impacts to species of concern, additional studies may be necessary to quantify significant adverse impacts and determine the need for mitigation of those impacts.

Chapter 7, Best Management Practices, and Chapter 8, Mitigation, outline measures that can be taken to mitigate impacts throughout all phases of a project.

The following discussion of prairie grouse and sage grouse as species of concern illustrates the uncertainty mentioned above by describing the present state of scientific knowledge relative to these species, which should be considered when designing mitigation measures. The extent of the impact of wind energy development on prairie grouse and sage grouse lekking activity (e.g., social structure, mating success, persistence) and the associated impacts on productivity (e.g., nesting, nest success, chick survival) is poorly understood (Arnett et al. 2007, NRC 2007, Manville 2004). However, recent published research documents that anthropogenic features (e.g., tall structures, buildings, roads, transmission lines) can adversely impact vital rates (e.g., nesting, nest success, lekking behavior) of lesser prairie-chickens (Pruett et al. 2009, Pitman et al. 2005, Hagen et al. 2009, Hagen et al. 2011) and greater prairie-chickens over long distances. Pitman et al. (2005) found that transmission lines reduced nesting of lesser prairie chicken by 90 percent out to a distance of 0.25 miles, improved roads at a distance of 0.25 miles, a house at 0.3 miles, and a power plant at >0.6 miles. Reduced nesting activity of lesser prairie chickens may extend farther, but Pitman et al. (2005) did not analyze their data for lower impacts (less than 90 percent reduction in nesting) of those anthropogenic features on lesser prairie chicken nesting activities at greater distances. Hagen et al. (2011) suggested that development within 1 to 1 ½ miles of active leks of prairie grouse may have significant adverse impacts on the affected grouse population. It is not unreasonable to infer that impacts from wind energy facilities may be similar to those from these other anthropogenic structures. Kansas State University, as part of the National Wind Coordinating Collaborative's Grassland and Shrub Steppe Species Subgroup, is undertaking a multi-year telemetry study to evaluate the effects of a proposed wind-energy facility on displacement and demographic parameters (e.g., survival, nest success, brood success, fecundity) of greater prairie-chickens in Kansas.[5]

The distances over which anthropogenic activities impact sage grouse are greater than for prairie grouse. Based primarily on data documenting reduced fecundity (a combination of nesting, clutch size, nest success, juvenile survival, and other factors) in sage grouse populations near roads, transmissions lines, and areas of oil and gas development/production (Holloran 2005, Connelly et al. 2000), development within three to five miles (or more) of active sage grouse leks may have significant adverse impacts on the affected grouse population. Lyon and Anderson (2003) found that in habitats fragmented by natural gas development, only 26 percent of hens captured on disturbed leks nested within 1.8 miles of the lek of capture, whereas 91 percent of hens from undisturbed areas nested within the same area. Holloran (2005) found that active drilling within 3.1 miles of sage grouse lek reduced the number of breeding males by displacing adult males and reducing recruitment of juvenile males. The magnitudes and proximal causes (e.g., noise, height of structures, movement, human activity, etc.) of those impacts on vital rates in grouse populations are areas of much needed research (Becker et al. 2009). Data accumulated through such research may improve our understanding of the buffer distances necessary to avoid or minimize significant adverse impacts to prairie grouse and sage grouse populations.

When significant adverse impacts cannot be fully avoided or adequately minimized, some form of compensatory mitigation may be

[5] www.nationalwind.org

appropriate to address the loss of habitat value. For example, it may be possible to mitigate habitat loss or degradation for a species of concern by enhancing or restoring nearby habitat value comparable to that potentially influenced by the project.

6. Are there studies that should be initiated at this stage that would be continued in post-construction?

During Tier 3 problem formulation, it is necessary to identify the studies needed to address the Tier 3 questions. Consideration of how the resulting data may be used in conjunction with post-construction Tier 4 and 5 studies is also recommended. The design of post-construction impact or mitigation assessment studies will depend on the specific impact questions being addressed. Tier 3 predictions will be evaluated using data from Tier 4 studies designed to estimate fatalities for species of concern and impacts to their habitat, including species of habitat fragmentation concern. Tier 3 studies may demonstrate the need for mitigation of significant adverse impacts. Where Tier 3 studies indicate the potential for significant adverse direct and indirect impacts to habitat, Tier 4 studies will provide data that evaluate predictions of those impacts, and Tier 5 studies, if necessary, will provide data to evaluate the effect of those impacts on populations and the effectiveness of mitigation measures. Evaluations of the impacts of a project on demographic parameters of local populations, habitat use, or some other parameter(s) are considered Tier 5 studies, and typically will require data on these parameters prior to as well as after construction of the project.

Tier 3 Study Design Considerations

Specific study designs will vary from site to site and should be adjusted to the circumstances of individual projects. Study designs will depend on the types of questions, the specific project, and practical considerations. The most common considerations include the area being studied, the species of concern and potential risk to those species, potentially confounding variables, time available to conduct studies, project budget, and the magnitude of the anticipated impacts. Studies will be necessary in part to assess a) which species of concern are present within the project area; b) how these species are using the area (behavior); and c) what risks are posed to them by the proposed wind energy project.



Rows of wind turbines. Credit: Joshua Winchell, USFWS

Assessing Presence

A developer should assess whether species of concern are likely to be present in the project area during the life of the project. Assessing species use from databases and site characteristics is a potential first step. However, it can be difficult to assess potential use by certain species from site characteristics alone. Various species in different locations may require developers to use specific survey protocols or make certain assumptions regarding presence. Project developers should seek local wildlife expertise, such as Service Field Office staff, in using the proper procedures and making assumptions.

Some species will present particular challenges when trying to determine potential presence. For instance, species that a) are rare or cryptic; b) migrate, conduct other daily movements, or use areas for short periods; c) are small or nocturnal; or d) have become extirpated in parts of their historical range can be difficult to observe. One of these challenges is migration, broadly defined as the act of moving from one spatial unit to another (Baker 1978), or as a periodic movement of animals from one location to another. Migration is species-specific, and for birds and bats occurs throughout the year.

Assessing Site Use/Behavior

Developers should monitor potential sites to determine the types of migratory species present, what type of spatial and temporal use these species make of the site (e.g., chronology of migration or other use), and the ecological function the site may provide in terms of the migration cycle of these species. Wind developers should determine not only what species may migrate through a proposed development site and when, but also whether a site may function as a staging area or stopover habitat for wildlife on their migration pathway.

For some species, movements between foraging and breeding habitat, or between sheltering and feeding habitats, occur on a daily basis. Consideration of daily movements (morning and evening; coming and going) is a critical factor when considering project development.

Duration/Intensity of Studies

Where pre-construction assessments are warranted to help assess risk to wildlife, the studies should be of sufficient duration and intensity to ensure adequate data are collected to accurately characterize wildlife presence and use of the area. In ecological systems, resource quality and quantity can fluctuate rapidly. These fluctuations occur naturally, but human actions can significantly affect (i.e., increase or decrease) natural oscillations. Pre-construction monitoring and assessment of proposed wind energy sites are "snapshots in time," showing occurrence or no occurrence of a species or habitat at the specific time surveyed. Often due to prohibitive costs, assessments and surveys are conducted for very low percentages (e.g., less than 5 percent) of the available sample time in a given year, however, these data are used to support risk analyses over the projected life of a project (e.g., 30 years of operations).

To establish a trend in site use and conditions that incorporates annual and seasonal variation in meteorological conditions, biological factors, and other variables, pre-construction studies may need to occur over multiple years. However, the level of risk and the question of data requirements will be based on site sensitivity, affected species, and the availability of data from other sources. Accordingly, decisions regarding studies should consider information gathered during the previous tiers, variability within and between seasons, and years where variability is likely to substantially affect answers to the Tier 3 questions. These studies should also be designed to collect data during relevant breeding, feeding, sheltering, staging, or migration periods for each species being studied. Additionally, consideration for the frequency and intensity of pre-construction monitoring should be site-specific and determined through consultation with an expert authority based on their knowledge of the specific species, level of risk and other variables present at each individual site.

Assessing Risk to Species of Concern

Once likely presence and factors such as abundance, frequency of use, habitat use patterns, and behavior have been determined or assumed, the developer should consider and/or determine the consequences to the "populations" and species.

Below is a brief discussion of several types of risk factors that can be considered. This does not include all potential risk factors for all species, but addresses the most common ones.

Collision

Collision likelihood for individual birds and bats at a particular wind energy facility may be the result of complex interactions among species distribution, "relative abundance," behavior, visibility, weather conditions, and site characteristics. Collision likelihood for an individual may be low regardless of abundance if its behavior does not place it within the "rotor-swept zone." Individuals that frequently occupy the rotor-swept zone but effectively avoid collisions are also at low likelihood of collision with a turbine.

Alternatively, if the behavior of individuals frequently places them in the rotor-swept zone, and they do not actively avoid turbine blade strikes, they are at higher likelihood of collisions with turbines regardless of abundance. Some species, even at lower abundance, may have a higher collision rate than similar species due to subtle differences in their ecology and behavior.

At many projects, the numbers of bat fatalities are higher than the numbers of bird fatalities, but the exposure risk of bats at these facilities is not fully understood. Researchers (Horn et al. 2008 and Cryan 2008) hypothesize that some bats may be attracted to turbines, which, if true, would further complicate estimation of exposure. Further research is required to determine whether bats are attracted to turbines and if so, whether this increased individual risk translates into higher population-scale effects.

Habitat Loss and Degradation

Wind project development results in direct habitat loss and habitat modification, especially at sites previously undeveloped. Many of North America's native landscapes are greatly diminished or degraded from multiple causes unrelated to wind energy. Important remnants of these landscapes are identified and documented in various databases held by private conservation organizations, state wildlife agencies, and, in some cases, by the Service. Species that depend on these landscapes are susceptible to further loss of habitat, which will affect their ability to reproduce and survive. While habitat lost due to footprints of turbines, roads, and other infrastructure is obvious, less obvious is the potential reduction of habitat quality.

Habitat Fragmentation

Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Site clearing, access roads, transmission lines, and arrays of turbine towers may displace some species or fragment continuous habitat areas into smaller, isolated tracts. Habitat fragmentation is of particular concern when species require large expanses of habitat for activities such as breeding, foraging, and sheltering.

Habitat fragmentation can result in increases in "edge" resulting in direct effects of barriers

and displacement as well as indirect effects of nest parasitism and predation. Sensitivity to fragmentation effects varies among species. Habitat fragmentation and site modification are important issues that should be assessed at the landscape scale early in the siting process. Identify areas of high sensitivity due to the presence of blocks of native habitats, paying particular attention to known or suspected "species sensitive to habitat fragmentation."

Displacement and Behavioral Changes

Estimating displacement risk requires an understanding of animal behavior in response to a project and its infrastructure and activities, and a pre-construction estimate of presence/absence of species whose behavior would cause them to avoid or seek areas in proximity to turbines, roads, and other components of the project. Displacement is a function of the sensitivity of individuals to the project and activity levels associated with operations.

Indirect Effects

Wind development can also have indirect effects to wildlife and habitats. Indirect effects include reduced nesting and breeding densities and the social ramifications of those reductions; loss or modification of foraging habitat; loss of population vigor and overall population density; increased isolation between habitat patches, loss of habitat refugia; attraction to modified habitats; effects on behavior; physiological disturbance, and habitat unsuitability. Indirect effects can result from introduction of invasive plants; increased predator populations or facilitated predation; alterations in the natural fire regime; or other effects, and can manifest themselves later in time than the causing action.

When collection of both pre- and post-construction data in the areas of interest and reference areas is possible, then the Before-After-Control-Impact (BACI) is the most statistically robust design. The BACI design is most like the classic manipulative experiment.[6] In the absence of a suitable reference area, the design is reduced to a Before-After (BA) analysis of effect where the differences between pre- and post-construction parameters of interest are assumed to be the result of the project, independent of other potential factors affecting the assessment area. With respect to BA studies, the key question is whether the observations taken immediately after the incident can reasonably be expected within the expected range for the system (Manly 2009). Reliable quantification of impact usually will include additional study components to limit variation and the confounding effects of natural factors that may change with time.



Virginia big-eared bat. Credit: USFWS

The developer's timeline for the development of a wind energy facility often does not allow for the collection of sufficient pre-construction data and/or identification of suitable reference areas to complete a BACI or BA study. Furthermore, alterations in land use or disturbance over the course of a multi-year BACI or BA study may complicate the analysis of study results. Additional discussion of these issues can be found in Tier 5 Study Design Considerations.

Tier 3 Technical Resources

The following methods and metrics are provided as suggested sources for developers to use in answering the Tier 3 questions.

Tier 3, Question 1

Acoustic monitoring can be a practical method for determining the presence of threatened, endangered or otherwise rare species of bats throughout a proposed project (Kunz et al. 2007). There are two general types of acoustic detectors used for collection of information on bat activity and species identification: the full-spectrum, time-expansion and the zero-crossing techniques for ultrasound bat detection (see Kunz et al. 2007 for detailed discussion). Full-spectrum time expansion detectors provide nearly complete species discrimination, while zero-crossing detectors provide reliable and cost-effective estimates of total bat use at a site and some species discrimination. Myotis species can be especially difficult to discriminate with zero-crossing detectors (Kunz et al. 2007). Kunz et al. (2007) describe the strengths and weaknesses of each technique for ultrasonic bat detection, and either type of detector may be useful in most situations except where species identification is especially important and zero-crossing methods are inadequate to provide the necessary data. Bat acoustics technology is evolving rapidly and study objectives are an important consideration when selecting detectors. When rare or endangered species of bats are suspected, sampling should occur during different seasons and at

[6] In this context, such designs are not true experiments in that the treatments (project development and control) are not randomly assigned to an experimental unit, and there is often no true replication. Such constraints are not fatal flaws, but do limit statistical inferences of the results.

multiple sampling stations to account for temporal and spatial variability.

Mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or otherwise rare species. Mist-netting is best used in combination with acoustic monitoring to inventory the species of bats present at a site, especially to detect the presence of threatened or endangered species. Efforts should concentrate on potential commuting, foraging, drinking, and roosting sites (Kuenzi and Morrison 1998, O'Farrell et al. 1999). Mist-netting and other activities that involve capturing and handling threatened or endangered species of bats will require permits from state and/or federal agencies.

Tier 3, Question 2

The following protocol should be used to answer Tier 3, Question 2. This protocol for analysis of habitat fragmentation at project sites should be adapted to the species of habitat fragmentation concern as identified in response to Question 5 in Tier 2 and to the landscape in which development is contemplated. The developer should:

1. Define the study area. The study area for the site should include the "footprint" for the proposed facility plus an appropriate surrounding area. The extent of the study area should be based on the area where there is potential for significant adverse habitat impacts, including indirect impacts, within the distribution of habitat for the species of habitat fragmentation concern.

2. Determine the potential for occupancy of the study area based on the guidance provided for the species of habitat fragmentation concern described above in Question 1.

3. Analyze current habitat quality and spatial configuration of the study area for the species of habitat fragmentation concern.

   a. Use recent aerial or remote imagery to determine distinct habitat patches or boundaries within the study area, and the extent of existing habitat fragmenting features.

      i. Assess the level of fragmentation of the existing habitat for the species of habitat fragmentation concern and categorize into three classes:

         - High quality: little or no apparent fragmentation of intact habitat
         - Medium quality: intact habitat exhibiting some recent disturbance activity
         - Low quality: extensive fragmentation of habitat (e.g., row-cropped agricultural lands, active surface mining areas)

      ii. Determine edge and interior habitat metrics of the study area:

         - Identify habitat, non-habitat landscape features and existing fragmenting features relative to the species of habitat fragmentation concern, to estimate existing edge
         - Calculate area and acres of edge
         - Calculate area of intact patches of habitat and compare to needs of species of habitat fragmentation concern

   b. Determine potential changes in quality and spatial configuration of the habitat in the study area if development proceeds as proposed using existing site information and the best available spatial data regarding placement of wind turbines and ancillary infrastructure:

      i. Identify, delineate and classify all additional features added by the development that potentially fragment habitat for the species of habitat fragmentation concern (e.g., roads, transmission lines, maintenance structures, etc.)

      ii. Assess the expected future size and quality of habitat patches for the species of habitat fragmentation concern and the additional fragmenting features, and categorize into three classes as described above

      iii. Determine expected future acreages of edge and interior habitats

      iv. Calculate the area of the remaining patches of intact habitat

   c. Compare pre-construction and expected post-construction fragmentation metrics:

      i. Determine the area of intact habitat lost (to the displacement footprint or by alteration due to the edge effect)

      ii. Identify habitat patches that are expected to be moved to a lower habitat quality classification as a result of the development

4. Assess the likelihood of a significant reduction in the demographic and genetic viability of the local population of the species of habitat fragmentation concern using the habitat fragmentation information collected under item 3 above and any currently available demographic and genetic data. Based on this assessment, the developer makes the finding whether or not there is significant reduction. The developer should share the finding with the relevant agencies. If the developer finds the likelihood of a significant reduction, the developer should

consider items a, b or c below:

a. Consider alternative locations and development configurations to minimize fragmentation of habitat in communication with species experts, for all species of habitat fragmentation concern in the area of interest.

b. Identify high quality habitat parcels that may be protected as part of a plan to limit future loss of habitat for the impacted population of the species of habitat fragmentation concern in the area.

c. Identify areas of medium or low quality habitat within the range of the impacted population that may be restored or improved to compensate for losses of habitat that result from the project (e.g., management of unpaved roads and ORV trails).

Tier 3, Question 3

The following protocols are suggested for use in answering Tier 3, Question 3.

Bird distribution, abundance, behavior and site use

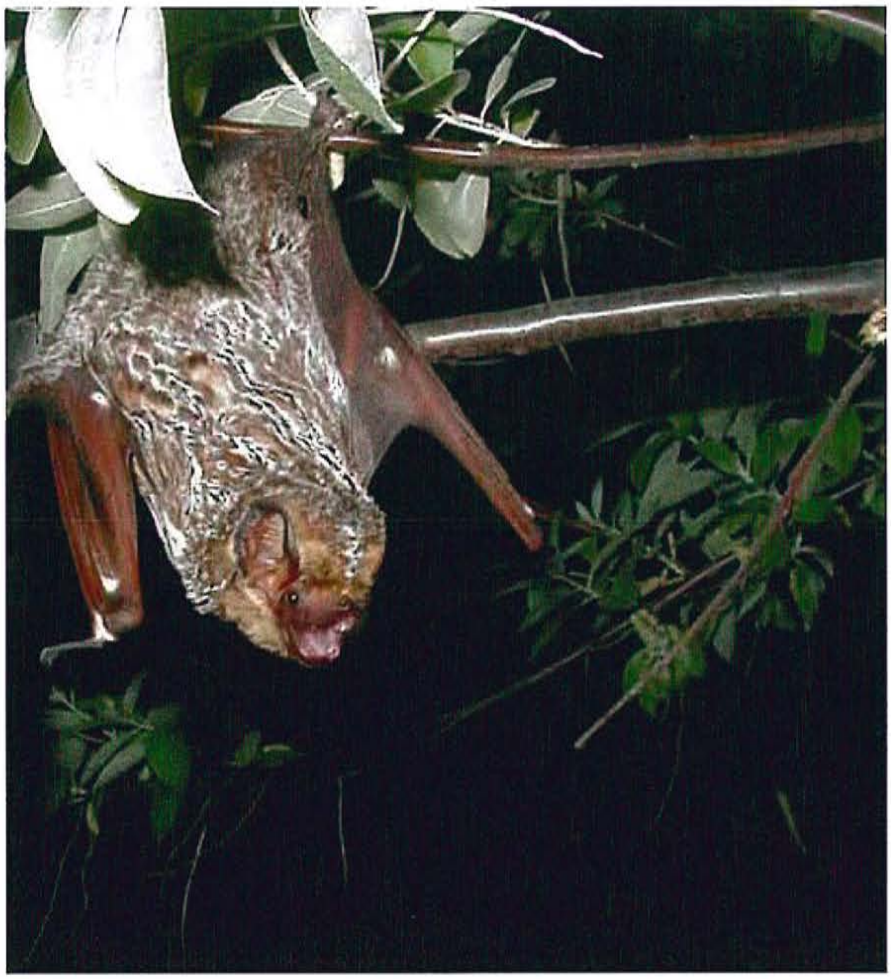
Diurnal Avian Activity Surveys

The commonly used data collection methods for estimating the spatial distribution and relative abundance of diurnal birds includes counts of birds seen or heard at specific survey points (point count), along transects (transect surveys), and observational studies. Both methods result in estimates of bird use, which are assumed to be indices of abundance in the area surveyed. Absolute abundance is difficult to determine for most species and is not necessary to evaluate species risk. Depending on the characteristics of the area of interest and the bird species potentially affected by the project, additional pre-construction study methods may be necessary. Point counts or line transects should collect vertical as well as horizontal data to identify levels of activity within the rotor-swept zone.

Avian point counts should follow the general methodology described by Reynolds et al. (1980) for point counts within a fixed area, or the line transect survey similar to Schaffer and Johnson (2008), where all birds seen within a fixed distance of a line are counted. These methods are most useful for pre- and post-construction studies to quantify avian use of the project site by habitat, determine the presence of species of concern, and to provide a baseline for assessing displacement effects and habitat loss. Point counts for large birds (e.g., raptors) follow the same point count method described by Reynolds et al. (1980), Ralph et al. (1993) and Ralph et al. 1995).

Point count plots, transects, and observational studies should allow for statistical extrapolation of data and be distributed throughout the area of interest using a probability sampling approach (e.g., systematic sample with a random start). For most projects, the area of interest is the area where wind turbines and permanent meteorological (met) towers are proposed or expected to be sited. Alternatively, the centers of the larger plots can be located at vantage points throughout the potential area being considered with the objective of covering most of the area of interest. Flight height should also be collected to focus estimates of use on activity occurring in the rotor-swept zone.

Sampling duration and frequency will be determined on a project-by-project basis and by the questions being addressed. The most important consideration for sampling frequency when estimating abundance is the amount of variation



Hoary bat. Credit: Paul Cryan, USGS

expected among survey dates and locations and the species of concern.

The use of comparable methods and metrics should allow data comparison from plot to plot within the area of interest and from site to site where similar data exist. The data should be collected so that avian activity can be estimated within the rotor-swept zone. Relating use to site characteristics requires that samples of use also measure site characteristics thought to influence use (i.e., covariates such as vegetation and topography) in relation to the location of use. The statistical relationship of use to these covariates can be used to predict occurrence in unsurveyed areas during the survey period and for the same areas in the future.

Surveys should be conducted at different intervals during the year to account for variation in expected bird activity with lower frequency during winter months if avian activity is low. Sampling frequency should also consider the episodic nature of activity during fall and spring migration. Standardized protocols for estimating avian abundance are well-established and should be consulted (e.g., Dettmers et al. 1999). If a more precise estimate of density is required for a particular species (e.g., when the goal is to determine densities of a special-status breeding bird species), the researcher will need more sophisticated sampling procedures, including estimates of detection probability.

Raptor Nest Searches

An estimate of raptor use of the project site is obtained through appropriate surveys, but if potential impacts to breeding raptors are a concern on a project, raptor nest searches are also recommended. These surveys provide information to predict risk to the local breeding population of raptors, for micro-siting decisions, and for developing an appropriate-sized non-disturbance buffer around nests. Surveys also provide baseline data for estimating impacts and determining mitigation



Red-tailed hawk. Credit: Dave Menke, USFWS

requirements. A good source of information for raptor surveys and monitoring is Bird and Bildstein (2007).

Searches for raptor nests or raptor breeding territories on projects with potential for impacts to raptors should be conducted in suitable habitat during the breeding season. While there is no consensus on the recommended buffer zones around nest sites to avoid disturbance of most species (Sutter and Jones 1981), a nest search within at least one mile of the wind turbines and transmission lines, and other infrastructure should be conducted. However, larger nest search areas are needed for eagles, as explained in the Service's ECP Guidance, when bald or golden eagles are likely to be present.

Methods for these surveys are fairly common and will vary with the species, terrain, and vegetation within the survey area. The Service recommends that protocols be discussed with biologists from the lead agency, Service, state wildlife agency, and Tribes where they have jurisdiction. It may be useful to consult other scientifically credible information sources. At minimum, the protocols should contain the list of target raptor species for nest surveys and the appropriate search protocol for each site, including timing and number of surveys needed, search area, and search techniques.

Prairie Grouse and Sage Grouse Population Assessments

Sage grouse and prairie grouse merit special attention in this context for three reasons:

1. The scale and biotic nature of their habitat requirements uniquely position them as reliable indicators of impacts on, and needs of, a suite of species that depend on sage and grassland habitats, which are among the nation's most diminished ecological communities (Vodehnal and Haufler 2007).

2. Their ranges and habitats are highly congruent with the nation's richest inland wind resources.

3. They are species for which some known impacts of anthropogenic features (e.g., tall structures, buildings, roads, transmission lines, wind energy facilities, etc.) have been documented.

Populations of prairie grouse and sage grouse generally are assessed by either lek counts (a count of the maximum number of males attending a lek) or lek surveys (classification of known leks as active or inactive) during the breeding season (e.g., Connelly et al. 2000). Methods for lek counts vary slightly by species but in general require repeated visits to known sites and a systematic search of all suitable habitat for leks, followed by repeated visits to active leks to estimate the number of grouse using them.

Recent research indicates that viable prairie grouse and sage grouse populations are dependent on suitable nesting and brood-rearing habitat (Connelly et al. 2000, Hagen et al. 2009). These habitats generally are associated with leks. Leks are the approximate centers of nesting and brood-rearing habitats (Connelly et al. 2000, but see Connelly et al. 1988 and Becker et al. 2009). High quality nesting and

brood rearing habitats surrounding leks are critical to sustaining viable prairie grouse and sage grouse populations (Giesen and Connelly 1993, Hagen et al. 2004, Connelly et al. 2000). A population assessment study area should include nesting and brood rearing habitats that may extend several miles from leks. For example, greater and lesser prairie-chickens generally nest in suitable habitats within one to two miles of active leks (Hagen et al. 2004), whereas the average distances from nests to active leks of non-migratory sage grouse range from 0.7 to four miles (Connelly et al. 2000), and potentially much more for migratory populations (Connelly et al. 1988).

While surveying leks during the spring breeding season is the most common and convenient tool for monitoring population trends of prairie grouse and sage grouse, documenting available nesting and brood rearing habitat within and adjacent to the potentially affected area is recommended. Suitable nesting and brood rearing habitats can be mapped based on habitat requirements of individual species. The distribution and abundance of nesting and brood rearing habitats can be used to help in the assessment of adverse impacts of the proposed project to prairie grouse and sage grouse.

Mist-Netting for Birds

Mist-netting is not recommended as a method for assessing risk of wind development for birds. Mist-netting cannot generally be used to develop indices of relative bird abundance, nor does it provide an estimate of collision risk as mist-netting is not feasible at the heights of the rotor-swept zone and captures below that zone may not adequately reflect risk. Operating mist-nets requires considerable experience, as well as state and federal permits.

Occasionally mist-netting can help confirm the presence of rare species at documented fallout or migrant stopover sites near a proposed project. If mist-netting is to be used, the Service recommends that procedures for operating nets and collecting data be followed in accordance with Ralph et al. (1993).

Nocturnal and Crepuscular Bird Survey Methods

Additional studies using different methods should be conducted if characteristics of the project site and surrounding areas potentially pose a high risk of collision to night migrating songbirds and other nocturnal or crepuscular species. For most of their flight, songbirds and other nocturnal migrants are above the reach of wind turbines, but they pass through the altitudinal range of wind turbines during ascents and descents and may also fly closer to the ground during inclement weather (Able, 1970; Richardson, 2000). Factors affecting flight path, behavior, and "fall-out" locations of nocturnal migrants are reviewed elsewhere (e.g., Williams et al., 2001; Gauthreaux and Belser, 2003; Richardson, 2000; Mabee et al., 2006).

In general, pre-construction nocturnal studies are not recommended unless the site has features that might strongly concentrate nocturnal birds, such as along coastlines that are known to be migratory songbird corridors. Biologists knowledgeable about nocturnal bird migration and familiar with patterns of migratory stopovers in the region should assess the potential risks to nocturnal migrants at a proposed project site. No single method can adequately assess the spatial and temporal variation in nocturnal bird populations or the potential collision risk. Following nocturnal study methods in Kunz et al. (2007) is recommended to determine relative abundance, flight direction and flight altitude for assessing risk to migrating birds, if warranted. If areas of interest are within the range of nocturnal species of concern (e.g., marbled murrelet, northern spotted owl, Hawaiian petrel, Newell's shearwater), surveyors should use species-specific protocols recommended by state wildlife agencies, Tribes or Service to assess the species' potential presence in the area of interest.

In contrast to the diurnal avian survey techniques previously described, considerable variation and uncertainty exist on the optimal protocols for using acoustic monitoring devices, radar, and other techniques to evaluate species composition, relative abundance, flight height, and trajectory of nocturnal migrating birds. While an active area of research, the use of radar for determining passage rates, flight heights and flight directions of nocturnal migrating animals has yet to be shown as a good indicator of collision risk. Pre- and post-construction studies comparing radar monitoring results to estimates of bird and bat fatalities will be necessary to evaluate radar as a tool for predicting collision risk. Additional studies are also needed before making recommendations on the number of nights per season or the number of hours per night that are appropriate for radar studies of nocturnal bird migration (Mabee et al., 2006).

Bat survey methods

The Service recommends that all techniques discussed below be conducted by biologists trained in bat identification, equipment use, and the analysis and interpretation of data resulting from the design and conduct of the studies. Activities that involve capturing and handling bats may require permits from state and/or federal agencies.

Acoustic Monitoring

Acoustic monitoring provides information about bat presence and activity, as well as seasonal changes in species occurrence and use, but does not measure the number of individual bats or population density. The goal of acoustic monitoring is to provide a prediction of the potential risk of bat fatalities resulting from the construction and operation of a project. Our current state of knowledge about bat-wind turbine interactions, however, does not allow a quantitative link between pre-construction acoustic assessments of bat activity and operations fatalities. Discussions with experts, state wildlife trustee agencies, Tribes, and



Tri-colored bat. Credit: USFWS

Service will be needed to determine whether acoustic monitoring is warranted at a proposed project site.

The predominance of bat fatalities detected to date are migratory species and acoustic monitoring should adequately cover periods of migration and periods of known high activity for other (i.e., non-migratory) species. Monitoring for a full year is recommended in areas where there is year round bat activity. Data on environmental variables such as temperature and wind speed should be collected concurrently with acoustic monitoring so these weather data can be used in the analysis of bat activity levels.

The number and distribution of sampling stations necessary to adequately estimate bat activity have not been well established but will depend, at least in part, on the size of the project area, variability within the project area, and a Tier 2 assessment of potential bat occurrence.

The number of detectors needed to achieve the desired level of precision will vary depending on the within-site variation (e.g., Arnett et al. 2006, Weller 2007, See also, Bat Conservation International website for up-to-date survey methodologies). One frequently used method is to place acoustic detectors on existing met towers, approximately every two kilometers across the site where turbines are expected to be sited. Acoustic detectors should be placed at high positions (as high as practicable, based on tower height) on each met tower included in the sample to record bat activity at or near the rotor swept zone, the area of presumed greatest risk for bats. Developers should evaluate whether it would be cost effective to install detectors when met towers are first established on a site. Doing so might reduce the cost of installation later and might alleviate time delays to conduct such studies.

If sampling at met towers does not adequately cover the study area or provide sufficient replication, additional sampling stations can be established at low positions (~1.5-2 meters) at a sample of existing met towers and one or more mobile units (i.e., units that are moved to different locations throughout the study period) to increase coverage of the proposed project area. When practical and based on information from Tier 2, it may be appropriate to conduct some acoustic monitoring of features identified as potentially high bat use areas within the study area (e.g., bat roosts and caves) to determine use of such features.

There is growing interest in determining whether "low" position samples (~1.5-2 meters) can provide equal or greater correlation with bat fatalities than "high" position samples (described above) because this would substantially lower cost of this work. Developers could then install a greater number of detectors at lower cost resulting in improved estimates of bat activity and, potentially, improved qualitative estimates of risk to bats. This is a research question that is not expected to be addressed at a project.

Other bat survey techniques

Occasionally, other techniques may be needed to answer Tier 3 questions and complement the information from acoustic surveys. Kunz et al. (2007), NAS (2007), Kunz and Parsons (2009) provide comprehensive descriptions of bat survey techniques, including those identified below that are relevant for Tier 3 studies at wind energy facilities.

Roost Searches and Exit Counts

Pre-construction survey efforts may be recommended to determine whether known or likely bat roosts in mines, caves, bridges, buildings, or other potential roost sites occur within the project vicinity, and to confirm whether known or likely bat roosts are present and occupied by bats. If active roosts are detected, it may be appropriate to address questions about colony size and species composition of roosts. Exit counts and roost searches are two approaches to answering these questions, and Rainey (1995), Kunz and Parsons (2009), and Sherwin et al. (2009) are resources that describe options and approaches for these techniques. Roost searches should be performed cautiously because roosting bats are sensitive to human disturbance (Kunz et al. 1996). Known maternity and hibernation roosts should not be entered or otherwise disturbed unless authorized by state and/or federal wildlife agencies. Internal searches of abandoned mines or caves can be dangerous and should only be conducted by trained researchers. For mine survey protocol and

guidelines for protection of bat roosts, see the appendices in Pierson et al. (1999). Exit surveys at known roosts generally should be limited to non-invasive observation using low-light binoculars and infrared video cameras.

Multiple surveys should be conducted to determine the presence or absence of bats in caves and mines, and the number of surveys needed will vary by species of bats, sex (maternity or bachelor colony) of bats, seasonality of use, and type of roost structure (e.g., caves or mines). For example, Sherwin et al. (2003) demonstrated that a minimum of three surveys are needed to determine the absence of large hibernating colonies of Townsend's big-eared bats in mines (90 percent probability), while a minimum of nine surveys (during a single warm season) are necessary before a mine could be eliminated as a bachelor roost for this species (90 percent probability). An average of three surveys was needed before surveyed caves could be eliminated as bachelor roosts (90 percent probability). The Service recommends that decisions on level of effort follow discussion with relevant agencies and bat experts.

Activity Patterns

If active roosts are detected, it may be necessary to answer questions about behavior, movement patterns, and patterns of roost use for bat species of concern, or to further investigate habitat features that might attract bats and pose fatality risk. For some bat species, typically threatened, endangered, or state-listed species, radio telemetry or radar may be recommended to assess both the direction of movement as bats leave roosts, and the bats' use of the area being considered for development. Kunz et al. (2007) describe the use of telemetry, radar and other tools to evaluate use of roosts, activity patterns, and flight direction from roosts.

Mist-Netting for Bats

While mist-netting for bats is required in some situations by state agencies, Tribes, and the Service to determine the presence of threatened, endangered or other bat species of concern, mist-netting is not generally recommended for determining levels of activity or assessing risk of wind energy development to bats for the following reasons: 1) not all proposed or operational wind energy facilities offer conditions conducive to capturing bats, and often the number of suitable sampling points is minimal or not closely associated with the project location; 2) capture efforts often occur at water sources offsite or at nearby roosts and the results may not reflect species presence or use on the site where turbines are to be erected; and 3) mist-netting isn't feasible at the height of the rotor-swept zone, and captures below that zone may not adequately reflect risk of fatality. If mist-netting is employed, it is best used in combination with acoustic monitoring to inventory the species of bats present at a site.

White-Nose Syndrome

White-nose syndrome is a disease affecting hibernating bats. Named for the white fungus that appears on the muzzle and other body parts of hibernating bats, WNS is associated with extensive mortality of bats in eastern North America. All contractors and consultants hired by developers should employ the most current version of survey and handling protocols to avoid transmitting white-nose syndrome between bats.

Other wildlife

While the above guidance emphasizes the evaluation of potential impacts to birds and bats, Tier 1 and 2 evaluations may identify other species of concern. Developers are encouraged to assess adverse impacts potentially caused by development for those species most likely to be negatively affected by such development. Impacts to other species are primarily derived from potential habitat loss or displacement. The general guidance on the study design and methods for estimation of the distribution, relative abundance, and habitat use for birds is applicable to the study of other wildlife. References regarding monitoring for other wildlife are available in Appendix C:



Mule deer. Credit: Tupper Ansel Blake, USFWS

Sources of Information Pertaining to Methods to Assess Impacts to Wildlife. Nevertheless, most methods and metrics will be species-specific and developers are advised to work with the state, tribal, or federal agencies, or other credible experts, as appropriate, during problem formulation for Tier 3.

Tier 3 Decision Points

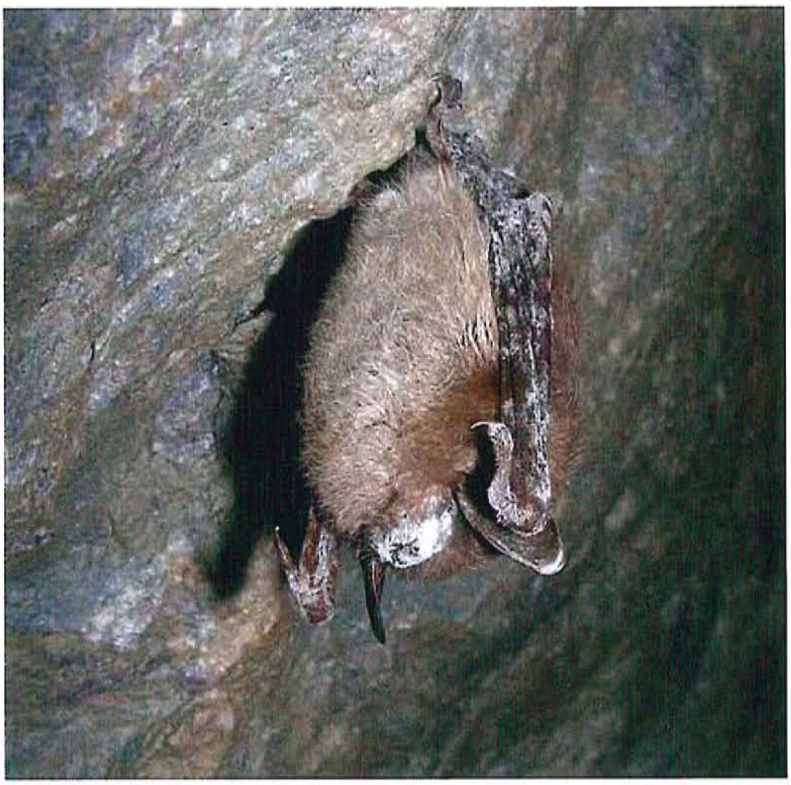
Developers and the Service should communicate prior to completing the Tier 3 decision process. A developer should inform the Service of the results of its studies and plans. The Service will provide written comments to a developer on study and project development plans that identify concerns and recommendations to resolve the concerns. The developer and, when applicable, the permitting authority will make a decision regarding whether and how to develop the project. The decision point at the end of Tier 3 involves three potential outcomes:

1. Development of the site has a low probability of significant adverse impact based on existing and new information.

   There is little uncertainty regarding when and how development should proceed, and adequate information exists to satisfy any required permitting. The decision process proceeds to permitting, when required, and/or development, and Tier 4.

2. Development of the site has a moderate to high probability of significant adverse impacts without proper measures being taken to mitigate those impacts. This outcome may be subdivided into two possible scenarios:

   a. There is certainty regarding how to develop the site to adequately mitigate significant adverse impacts. The developer bases their decision to develop the site adopting proper mitigation measures and appropriate post-construction fatality and habitat studies (Tier 4).



Little brown bat with white nose syndrome. Credit: Marvin Moriarty, USFWS

   b. There is uncertainty regarding how to develop the site to adequately mitigate significant adverse impacts, or a permitting process requires additional information on potential significant adverse wildlife impacts before permitting future phases of the project. The developer bases their decision to develop the site adopting proper mitigation measures and appropriate post-construction fatality and habitat studies (Tier 4).

3. Development of the site has a high probability of significant impact that:

   a. Cannot be adequately mitigated.

   Site development should be delayed until plans can be developed that satisfactorily mitigate for the significant adverse impacts. Alternatively, the site should be abandoned in favor of known sites with less potential for environmental impact, or the developer begins an evaluation of other sites or landscapes for more acceptable sites to develop.

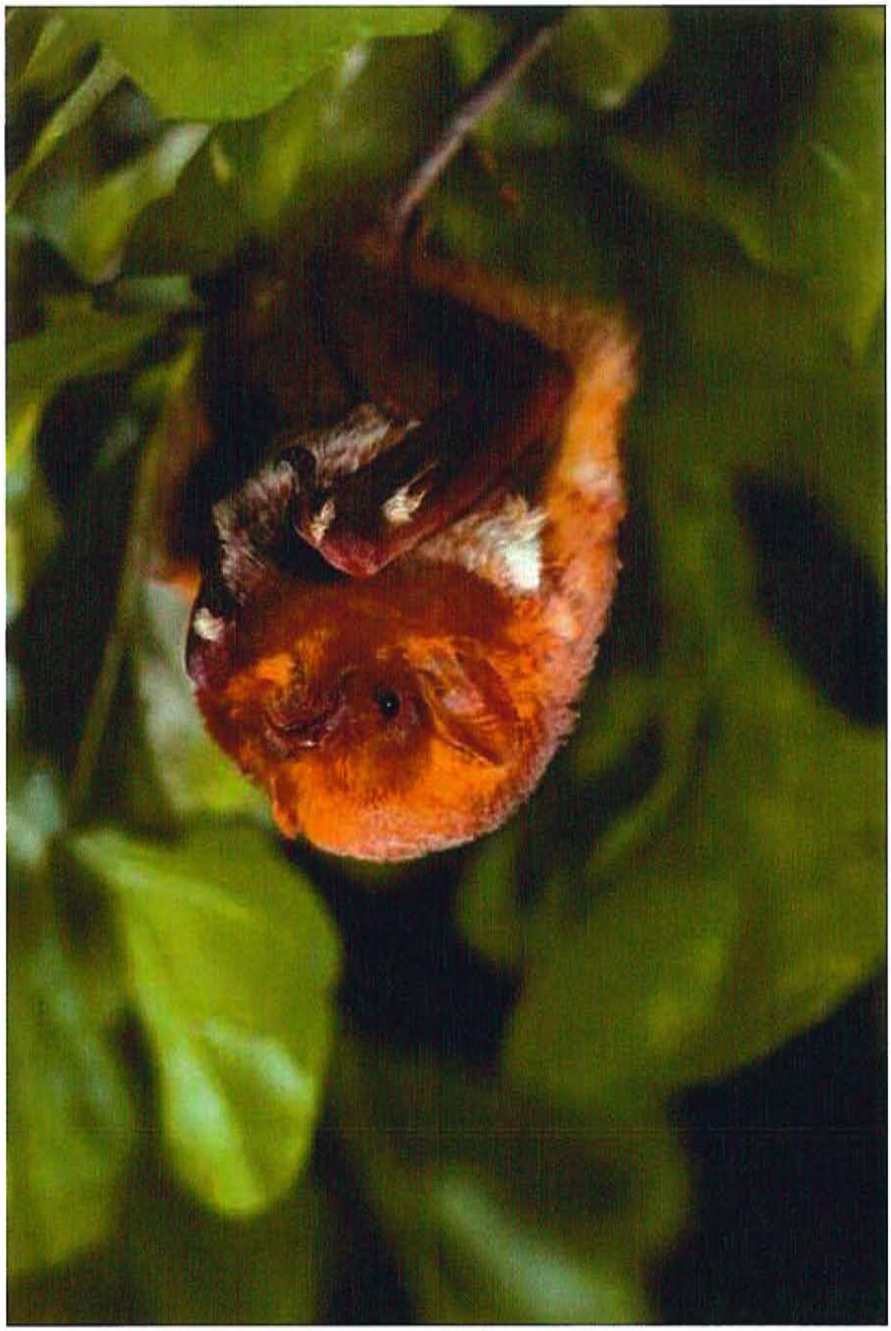
   b. Can be adequately mitigated.

   Developer should implement mitigation measures and proceed to Tier 4.

Chapter 5: Tier 4 – Post-construction Studies to Estimate Impacts

The outcome of studies in Tiers 1, 2, and 3 will determine the duration and level of effort of post-construction studies.

Tier 4 post-construction studies are designed to assess whether predictions of fatality risk and direct and indirect impacts to habitat of species of concern were correct. Fatality studies involve searching for bird and bat carcasses beneath turbines to estimate the number and species composition of fatalities (Tier 4a). Habitat studies involve application of GIS and use data collected in Tier 3 and Tier 4b and/or published information. Post-construction studies on direct and indirect impacts to habitat of species of concern, including species of habitat fragmentation concern need only be conducted if Tier 3 studies indicate the potential for significant adverse impacts.



A male Eastern red bat perches among green foliage. Credit: ©MerlinD.Tuttle,BatConservationInternational,www.batcon.org

Tier 4a – Fatality Studies

At this time, community- and utility-scale projects should conduct at least one year of fatality monitoring. The intensity of the studies should be related to risks of significant adverse impacts identified in pre-construction assessments. As data collected with consistent methods and metrics increases (see discussion below), it is possible that some future projects will not warrant fatality monitoring, but such a situation is rare with the present state of knowledge.

Fatality monitoring should occur over all seasons of occupancy for the species being monitored, based on information produced in previous tiers. The number of seasons and total length of the monitoring may be determined separately for bats and birds, depending on the pre-construction risk assessment, results of Tier 3 studies and Tier 4 monitoring from comparable sites (see Glossary in Appendix A) and the results of first year fatality monitoring. Guidance on the relationship between these variables and monitoring for fatalities is provided in Table 2.

It may be appropriate to conduct monitoring using different durations and intervals depending on the species of concern. For example, if raptors occupy an area year-round, it may be appropriate to monitor for raptors throughout the year (12 months). It may be warranted to monitor for bats when they are active (spring, summer and fall or

approximately eight months). It may be appropriate to increase the search frequency during the months bats are active and decrease the frequency during periods of inactivity. All fatality monitoring should include estimates of carcass removal and carcass detection bias likely to influence those rates.

Tier 4a Questions

Post-construction fatality monitoring should be designed to answer the following questions as appropriate for the individual project:

1. **What are the bird and bat fatality rates for the project?**
2. **What are the fatality rates of species of concern?**
3. **How do the estimated fatality rates compare to the predicted fatality rates?**
4. **Do bird and bat fatalities vary within the project site in relation to site characteristics?**
5. **How do the fatality rates compare to the fatality rates from existing projects in similar landscapes with similar species composition and use?**
6. **What is the composition of fatalities in relation to migrating and resident birds and bats at the site?**
7. **Do fatality data suggest the need for measures to reduce impacts?**

Tier 4a studies should be of sufficient statistical validity to address Tier 4a questions and enable determination of whether Tier 3 fatality predictions were correct. Fatality monitoring results also should allow comparisons with other sites, and provide a basis for determining if operational changes or other mitigation measures at the site are appropriate. The Service encourages project operators to discuss Tier 4 studies with local, state, federal, and tribal wildlife agencies. The number of years of monitoring is based on outcomes of Tier 3 and Tier 4 studies and analysis of comparable Tier 4 data from other projects as indicated in Table 2. The Service may recommend multiple years of monitoring for projects located near a listed species or bald or golden eagle, or other situations, as appropriate.

Tier 4a Protocol Design Considerations

The basic method of measuring fatality rates is the carcass search. Search protocols should be standardized to the greatest extent possible, especially for common objectives and species of concern, and they should include methods for adequately accounting for sampling biases (searcher efficiency and scavenger removal). However, some situations warrant exceptions to standardized protocol. The responsibility of demonstrating that an exception is appropriate and applicable should be on the project operator to justify increasing or decreasing the duration or intensity of operations monitoring.

Some general guidance is given below with regard to the following fatality monitoring protocol design issues:

- Duration and frequency of monitoring
- Number of turbines to monitor
- Delineation of carcass search plots, transects, and habitat mapping
- General search protocol
- Field bias and error assessment
- Estimators of fatality

More detailed descriptions and methods of fatality search protocols can be found in the California (California Energy Commission 2007) and Pennsylvania (Pennsylvania Game Commission 2007) state guidelines and in Kunz et al. (2007), Smallwood (2007), and Strickland et al. (2011).

Duration and frequency of monitoring

Frequency of carcass searches (search interval) may vary for birds and bats, and will vary depending on the questions to be answered, the species of concern, and their seasonal abundance at the project site. The carcass searching protocol should be adequate to answer applicable Tier 4 questions at an appropriate level of precision to make general conclusions about the project, and is not intended to provide highly precise measurements of fatalities. Except during low use times (e.g. winter months in northern states), the Service recommends that protocols be designed such that carcass searches occur at some turbines within the project area most days each week of the study.

The search interval is the interval between carcass searches at individual turbines, and this interval may be lengthened or shortened depending on the carcass removal rates. If the primary focus is on fatalities of large raptors, where carcass removal is typically low, then a longer interval between searches (e.g., 14-28 days) is sufficient. However, if the focus is on fatalities of bats and small birds and carcass removal is high, then a shorter search interval will be necessary.

There are situations in which studies of higher intensity (e.g., daily searches at individual turbines within the sample) may be appropriate. These would be considered only in Tier 5 studies or in research programs because the greater complexity and level of effort goes beyond that recommended for typical Tier 4 post construction monitoring. Tier 5 and research studies could include evaluation of specific measures that have been implemented to mitigate potential significant adverse impacts to species of concern identified during pre-construction studies.

Number of turbines to monitor

If available, data on variability among turbines from existing



Wind turbine. Credit: NREL

projects in similar conditions within the same region are recommended as a basis for determining needed sample size (see Morrison et al., 2008). If data are not available, the Service recommends that an operator select a sufficient number of turbines via a systematic sample with a random start point. Sampling plans can be varied (e.g., rotating panels [McDonald 2003, Fuller 1999, Breidt and Fuller 1999, and Urquhart et al. 1998]) to increase efficiency as long as a probability sampling approach is used. If the project contains fewer than 10 turbines, the Service recommends that all turbines in the area of interest be searched unless otherwise agreed to by the permitting or wildlife resource agencies. When selecting turbines, the Service recommends that a systematic sample with a random start be used when selecting search plots to ensure interspersion among turbines. Stratification among different habitat types also is recommended to account for differences in fatality rates among different habitats (e.g., grass versus cropland or forest); a sufficient number of turbines should be sampled in each strata.

Delineation of carcass search plots, transects, and habitat mapping

Evidence suggests that greater than 80 percent of bat fatalities fall within half the maximum distance of turbine height to ground (Erickson 2003 a, b), and a minimum plot width of 120 meters from the turbine should be established at sample turbines. Plots will need to be larger for birds, with a width twice the turbine height to ground. Decisions regarding search plot size should be made in discussions with the Service, state wildlife agency, permitting agency and Tribes. It may be useful to consult other scientifically credible information sources.

The Service recommends that each search plot should be divided into oblong subplots or belt transects and that each subplot be searched. The objective is to find as many carcasses as possible so the width of the belt will vary depending on the ground cover and its influence on carcass visibility. In most situations, a search width of 6 meters should be adequate, but this may vary from 3-10 meters depending on ground cover.

Searchable area within the theoretical maximum plot size varies, and heavily vegetated areas (e.g., eastern mountains) often do not allow surveys to consistently extend to the maximum plot width. In other cases it may be preferable to search a portion of the maximum plot instead of the entire plot. For example, in some landscapes it may be impractical to search the entire plot because of the time required to do an effective search, even if it is accessible (e.g., croplands), and data from a probability sample of subplots within the maximum plot size can provide a reasonable estimate of fatalities. It is important to accurately delineate and map the area searched for each turbine to adjust fatality estimates based on the actual area searched. It may be advisable to establish habitat visibility classes in each plot to account for differential detectability, and to develop visibility classes for different landscapes (e.g., rocks, vegetation) within each search plot. For example, the Pennsylvania Game Commission (2007) identified four classes based on the percentage of bare ground.

The use of visibility classes requires that detection and removal biases be estimated for each class. Fatality estimates should be made for each class and summed for the total area sampled. Global positioning systems (GPS) are useful for accurately mapping the actual total area searched and area searched in each habitat visibility class, which can be used to adjust fatality estimates. The width of the belt or subplot searched may vary depending on the habitat and species of concern; the key is to determine actual searched area and area searched in each visibility class regardless of transect width. An adjustment may also be needed to take into account the density of fatalities as a function of the width of the search plot.

General search protocol

Personnel trained in proper search techniques should look for bird and bat carcasses along transects or subplots within each plot and record and collect all carcasses located in the searchable areas. The Service will work with developers and operators to provide necessary permits for carcass possession. A complete search of the area should be accomplished and subplot size (e.g., transect width) should be adjusted to compensate for detectability differences in the search area. Subplots should be smaller when vegetation makes it difficult to detect carcasses; subplots can be wider in open terrain. Subplot width also can vary depending on the size of the species being looked for. For example, small species such as bats may require smaller subplots than larger species such as raptors.

Data to be recorded include date, start time, end time, observer, which turbine area was searched (including GPS coordinates) and weather data for each search. When a dead bat or bird is found, the searcher should place a flag near the carcass and continue the search. After searching the entire plot, the searcher returns to each carcass and records information

on a fatality data sheet, including date, species, sex and age (when possible), observer name, turbine number, distance from turbine, azimuth from turbine (including GPS coordinates), habitat surrounding carcass, condition of carcass (entire, partial, scavenged), and estimated time of death (e.g., <1 day, 2 days). The recorded data will ultimately be housed in the FWS Office of Law Enforcement Bird Mortality Reporting System. A digital photograph of the carcass should be taken. Rubber gloves should be used to handle all carcasses to eliminate possible transmission of rabies or other diseases and to reduce possible human scent bias for carcasses later used in scavenger removal trials. Carcasses should be placed in a plastic bag and labeled. Unless otherwise conditioned by the carcass possession permit, fresh carcasses (those determined to have been killed the night immediately before a search) should be redistributed at random points on the same day for scavenging trials.

Field bias and error assessment

During searches conducted at wind turbines, actual fatalities are likely incompletely observed. Therefore carcass counts must be adjusted by some factor that accounts for imperfect detectability (Huso 2011). Important sources of bias and error include: 1) fatalities that occur on a highly periodic basis; 2) carcass removal by scavengers; 3) differences in searcher efficiency; 4) failure to account for the influence of site (e.g. vegetation) conditions in relation to carcass removal and searcher efficiency; and 5) fatalities or injured birds and bats that may land or move outside search plots.

Some fatalities may occur on a highly periodic basis creating a potential sampling error (number 1 above). The Service recommends that sampling be scheduled so that some turbines are searched most days and episodic events are more likely detected, regardless of the search interval. To address bias sources 2-4 above, it is strongly recommended that all fatality studies conduct carcass removal and searcher efficiency trials using accepted methods (Anderson 1999, Kunz et al. 2007, Arnett et al. 2007, NRC 2007, Strickland et al. 2011). Bias trials should be conducted throughout the entire study period and searchers should be unaware of which turbines are to be used or the number of carcasses placed beneath those turbines during trials. Carcasses or injured individuals may land or move outside the search plots (number 5 above). With respect to Tier 4a fatality estimates, this potential sampling error is considered to be small and can be assumed insignificant (Strickland et al. 2011).

Prior to a study's inception, a list of random turbine numbers and random azimuths and distances (in meters) from turbines should be generated for placement of each bat or bird used in bias trials. Data recorded for each trial carcass prior to placement should include date of placement, species, turbine number, distance and direction from turbine, and visibility class surrounding the carcass. Trial carcasses should be distributed as equally as possible among the different visibility classes throughout the study period and study area. Studies should attempt to avoid "over-seeding" any one turbine with carcasses by placing no more than one or two carcasses at any one time at a given turbine. Before placement, each carcass must be uniquely marked in a manner that does not cause additional attraction, and its location should be recorded. There is no agreed upon sample size for bias trials, though some state guidelines recommend from 50 - 200 carcasses (e.g., PGC 2007).

Estimators of fatality

If there were a direct relationship between the number of carcasses observed and the number killed, there would be no need to develop a complex estimator that adjusts observed counts for detectability, and observed counts could be used as a simple index of fatality (Huso 2011). But the relationship is not direct and raw carcass counts recorded using different search intervals and under different carcass removal rates and searcher efficiency rates are not directly comparable. It is strongly recommended that only the most contemporary equations for estimating fatality be used, as some original versions are now known to be extremely biased under many commonly encountered field conditions (Erickson et al. 2000b, Erickson et al. 2004, Johnson et al. 2003, Kerns and Kerlinger 2004, Fiedler et al. 2007, Kronner et al. 2007, Smallwood 2007, Huso 2011, Strickland et al. 2011).

Tier 4a Study Objectives

In addition to the monitoring protocol design considerations described above, the metrics used to estimate fatality rates must be selected with the Tier 4a questions and objectives in mind. Metrics considerations for each of the Tier 4a questions are discussed briefly below. Not all questions will be relevant for each project, and which questions apply would depend on Tier 3 outcomes.

1. What are the bird and bat fatality rates for the project?

The primary objective of fatality searches is to determine the overall estimated fatality rates for birds and bats for the project. These rates serve as the fundamental basis for all comparisons of fatalities, and if studies are designed appropriately they allow researchers to relate fatalities to site characteristics and environmental variables, and to evaluate mitigation measures. Several metrics are available for expressing fatality rates. Early studies reported fatality rates per turbine. However, this metric is somewhat misleading as turbine sizes and their risks to birds vary significantly (NRC 2007). Fatalities are frequently reported per nameplate capacity (i.e. MW), a metric that is easily calculated and better for comparing fatality rates among different sized turbines. Even with turbines of the same name plate capacity, the size of the rotor swept area may vary among manufacturers, and turbines at various sites may operate for

different lengths of time and during different times of the day and seasons. With these considerations in mind, the Service recommends that fatality rates be expressed on a per-turbine and per-nameplate MW basis until a better metric becomes available.

2. What are the fatality rates of species of concern?

This analysis simply involves calculating fatalities per turbine of all species of concern at a site when sample sizes are sufficient to do so. These fatalities should be expressed on a per nameplate MW basis if comparing species fatality rates among projects.

3. How do the estimated fatality rates compare to the predicted fatality rates?

There are several ways that predictions can be evaluated with actual fatality data. During the planning stages in Tier 2, predicted fatalities may be based on existing data at similar facilities in similar landscapes used by similar species. In this case, the assumption is that use is similar, and therefore that fatalities may be similar at the proposed facility. Alternatively, metrics derived from pre-construction assessments for an individual species or group of species – usually an index of activity or abundance at a proposed project – could be used in conjunction with use and fatality estimates from existing projects to develop a model for predicting fatalities at the proposed project site. Finally, physical models can be used to predict the probability of a bird of a particular size striking a turbine, and this probability, in conjunction with estimates of use and avoidance behavior, can be used to predict fatalities.

The most current equations for estimating fatality should be used to evaluate fatality predictions. Several statistical methods can be found in the revised Strickland et al. 2011 and used to evaluate fatality predictions. Metrics derived from Tier 3 pre-construction assessments may be correlated with fatality rates, and (using the project as the experimental unit), in Tier 5 studies it should be possible to determine if different preconstruction metrics can in fact accurately predict fatalities and, thus, risk.

4. Do bird and bat fatalities vary within the project site in relation to site characteristics?

Data from pre-construction studies can demonstrate patterns of activity that may depend upon the site characteristics. Turbines placed near escarpments or cliffs may intrude upon airspace used by raptors soaring on thermals. Pre-construction and post construction studies and assessments can be used to avoid siting individual, specific turbines within an area used by species of concern. Turbine-specific fatality rates may be related to site characteristics such as proximity to water, forest edge, staging and roosting sites, known stop-over sites, or other key resources, and this relationship may be estimated using regression analysis. This information is particularly useful for evaluating micro-siting options when planning a future facility or, on a broader scale, in determining the location of the entire project.

5. How do the fatality rates compare to the fatality rates from existing facilities in similar landscapes with similar species composition and use?

Comparing fatality rates among facilities with similar characteristics can be useful to determine patterns and broader landscape relationships. Developers should communicate with the Service to ensure that such comparisons are appropriate to avoid false conclusions. Fatality rates should be expressed on a per nameplate MW or some other standardized metric basis for comparison with other projects,



Big brown bat. Credit: USFWS

and may be correlated with site characteristics – such as proximity to wetlands, riparian corridors, mountain-foothill interface, wind patterns, or other broader landscape features – using regression analysis. Comparing fatality rates from one project to fatality rates of other projects provides insight into whether a project has relatively high, moderate or low fatalities.

6. What is the composition of fatalities in relation to migrating and resident birds and bats at the site?

The simplest way to address this question is to separate fatalities per turbine of known resident species (e.g., big brown bat, prairie horned lark) and those known to migrate long distances (e.g. hoary bat, red-eyed vireo). These data are useful in determining patterns of species composition of fatalities and possible mitigation measures directed at residents, migrants, or perhaps both, and can be used in assessing potential population effects.

[7] In situations where a project operator was not the developer, the Service expects that obligations of the developer for adhering to the Guidelines transfer with the project.

Table 2. Decision Framework for Tier 4a Fatality Monitoring of Species of Concern.[8]

Probability of Significant Adverse Impacts in Tier 3	*Recommended Fatality Monitoring Duration and Effort*	*Possible Outcomes of Monitoring Results*
Tier 3 Studies indicate LOW probability of significant adverse impacts	Duration: At least one year of fatality monitoring to estimate fatalities of birds and bats. Field assessments should be sufficient to confirm that risk to birds and/or bats is indeed "low."	1. Documented fatalities are approximately equal to or lower than predicted risk. No further fatality monitoring or mitigation is needed. 2. Fatalities are greater than predicted, but are not likely to be significant (i.e., unlikely to affect the long-term status of the population). If comparable fatality data at similar sites also supports that impacts are not likely to be high enough to affect population status, no further monitoring or mitigation is needed. If no comparable fatality data are available or such data indicates high risk, one additional year of fatality monitoring is recommended. If two years of fatality monitoring indicate levels of impacts that are not significant, no further fatality monitoring or mitigation is recommended. 3. Fatalities are greater than predicted and are likely to be significant OR federally endangered or threatened species or BGEPA species are affected. Communication with the Service is recommended. Further efforts to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.
Tier 3 studies indicate MODERATE probability of significant adverse impacts	Duration: Two or more years of fatality monitoring may be necessary. Field assessments should be sufficient to confirm that risk to birds and/or bats is indeed "moderate." Closely compare estimated effects to species to those determined from the risk assessment protocol(s).	1. Documented fatalities after the first two years are lower or not different than predicted and are not significant and no federally endangered species or BGEPA species are affected - no further fatality monitoring or mitigation is needed. 2. Fatalities are greater than predicted and are likely to be significant OR federally endangered or threatened species or BGEPA species are affected, communication with the Service is recommended. Further efforts to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.
Tier 3 studies indicate HIGH probability of significant adverse impacts	Duration: Two or more years of fatality monitoring may be necessary to document fatality patterns. If fatality is high, developers should shift emphasis to exploring opportunities for mitigation rather than continuing to monitor fatalities. If fatalities are variable, additional years are likely warranted.	1. Documented fatalities during each year of fatality monitoring are less than predicted and are not likely to be significant, and no federally endangered or threatened species or BGEPA species are affected – no further fatality monitoring or mitigation is needed. 2. Fatalities are equal to or greater than predicted and are likely to be significant - further efforts to reduce impacts are necessary; communication with the Service are recommended. Further efforts, such as Tier 5 studies, to address impacts to BGEPA or ESA species may be warranted, unless otherwise addressed in an ESA or BGEPA take permit.

[8] Ensure that survey protocols, and searcher efficiency and scavenger removal bias correction factors are the most reliable, robust, and up to date (after Huso 2009).

7. **Do fatality data suggest the need for measures to reduce impacts?**

The Service recommends that the wind project operator[7] and the relevant agencies discuss the results from Tier 4 studies to determine whether these impacts are significant. If fatalities are considered significant, the wind project operator and the relevant agencies should develop a plan to mitigate the impacts.

Tier 4b – Assessing direct and indirect impacts of habitat loss, degradation, and fragmentation

The objective of Tier 4b studies is to evaluate Tier 3 predictions of direct and indirect impacts to habitat and the potential for significant adverse impacts on species of concern as a result of these impacts. Tier 4b studies should be conducted if Tier 3 studies indicate the presence of species of habitat fragmentation concern, or if Tier 3 studies indicate significant direct and indirect adverse impacts to species of concern (see discussion below). Tier 4b studies should also inform project operators and the Service as to whether additional mitigation is necessary.

Tier 4b studies should evaluate the following questions:

1. **How do post-construction habitat quality and spatial configuration of the study area compare to predictions for species of concern identified in Tier 3 studies?**

2. **Were any behavioral modifications or indirect impacts noted in regard to species of concern?**

3. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**

4. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**

The answers to these questions will be based on information estimating habitat loss, degradation, and fragmentation information collected in Tier 3, currently available demographic and genetic data, and studies initiated in Tier 3. As in the case of Tier 4a, the answers to these questions will determine the need to conduct Tier 5 studies. For example, in the case that significant adverse impacts to species of concern were predicted, but mitigation was not successful, then additional mitigation and Tier 5 studies may be necessary. See Table 3 for further guidance.

1. **How do post-construction habitat quality and spatial configuration of the study area compare to predictions for species of concern identified in Tier 3 studies?**

GIS and demographic data collected in Tier 3 and/or published information can be used to determine predictions of impacts to species of concern from habitat loss, degradation, and fragmentation. The developer can provide development assumptions based on Tier 3 information that can be compared to post-construction information. Additional post-construction studies on impacts to species of concern due to direct and indirect impacts to habitat should only be conducted if Tier 3 studies indicate the potential for significant adverse impacts.

2. **Were any behavioral modifications or indirect impacts noted in regard to affected species?**

Evaluation of this question is based on the analysis of observed use of the area by species of concern prior to construction in comparison with observed use during operation. Observations and demographic data collected during Tier 3, and assessment of published information about the potential for displacement and demographic responses to habit impacts could be the basis for this analysis. If this analysis suggests that direct and/or indirect loss of habitat for a species of concern leads to behavioral modifications or displacement that are significant, further studies of these impacts in Tier 5 may be appropriate.

3. **If significant adverse impacts were not predicted in Tier 3 because of loss, degradation, or fragmentation of habitat, but Tier 4b studies indicate such impacts have the potential to occur, can these impacts be mitigated?**

When Tier 4b studies indicate significant impacts may be occurring, the developer may need to conduct an assessment of these impacts and what opportunities exist for additional mitigation.

4. **If significant adverse impacts were predicted for species of concern, and the project was altered to mitigate for adverse impacts, were those efforts successful?**

When Tier 4b studies indicate significant impacts may be occurring, the developer may need to conduct an assessment of these impacts and what opportunities exist for additional mitigation. Evaluation of the effectiveness of mitigation is a Tier 4 study and should follow design considerations discussed in Tier 5 and from guidance in the scientific literature (e.g. Strickland et al. 2011).

When Tier 3 studies identified potential moderate or high risks to species of concern that caused a developer to incorporate mitigation measures into the project, Tier 4b studies should evaluate the effectiveness of those mitigation measures. Determining such effectiveness is important for the project being evaluated to ascertain whether additional mitigation measures are appropriate as well as informing future decisions about how to improve mitigation at wind

energy facilities being developed.

Tier 4b Protocol Design Considerations

Impacts to a species of concern resulting from the direct and indirect loss of habitat are important and must be considered when a wind project is being considered for development. Some species of concern are likely to occur at every proposed wind energy facility. This occurrence may range from a breeding population, to seasonal occupancy, such as a brief occurrence while migrating through the area. Consequently the level of concern regarding impacts due to direct and indirect loss of habitat will vary depending on the species and the impacts that occur.

If a breeding population of a species of habitat fragmentation concern occurs in the project area and Tier 3 studies indicate that fragmentation of their habitat is possible, these predictions should be evaluated following the guidance indicated in Table 3 using the protocols described in Tier 3. If the analysis of post-construction GIS data on direct and indirect habitat loss suggests that fragmentation is likely, then additional displacement studies and mitigation may be necessary. These studies would typically begin immediately and would be considered Tier 5 studies using design considerations illustrated by examples in Tier 5 below and from guidance in the scientific literature (e.g. Strickland et al. 2011).

Significant direct or indirect loss of habitat for a species of concern may occur without habitat fragmentation if project impacts result in the reduction of a habitat resource that potentially is limiting to the affected population. Impacts of this type include loss of use of breeding habitat or loss of a significant portion of the habitat of a federally or state protected species. This would be evaluated by determining the amount of the resource that is lost and determining if this loss would potentially result in significant impacts to the affected population. Evaluation of potential significant impacts would occur in Tier 5 studies that measure the demographic response of the affected population.



Black-capped Vireo. Credit: Greg W. Lasley

The intention of the Guidelines is to focus industry and agency resources on the direct and indirect loss of habitat and limiting resources that potentially reduce the viability of a species of concern. Not all direct and indirect loss of a species' habitat will affect limiting resources for that species, and when habitat losses are minor or non-existent no further study is necessary.

Tier 4b Decision Points

The developer should use the results of the Tier 4b studies to evaluate whether further studies and/or mitigation are needed. The developer should communicate the results of these studies, and decisions about further studies and mitigation, with the Service. Table 3 provides a framework for evaluating the need for further studies and mitigation. Level of effort for studies should be sufficient to answer all questions of interest. Refer to the relevant methods sections for Tier 2 Question 5 and Tier 3 Question 2 in the text for specific guidance on study protocols.

Table 3. Decision Framework to Guide Studies for Minimizing Impacts to Habitat and Species of Habitat Fragmentation (HF) Concern.

Outcomes of Tier 2	*Outcomes of Tier 3*	*Outcomes of Tier 4b*	*Suggested Study/Mitigation*
• No species of HF concern potentially present	• No further studies needed	• n/a	• n/a
• Species of HF concern potentially present	• No species of HF concern confirmed to be present	• No further studies needed	• n/a
	• Species of HF concern demonstrated to be present, but no significant adverse impacts predicted	• Tier 4b studies confirm Tier 3 predictions	• No further studies or mitigation needed
		• Tier 4b studies indicate potentially significant adverse impacts	• Tier 5 studies and mitigation may be needed
• Species of HF concern potentially present	• Species of HF concern demonstrated to be present; significant adverse impacts predicted	• Tier 4b studies determine mitigation plan is effective; no significant adverse impacts demonstrated	• No further studies or mitigation needed
	• Mitigation plan developed and implemented	• Tier 4b studies determine mitigation plan is NOT effective; potentially significant adverse impacts	• Further mitigation and, where appropriate, Tier 5 studies

Chapter 6: Tier 5 – Other Post-construction Studies

Tier 5 studies will not be necessary for most wind energy projects. Tier 5 studies can be complex and time consuming. The Service anticipates that the tiered approach will steer projects away from sites where Tier 5 studies would be necessary.

When Tier 5 studies are conducted, they should be site-specific and intended to: 1) analyze factors associated with impacts in those cases in which Tier 4 analyses indicate they are potentially significant; 2) identify why mitigation measures implemented for a project were not adequate; and 3) assess demographic effects on local populations of species of concern when demographic information is important, including species of habitat fragmentation concern.

Tier 5 Questions

Tier 5 studies are intended to answer questions that fall in three major categories; answering yes to any of these questions might indicate a Tier 5 study is needed:

1. **To the extent that the observed fatalities exceed anticipated fatalities, are those fatalities potentially having a significant adverse impact on local populations? Are observed direct and indirect impacts to habitat having a significant adverse impact on local populations?**

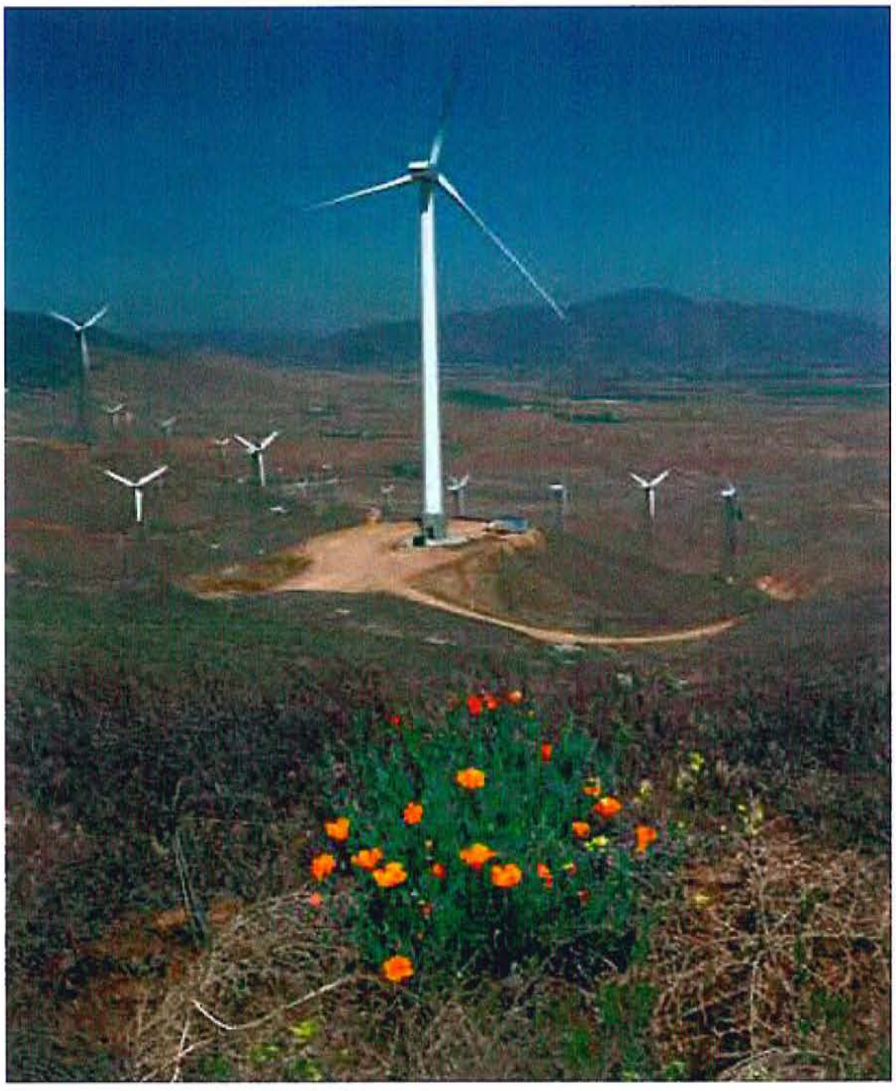
For example, in the Tier 3 risk assessment, predictions of collision fatalities and habitat impacts (direct and indirect) are developed. Post-construction studies in Tier 4 evaluate the accuracy of those predictions by estimating impacts. If post-construction studies demonstrate potentially significant adverse impacts, Tier 5 studies may also be warranted and should be designed to understand observed versus predicted impacts.

2. **Were mitigation measures implemented (other than fee in lieu) not effective? This includes habitat mitigation measures as well as measures undertaken to reduce collision fatalities.**

Tier 4a and b studies can assess the effectiveness of measures taken to reduce direct and indirect impacts as part of the project and to identify such alternative or additional measures as are necessary. If alternative or additional measures were unsuccessful, the reasons why would be evaluated using Tier 5 studies.

3. **Are the estimated impacts of the proposed project likely to lead to population declines in the species of concern (other than federally-listed species)?**

Impacts of a project will have population level effects if the project causes a population decline in the species of concern. For non-listed species, this assessment will apply only to the local population.



Wind turbines and habitat. Credit: NREL

Tier 5 studies may need to be conducted when:

- Realized fatality levels for individual species of concern reach a level at which they are considered significant adverse impacts by the relevant agencies.

  For example, if Tier 4a fatality studies document that a particular turbine or set of turbines exhibits bird or bat collision fatality higher than predicted, Tier 5 studies may be useful in evaluating alternative mitigation measures at that turbine/turbine string.

- There is the potential for significant fatality impacts or significant adverse impacts to habitat for species of concern, there is a need to assess the impacts more closely, and there is uncertainty over how these impacts will be mitigated.

- Fatality and/or significant adverse habitat impacts suggest the potential for a reduction in the viability of an affected population, in which case studies on the potential for population impacts may be warranted.

- A developer evaluates the effectiveness of a risk reduction measure before deciding to continue the measure permanently or whether to use the measure when implementing future phases of a project.

  In the event additional turbines are proposed as an expansion of an existing project, results from Tier 4 and Tier 5 studies and the decision-making framework contained in the tiered approach can be used to determine whether the project should be expanded and whether additional information should be collected. It may also be necessary to evaluate whether additional measures are warranted to reduce significant adverse impacts to species.

Tier 5 Study Design Considerations

As discussed in Chapter 4 Tier 3, Tier 5 studies will be highly variable and unique to the circumstances of the individual project, and therefore these Guidelines do not provide specific guidance on all potential approaches, but make some general statements about study design. Specific Tier 5 study designs will depend on the types of questions, the specific project, and practical considerations. The most common practical considerations include the area being studied, the time period of interest, the species of concern, potentially confounding variables, time available to conduct studies, project budget, and the magnitude of the anticipated impacts. When possible it is usually desirable to collect data before construction to address Tier 5 questions. Design considerations for these studies are including in Tier 3.

One study design is based on an experimental approach to evaluating mitigation measures, where the project proponent will generally select several alternative management approaches to design, implement, and test. The alternatives are generally incorporated into sound experimental designs. Monitoring and evaluation of each alternative helps the developer to decide which alternative is more effective in meeting objectives, and informs adjustments to the next round of management decisions. The need for this type of study design can be best determined by communication between the project operator, the Service field office, and the state wildlife agency, on a project-by-project basis. This study design requires developers and operators to identify strategies to adjust management and/or mitigation measures if monitoring indicates that anticipated impacts are being exceeded. Such strategies should include a timeline for periodic reviews and adjustments as well as a mechanism to consider and implement additional mitigation measures as necessary after the project is developed.

When pre-construction data are unavailable and/or a suitable reference area is lacking, the reference Control Impact Design (Morrison et al. 2008) is the recommended design. The lack of a suitable reference area also can be addressed using the Impact Gradient Design, when habitat and species use are homogenous in the assessment area prior to development. When applied both pre- and post-construction, the Impact Gradient Design is a suitable replacement for the classic BACI (Morrison et al. 2008).

In the study of habitat impacts, the resource selection function (RSF) study design (see Anderson et al 1999; Morrison et al. 2008; Manly et al. 2002) is a statistically robust design, either with or without pre-construction and reference data. Habitat selection is modeled as a function of characteristics measured on resource units and the use of those units by the animals of interest. The RSF allows the estimation of the probability of use as a function of the distance to various environmental features, including wind energy facilities, and thus provides a direct quantification of the magnitude of the displacement effect. RSF could be improved with pre-construction and reference area data. Nevertheless, it is a relatively powerful approach to documenting displacement or the effect of mitigation measures designed to reduce displacement even without those additional data.

Tier 5 Examples

As described earlier, Tier 5 studies will not be conducted at most projects, and the specific Tier 5 questions and methods for addressing these questions will depend on the individual project and the concerns raised during pre-construction studies and during operational phases. Rather than provide specific guidance on all potential approaches, these Guidelines offer the following case studies as examples of studies that have attempted to answer Tier 5 questions.

<u>Habitat impacts - displacement and demographic impact studies</u>



Rows of wind turbines. Credit: Joshua Winchell, USFWS

Studies to assess impacts may include quantifying species' habitat loss (e.g., acres of lost grassland habitat for grassland songbirds) and habitat modification. For example, an increase in edge may result in greater nest parasitism and nest predation. Assessing indirect impacts may include two important components: 1) indirect effects on wildlife resulting from displacement, due to disturbance, habitat fragmentation, loss, and alteration; and 2) demographic effects that may occur at the local, regional or population-wide levels due to reduced nesting and breeding densities, increased isolation between habitat patches, and effects on behavior (e.g., stress, interruption, and modification). These factors can individually or cumulatively affect wildlife, although some species may be able to habituate to some or perhaps all habitat changes. Indirect impacts may be difficult to quantify but their effects may be significant (e.g., Stewart et al. 2007, Pearce-Higgins et al. 2008, Bright et al. 2008, Drewitt and Langston 2006, Robel et al. 2004, Pruett et al. 2009).

Example: in southwestern Pennsylvania, development of a project is proceeding at a site located within the range of a state-listed terrestrial species. Surveys were performed at habitat locations appropriate for use by the animal, including at control sites. Post-construction studies are planned at all locations to demonstrate any displacement effects resulting from the construction and operation of the project.

The Service recognizes that indirect impact studies may not be appropriate for most individual projects. Consideration should be given to developing collaborative research efforts with industry, government agencies, and NGOs to conduct studies to address indirect impacts.

Indirect impacts are considered potentially significant adverse threats to species such as prairie grouse (prairie chickens, sharp-tailed grouse), and sage grouse, and demographic studies may be necessary to determine the extent of these impacts and the need for mitigation.

Displacement studies may use any of the study designs describe earlier. The most scientifically robust study designs to estimate displacement effects are BACI, RSF, and impact gradient. RSF and impact gradient designs may not require specialized data gathering during Tier 3.

Telemetry studies that measure impacts of the project development on displacement, nesting, nest success, and survival of prairie grouse and sage grouse in different environments (e.g., tall grass, mixed grass, sandsage, sagebrush) will require spatial and temporal replication, undisturbed reference sites, and large sample sizes covering large areas. Examples of study designs and analyses used in the studies of other forms of energy development are presented in Holloran et al. (2005), Pitman et al. (2005), Robel et al. (2004), and Hagen et al. (2011). Anderson et al. (1999) provides a thorough discussion of the design, implementation, and analysis of these kinds of field studies and should be consulted when designing the BACI study.

Studies are being initiated to evaluate effects of wind energy development on greater sage grouse in Wyoming. In addition to measuring demographic patterns, these studies will use the RSF study design (see Sawyer et al. 2006) to estimate the probability of sage grouse use as a function of the distance to environmental features, including an existing and a proposed project.

In certain situations, such as for a proposed project site that is relatively small and in a more or less homogeneous landscape, an impact gradient design may be an appropriate means to assess avoidance of the wind energy facility by resident populations (Strickland et al., 2002). For example, Leddy et al. 1999 used the impact gradient design to evaluate grassland bird density as a function of the distance from wind turbines. Data were collected at various distances from turbines along transects.

This approach provides information on whether there is an effect, and may allow quantification of the gradient of the effect and the distance at which the displacement

effect no longer exists – the assumption being that the data collected at distances beyond the influence of turbines are the reference data (Erickson et al., 2007). An impact gradient analysis could also involve measuring the number of breeding grassland birds counted at point count plots as a function of distance from the wind turbines (Johnson et al. 2000).

Sound and Wildlife

Turbine blades at normal operating speeds can generate levels of sound beyond ambient background levels. Construction and maintenance activities can also contribute to sound levels by affecting communication distance, an animal's ability to detect calls or danger, or to forage. Sound associated with developments can also cause behavioral and/or physiological effects, damage to hearing from acoustic over-exposure, and masking of communication signals and other biologically relevant sounds (Dooling and Popper 2007). Some birds are able to shift their vocalizations to reduce the masking effects of noise. However, when shifts don't occur or are insignificant, masking may prove detrimental to the health and survival of wildlife (Barber et al. 2010). Data suggest noise increases of 3 dB to 10 dB correspond to 30 percent to 90 percent reductions in alerting distances for wildlife, respectively (Barber et al. 2010).

The National Park Service has been investigating potential impacts to wildlife due to alterations in sound level and type. However, further research is needed to better understand this potential impact. Research may include: how wind facilities affect background sound levels; whether masking, disturbance, and acoustical fragmentation occur; and how turbine, construction, and maintenance sound levels can vary by topographic area.

Levels of fatality beyond those predicted

More intensive post-construction fatality studies may be used to determine relationships between fatalities and weather, wind speed or other covariates, which usually require daily carcass searches. Fatalities determined to have occurred the previous night can be correlated with that night's weather or turbine characteristics to establish important relationships that can then be used to evaluate the most effective times and conditions to implement measures to reduce collision fatality at the project.

Measures to address fatalities

The efficacy of operational changes (e.g. changing turbine cut-in speed) of a project to reduce collision fatalities has only recently been evaluated (Arnett et al. 2009, Baerwald et al 2009). Operational changes to address fatalities should be applied only at sites where collision fatalities are predicted or demonstrated to have significant adverse impacts.

Tier 5 Studies and Research

The Service makes a distinction between Tier 5 studies focused on project-specific impacts and research (which is discussed earlier in the Guidelines). For example, developers may be encouraged to participate in collaborative studies (see earlier discussion of Research) or asked to conduct a study on an experimental mitigation technique, such as differences in turbine cut-in speed to reduce bat fatalities. Such techniques may show promise in mitigating the impacts of wind energy development to wildlife, but their broad applicability for mitigation purposes has not been demonstrated. Such techniques should not be routinely applied to projects, but application at appropriate sites will contribute to the breadth of knowledge regarding the efficacy of such measures in addressing collision fatalities. In addition, studies involving multiple sites and academic researchers can provide more robust research results, and such studies take more time and resources than are appropriately carried out by one developer at a single site. Examples below demonstrate collaborative research efforts to address displacement, operational changes, and population level impacts.

Studies of Indirect Effects

The Service provides two examples below of ongoing studies to assess the effects of indirect impacts related to wind energy facilities.

Kansas State University, as part of the NWCC Grassland Shrub-steppe Species Collaborative, is undertaking a multi-year research project to assess the effects of wind energy facilities on populations of greater prairie-chickens (GPCH) in Kansas. Initially the research was based on a Before/After Control/ Impact (BACI) experimental design involving three replicated study sites in the Flint Hills and Smoky Hills of eastern Kansas. Each study site consisted of an impact area where a wind energy facility was proposed to be developed and a nearby reference area with similar rangeland characteristics where no development was planned. The research project is a coordinated field/laboratory effort, i.e., collecting telemetry and observational data from adult and juvenile GPCH in the field, and determining population genetic attributes of GPCH in the laboratory from blood samples of birds and the impact and reference areas. Detailed data on GPCH movements, demography, and population genetics were gathered from all three sites from 2007 to 2010. By late 2008, only one of the proposed wind energy facilities was developed (the Meridian Way Wind Farm in the Smoky Hills of Cloud County), and on-going research efforts are focused on that site. The revised BACI study design now will produce two years of pre-construction data (2007 and 2008), and three years of post-construction data (2009, 2010, and 2011) from a single wind energy facility site (impact area) and its reference area. Several hypotheses were formulated for testing to determine if wind energy facilities impacted GPCH populations, including but not limited to addressing issues relating to: lek attendance, avoidance of turbines and associated features,

nest success and chick survival, habitat usage, adult mortality and survival, breeding behavior, and natal dispersal. A myriad of additional significant avenues are being pursued as a result of the rich database that has been developed for the GPCH during this research effort. GPCH reproductive data will be collected through the summer of 2011 whereas collection of data from transmitter-equipped GPCH will extend through the lekking season of 2012 to allow estimates of survival of GPCH over the 2011-2012 winter. At the conclusion of the study, the two years of pre-construction data and three years of post-construction data will be analyzed and submitted to peer-reviewed journals for publication.

Erickson et al. (2004) evaluated the displacement effect of a large wind energy facility in the Pacific Northwest. The study was conducted in a relatively homogeneous grassland landscape. Erickson et al. (2004) conducted surveys of breeding grassland birds along 300 meter transects perpendicular to strings of wind turbines. Surveys were conducted prior to construction and after commercial operation. The basic study design follows the Impact Gradient Design (Morrison et al. 2008) and in this application, conformed to a special case of BACI where areas at the distal end of each transect were considered controls (i.e., beyond the influence of the turbines). In this study, there is no attempt to census birds in the area, and observations per survey are used as an index of abundance. Additionally, the impact-gradient study design resulted in less effort than a BACI design with offsite control areas. Erickson et al. (2004) found that grassland passerines as a group, as well as grasshopper sparrows and western meadowlarks, showed reduced use in the first 50 meter segment nearest the turbine string. About half of the area within that segment, however, had disturbed vegetation and separation of behavior avoidance from physical loss of habitat in this portion of the area was impossible. Horned larks and savannah sparrows appeared unaffected. The impact gradient design is best used when the study area is relatively small and homogeneous.

Operational Changes to Reduce Collision Fatality

Arnett et al. (2009) conducted studies on the effectiveness of changing turbine cut-in speed on reducing bat fatality at wind turbines at the Casselman Wind Project in Somerset County, Pennsylvania. Their objectives were to: 1) determine the difference in bat fatalities at turbines with different cut-in-speeds relative to fully operational turbines; and 2) determine the economic costs of the experiment and estimated costs for the entire area of interest under different curtailment prescriptions and timeframes. Arnett et al. (2009) reported substantial reductions in bat fatalities with relatively modest power losses.

In Kenedy County, Texas, investigators are refining and testing a real-time curtailment protocol. The projects use an avian profiling radar system to detect approaching "flying vertebrates" (birds and bats), primarily during spring and fall bird and bat migrations. The blades automatically idle when risk reaches a certain level and weather conditions are particularly risky. Based on estimates of the number and timing of migrating raptors, feathering (real-time curtailment) experiments are underway in Tehuantepec, Mexico, where raptor migration through a mountain pass is extensive.

Other tools, such as thermal imaging (Horn et al. 2008) or acoustic detectors (Kunz et al. 2007), have been used to quantify post-construction bat activity in relation to weather and turbine characteristics for improving operational change efforts. For example, at the Mountaineer project in 2003, Tier 4 studies (weekly searches at every turbine) demonstrated unanticipated and high levels of bat fatalities (Kerns and Kerlinger 2004). Daily searches were instituted in 2004 and revealed that fatalities were strongly associated with low-average-wind-speed nights, thus providing a basis for testing operational changes (Arnett 2005, Arnett et al. 2008). The program also included behavioral observations using thermal imaging that demonstrated higher bat activity at lower wind speeds (Horn et al. 2008).

Studies are currently underway to design and test the efficacy of an acoustic deterrent device to reduce bat fatalities at wind facilities (E.B. Arnett, Bat Conservation International, under the auspices of BWEC). Prototypes of the device have been tested in the laboratory and in the field with some success. Spanjer (2006) tested the response of big brown bats to a prototype eight speaker deterrent emitting broadband white noise at frequencies from 12.5–112.5 kHz and found that during non-feeding trials, bats landed in the quadrant containing the device significantly less when it was broadcasting broadband noise. Spanjer (2006) also reported that during feeding trials, bats never successfully took a tethered mealworm when the device broadcast sound, but captured mealworms near the device in about 1/3 of trials when it was silent. Szewczak and Arnett (2006, 2007) tested the same acoustic deterrent in the field and found that when placed by the edge of a small pond where nightly bat activity was consistent, activity dropped significantly on nights when the deterrent was activated. Horn et al. (2007) tested the effectiveness of a larger, more powerful version of this deterrent device on reducing nightly bat activity and found mixed results. In 2009, a new prototype device was developed and tested at a project in Pennsylvania. Ten turbines were fitted with deterrent devices, daily fatality searches were conducted, and fatality estimates were compared with those from 15 turbines without deterrents (i.e., controls) to determine if bat fatalities were reduced. This experiment found that estimated bat fatalities per turbine were 20 to 53 percent lower at treatment turbines compared to controls.

More experimentation is required. At the present time, there is not an operational deterrent available that has demonstrated effective reductions in bat kills (E. B. Arnett, Bat Conservation International, unpublished data).

Assessment of Population-level Impacts

The Altamont Pass Wind Resource Area (APWRA) has been the subject of intensive scrutiny because of avian fatalities, especially for raptors, in an area encompassing more than 5,000 wind turbines (e.g., Orloff and Flannery 1992; Smallwood and Thelander 2004, 2005). Field studies on golden eagles, a long-lived raptor species, have been completed using radio telemetry at APWRA to understand population demographics, assess impacts from wind turbines, and explore measures to effectively reduce the incidence of golden eagle mortality for this area. (Hunt et al. 1999, and Hunt 2002). Results from nesting surveys (Hunt 2002) indicated that there was no decline in eagle territory occupancy. However Hunt (2002) also found that subadult and floater components of golden eagle populations at APWRA are highly vulnerable to wind turbine mortality and results from this study indicate that turbine mortality prevented the maintenance of substantial reserves of nonbreeding adults characteristic of healthy populations elsewhere, suggesting the possibility of an eventual decline in the breeding population (Hunt and Hunt 2006). Hunt conducted follow-up surveys in 2005 (Hunt and Hunt 2006) and determined that all 58 territories occupied by eagle pairs in 2000 were occupied in 2005. It should be noted however that golden eagle studies at APWRA (Hunt et al. 1999, Hunt 2002, and Hunt and Hunt 2006) were all conducted after the APWRA was constructed and the species does not nest within the footprint of the APWRA itself (Figure 4; Hunt and Hunt 2006). The APWRA is an area of about 160 sq. km (Hunt 2002) and presumably golden eagles formerly nested within this area. The loss of breeding eagle pairs from the APWRA suggests these birds have all been displaced by the project, or lost due to various types of mortality including collisions with turbine blades.

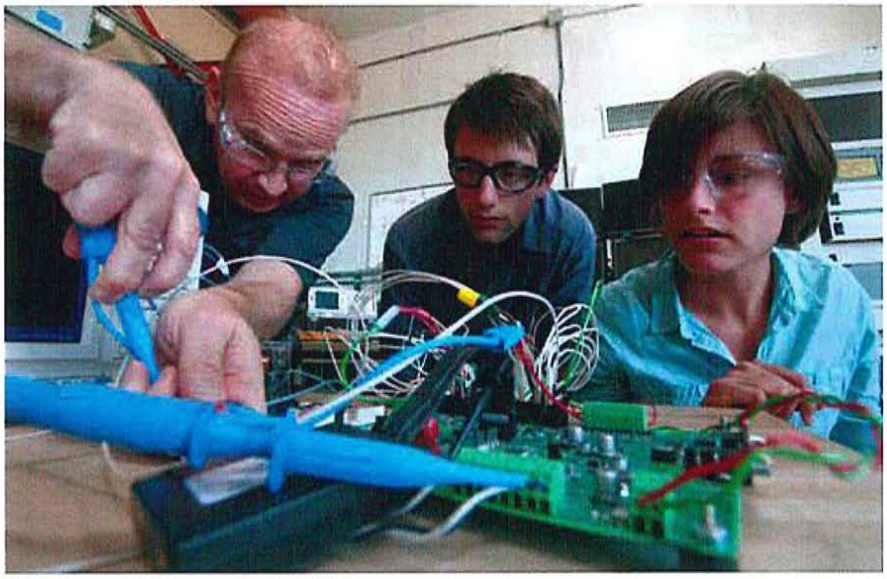


Golden eagle. Credit: George Gentry, USFWS

Chapter 7: Best Management Practices

Site Construction and Operation

During site planning and development, careful attention to reducing risk of adverse impacts to species of concern from wind energy projects, through careful site selection and facility design, is recommended. The following BMPs can assist a developer in the planning process to reduce potential impacts to species of concern. Use of these BMPs should ensure that the potentially adverse impacts to most species of concern and their habitats present at many project sites would be reduced, although compensatory mitigation may be appropriate at a project level to address significant site-specific concerns and pre-construction study results.



Wind electronic developers. Credit: NREL

These BMPs will evolve over time as additional experience, learning, monitoring and research becomes available on how to best minimize wildlife and habitat impacts from wind energy projects. Service should work with the industry, stakeholders and states to evaluate, revise and update these BMPs on a periodic basis, and the Service should maintain a readily available publication of recommended, generally accepted best practices.

1. Minimize, to the extent practicable, the area disturbed by pre-construction site monitoring and testing activities and installations.

2. Avoid locating wind energy facilities in areas identified as having a demonstrated and unmitigatable high risk to birds and bats.

3. Use available data from state and federal agencies, and other sources (which could include maps or databases), that show the location of sensitive resources and the results of Tier 2 and/or 3 studies to establish the layout of roads, power lines, fences, and other infrastructure.

4. Minimize, to the maximum extent practicable, roads, power lines, fences, and other infrastructure associated with a wind development project. When fencing is necessary, construction should use wildlife compatible design standards.

5. Use native species when seeding or planting during restoration. Consult with appropriate state and federal agencies regarding native species to use for restoration.

6. To reduce avian collisions, place low and medium voltage connecting power lines associated with the wind energy development underground to the extent possible, unless burial of the lines is prohibitively expensive (e.g., where shallow bedrock exists) or where greater adverse impacts to biological resources would result:

   a. Overhead lines may be acceptable if sited away from high bird crossing locations, to the extent practicable, such as between roosting and feeding areas or between lakes, rivers, prairie grouse and sage grouse leks, and nesting habitats. To the extent practicable, the lines should be marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines.

   b. Overhead lines may be used when the lines parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.

   c. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."

7. Avoid guyed communication towers and permanent met towers at wind energy project sites. If guy wires are necessary,

bird flight diverters or high visibility marking devices should be used.

8. Where permanent meteorological towers must be maintained on a project site, use the minimum number necessary.

9. Use construction and management practices to minimize activities that may attract prey and predators to the wind energy facility.

10. Employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights, to meet Federal Aviation Administration (FAA) requirements for visibility lighting of wind turbines, permanent met towers, and communication towers. Only a portion of the turbines within the wind project should be lighted, and all pilot warning lights should fire synchronously.

11. Keep lighting at both operation and maintenance facilities and substations located within half a mile of the turbines to the minimum required:

    a. Use lights with motion or heat sensors and switches to keep lights off when not required.

    b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

    c. Minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

    d. All internal turbine nacelle and tower lighting should be extinguished when unoccupied.

12. Establish non-disturbance buffer zones to protect sensitive habitats or areas of high risk for species of concern identified in pre-construction studies. Determine the extent of the buffer zone in consultation with the Service and state, local and tribal wildlife biologists, and land management agencies (e.g., U.S. Bureau of Land Management (BLM) and U.S. Forest Service (USFS)), or other credible experts as appropriate.

13. Locate turbines to avoid separating bird and bat species of concern from their daily roosting, feeding, or nesting sites if documented that the turbines' presence poses a risk to species.

14. Avoid impacts to hydrology and stream morphology, especially where federal or state-listed aquatic or riparian species may be involved. Use appropriate erosion control measures in construction and operation to eliminate or minimize runoff into water bodies.

15. When practical use tubular towers or best available technology to reduce ability of birds to perch and to reduce risk of collision.

16. After project construction, close roads not needed for site operations and restore these roadbeds to native vegetation, consistent with landowner agreements.

17. Minimize the number and length of access roads; use existing roads when feasible.

18. Minimize impacts to wetlands and water resources by following all applicable provisions of the Clean Water Act (33 USC 1251-1387) and the Rivers and Harbors Act (33 USC 301 et seq.); for instance, by developing and implementing a storm water management plan and taking measures to reduce erosion and avoid delivery of road-generated sediment into streams and waters.

19. Reduce vehicle collision risk to wildlife by instructing project personnel to drive at appropriate speeds, be alert for wildlife, and use additional caution in low visibility conditions.

20. Instruct employees, contractors, and site visitors to avoid harassing or disturbing wildlife, particularly during reproductive seasons.

21. Reduce fire hazard from vehicles and human activities (instruct employees to use spark arrestors on power equipment, ensure that no metal parts are dragging from vehicles, use caution with open flame, cigarettes, etc.). Site development and operation plans should specifically address the risk of wildfire and provide appropriate cautions and measures to be taken in the event of a wildfire.

22. Follow federal and state measures for handling toxic substances to minimize danger to water and wildlife resources from spills. Facility operators should maintain Hazardous Materials Spill Kits on site and train personnel in the use of these.

23. Reduce the introduction and spread of invasive species by following applicable local policies for invasive species prevention, containment, and control, such as cleaning vehicles and equipment arriving from areas with known invasive species issues, using locally sourced topsoil, and monitoring for and rapidly removing invasive species at least annually.

24. Use invasive species prevention and control measures as specified by county or state requirements, or by applicable federal agency requirements (such as Integrated Pest Management) when federal policies apply.

25. Properly manage garbage and waste disposal on project sites to avoid creating attractive nuisances for wildlife by providing them with supplemental food.

26. Promptly remove large animal carcasses (e.g., big game,

domestic livestock, or feral animal).

27. Wildlife habitat enhancements or improvements such as ponds, guzzlers, rock or brush piles for small mammals, bird nest boxes, nesting platforms, wildlife food plots, etc. should not be created or added to wind energy facilities. These wildlife habitat enhancements are often desirable but when added to a wind energy facility result in increased wildlife use of the facility which may result in increased levels of injury or mortality to them.

Retrofitting, Repowering, and Decommissioning

As with project construction, these Guidelines offer BMPs for the retrofitting, repowering, and decommissioning phases of wind energy projects.

Retrofitting

Retrofitting is defined as replacing portions of existing wind turbines or project facilities so that at least part of the original turbine, tower, electrical infrastructure or foundation is being utilized. Retrofitting BMPs include:

1. Retrofitting of turbines should use installation techniques that minimize new site disturbance, soil erosion, and removal of vegetation of habitat value.

2. Retrofits should employ shielded, separated or insulated electrical conductors that minimize electrocution risk to avian wildlife per APLIC (2006).

3. Retrofit designs should prevent nests or bird perches from being established in or on the wind turbine or tower.

4. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.

5. Lighting at both operation and maintenance facilities and substations located within half a mile of the turbines should be kept to the minimum required:

   a. Use lights with motion or heat sensors and switches to keep lights off when not required.

   b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

   c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

6. Remove wind turbines when they are no longer cost effective to retrofit.

Repowering

Repowering may include removal and replacement of turbines and associated infrastructure. BMPs include:

1. To the greatest extent practicable, existing roads, disturbed areas and turbine strings should be re-used in repower layouts.

2. Roads and facilities that are no longer needed should be demolished, removed, and their footprint stabilized and re-seeded with native plants appropriate for the soil conditions and adjacent habitat and of local seed sources where feasible, per landowner requirements and commitments.

3. Existing substations and ancillary facilities should be re-used in repowering projects to the extent practicable.

4. Existing overhead lines may be acceptable if located away from high bird crossing locations, such as between roosting and feeding areas, or between lakes, rivers and nesting areas. Overhead lines may be used when they parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.

5. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."

6. Guyed structures should be avoided. If use of guy wires is absolutely necessary, they should be treated with bird flight diverters or high visibility marking devices, or are located where known low bird use will occur.

7. FAA visibility lighting of wind turbines should employ only red, or dual red and white strobe, strobe-like, or flashing lights, not steady burning lights.

8. Lighting at both operation and maintenance facilities and substations located within ½ mile of the turbines should be kept to the minimum required.

   a. Use lights with motion or heat sensors and switches to keep lights off when not required.

   b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.



Towers are being lifted as work continues on the 2 MW Gamesa wind turbine that is being installed at the NWTC. Credit: NREL

c. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.

Decommissioning

Decommissioning is the cessation of wind energy operations and removal of all associated equipment, roads, and other infrastructure. The land is then used for another activity. During decommissioning, contractors and facility operators should apply BMPs for road grading and native plant re-establishment to ensure that erosion and overland flows are managed to restore pre-construction landscape conditions. The facility operator, in conjunction with the landowner and state and federal wildlife agencies, should restore the natural hydrology and plant community to the greatest extent practical.

1. Decommissioning methods should minimize new site disturbance and removal of native vegetation, to the greatest extent practicable.

2. Foundations should be removed to a minimum of three feet below surrounding grade, and covered with soil to allow adequate root penetration for native plants, and so that subsurface structures do not substantially disrupt ground water movements. Three feet is typically adequate for agricultural lands.

3. If topsoils are removed during decommissioning, they should be stockpiled and used as topsoil when restoring plant communities. Once decommissioning activity is complete, topsoils should be restored to assist in establishing and maintaining pre-construction native plant communities to the extent possible, consistent with landowner objectives.

4. Soil should be stabilized and re-vegetated with native plants appropriate for the soil conditions and adjacent habitat, and of local seed sources where feasible, consistent with landowner objectives.

5. Surface water flows should be restored to pre-disturbance conditions, including removal of stream crossings, roads, and pads, consistent with storm water management objectives and requirements.

6. Surveys should be conducted by qualified experts to detect populations of invasive species, and comprehensive approaches to preventing and controlling invasive species should be implemented and maintained as long as necessary.

7. Overhead pole lines that are no longer needed should be removed.

8. After decommissioning, erosion control measures should be installed in all disturbance areas where potential for erosion exists, consistent with storm water management objectives and requirements.

9. Fencing should be removed unless the landowner will be utilizing the fence.

10. Petroleum product leaks and chemical releases should be remediated prior to completion of decommissioning.

Chapter 8: Mitigation

Mitigation is defined in this document as avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts, as determined through the tiered approach described in the recommended Guidelines. The Service places emphasis in project planning on first avoiding, then minimizing, potential adverse impacts to wildlife and their habitats. Several tools are available to determine appropriate mitigation, including the Service Mitigation Policy (USFWS Mitigation Policy, 46 FR 7656 (1981)). The Service policy provides a common basis for determining how and when to use different mitigation strategies, and facilitates earlier consideration of wildlife values in wind energy project planning.

Under the Service Mitigation Policy, the highest priority is for mitigation to occur on-site within the project planning area. The secondary priority is for the mitigation to occur off-site. Off-site mitigation should first occur in proximity to the planning area within the same ecological region and secondarily elsewhere within the same ecological region. Generally, the Service prefers on-site mitigation over off-site mitigation because this approach most directly addresses project impacts at the location where they actually occur. However, there may be individual cases where off-site mitigation could result in greater net benefits to affected species and habitats. Developers should work with the Service in comparing benefits among multiple alternatives.

In some cases, a project's effects cannot be forecast with precision. The developer and the agencies may be unable to make some mitigation decisions until post-construction data have been collected. If significant adverse effects have not been adequately addressed, additional mitigation for those adverse effects from operations may need to be implemented.

Mitigation measures implemented post-construction, whether in addition to those implemented pre-construction or whether they are new, are appropriate elements of the tiered approach. The general terms and funding commitments for future mitigation and the triggers or thresholds for implementing such compensation should be developed at the earliest possible stage in project development. Any mitigation implemented after a project is operational should be well defined, bounded, technically feasible, and commensurate with the project effects.

NEPA Guidance on Mitigation

CEQ issued guidance in February 2011 on compliance with the National Environmental Policy Act (NEPA) entitled, "Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact." This new guidance clarifies that when agencies premise their Finding of No Significant Impact on a commitment to mitigate the environmental impacts of a proposed action, they should adhere to those commitments, publicly report on those efforts, monitor how they are implemented, and monitor the effectiveness of the mitigation.

To the extent that a federal nexus with a wind project exists, for example, developing a project on federal lands or obtaining a federal permit, the lead federal action agency should make its decision based in part on a developer's commitment to mitigate adverse environmental impacts. The federal action agency should ensure that the developer adheres to those commitments, monitors how they are implemented, and monitors the effectiveness of the mitigation. Additionally, the lead federal action agency should make information on mitigation monitoring available to the public through its web site;



Greater prairie chicken. Credit: Amy Thornburg, USFWS

and should ensure that mitigation successfully achieves its goals.

Compensatory Mitigation

Compensatory mitigation as defined in this document refers to replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value.

- **In-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.

- **Out-of-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically or biologically different from those lost. This may include conservation or mitigation banking, research or other options.

The amount of compensation, if necessary, will depend on the effectiveness of any avoidance and minimization measures undertaken. If a proposed wind development is poorly sited with regard to wildlife effects, the most important mitigation opportunity is largely lost and the remaining options can be expensive, with substantially greater environmental effects.

Compensation is most often appropriate for habitat loss under limited circumstances or for direct take of wildlife (e.g., Habitat Conservation Plans). Compensatory mitigation may involve contributing to a fund to protect habitat or otherwise support efforts to reduce existing impacts to species affected by a wind project. Developers should communicate with the Service and state agency prior to initiating such an approach.

Ideally, project impact assessment is a cooperative effort involving the developer, the Service, tribes, local authorities, and state resource agencies. The Service does not expect developers to provide compensation for the same habitat loss more than once. But the Service, state resource agencies, tribes, local authorities, state and federal land management agencies may have different species or habitats of concern, according to their responsibilities and statutory authorities. Hence, one entity may seek mitigation for a different group of species or habitat than does another.

Migratory Birds and Eagles

Some industries, such as the electric utilities, have developed operational and deterrent measures that when properly used can avoid or minimize "take" of migratory birds. Many of these measures to avoid collision and electrocution have been scientifically tested with publication in peer-reviewed, scientific journals. The Service encourages the wind industry to use these measures in siting, placing, and operating all power lines, including their distribution and grid-connecting transmission lines.

E.O. 13186, which addresses responsibilities of federal agencies to protect migratory birds, includes a directive to federal agencies to restore and enhance the habitat of migratory birds as practicable. E.O. 13186 provides a basis and a rationale for compensating for the loss of migratory bird habitat that results from developing wind energy projects that have a federal nexus.

Regulations concerning eagle take permits in 50 CFR 22.26 and 50 CFR 22.27 may allow for compensation as part of permit issuance. Compensation may be a condition of permit issuance in cases of nest removal, disturbance or take resulting in mortality that will likely occur over several seasons, result in permanent abandonment of one or more breeding territories, have large scale impacts, occur at multiple locations, or otherwise contribute to cumulative negative effects. The draft ECP Guidance has additional information on the use of compensation for programmatic permits.

Endangered Species

The ESA has provisions that allow for compensation through the issuance of an Incidental Take Permit (ITP). Under the ESA, mitigation measures are determined on a case by case basis, and are based on the needs of the species and the types of effects anticipated. If a federal nexus exists, or if a developer chooses to seek an ITP under the ESA, then effects to listed species need to be evaluated through the Section 7 and/or Section 10 processes. If an ITP is requested, it and the associated HCP must provide for minimization and mitigation to the maximum extent practicable, in addition to meeting other necessary criteria for permit issuance. For further information about compensation under federal laws administered by the Service, see the Service's Habitat and Resource Conservation website http://www.fws.gov/habitatconservation.



Bald eagle. Credit: USFWS

Chapter 9: Advancing Use, Cooperation and Effective Implementation

This chapter discusses a variety of policies and procedures that may affect the way wind project developers and the Service work with each other as well as with state and tribal governments and non-governmental organizations. The Service recommends that wind project developers work closely with field office staff for further elaboration of these policies and procedures.

Conflict Resolution

The Service and developers should attempt to resolve any issues arising from use of the Guidelines at the Field Office level. Deliberations should be in the context of the intent of the Guidelines and be based on the site-specific conditions and the best available data. However, if there is an issue that cannot be resolved within a timely manner at the field level, the developer and Service staff will coordinate to bring the matter up the chain of command in a stepwise manner.

Bird and Bat Conservation Strategies (BBCS)

The Service has recommended that developers prepare written records of their actions to avoid, minimize and compensate for potential adverse impacts. In the past, the Service has referred to these as Avian and Bat Protection Plans (ABPP). However, ABPPs have more recently been used for transmission projects and less for other types of development. For this reason the Service is introducing a distinct concept for wind energy projects and calling them Bird and Bat Conservation Strategies (BBCS).

Typically, a project-specific BBCS will explain the analyses, studies, and reasoning that support progressing from one tier to the next in the tiered approach. A wind energy project-specific BBCS is an example of a document or compilation of documents that describes the steps a developer could or has taken to apply these Guidelines to mitigate for adverse impacts and address the post-construction monitoring efforts the developer intends to undertake. A developer may prepare a BBCS in stages, over time, as analysis and studies are undertaken for each tier. It will also address the post-construction monitoring efforts for mortality and habitat effects, and may use many of the components suggested in the Suggested Practices for Avian Protection on Power Lines (APLIC 2006). Any Service review of, or discussion with a developer, concerning its BBCS is advisory only, does not result in approval or disapproval of the BBCS by the Service, and does not constitute a federal agency action subject to the National Environmental Policy Act or other federal law applicable to such an action.



Electricity towers and wind turbines. Credit: NREL

Project Interconnection Lines

The Guidelines are designed to address all elements of a wind energy facility, including the turbine string or array, access roads, ancillary buildings, and the above- and below-ground electrical lines which connect a project to the transmission system. The Service recommends that the project evaluation include consideration of the wildlife- and habitat-related impacts of these electrical lines, and that the developer include measures to reduce impacts of these lines, such

as those outlined in the Suggested Practices for Avian Protection on Power Lines (APLIC 2006). The Guidelines are not designed to address transmission beyond the point of interconnection to the transmission system. The national grid and proposed smart grid system are beyond the scope of these Guidelines.

Confidentiality of Site Evaluation Process as Appropriate

Some aspects of the initial pre-construction risk assessment, including preliminary screening and site characterization, occur early in the development process, when land or other competitive issues limit developers' willingness to share information on projects with the public and competitors. Any consultation or coordination with agencies at this stage may include confidentiality agreements.

Collaborative Research

Much uncertainty remains about predicting risk and estimating impacts of wind energy development on wildlife. Thus there is a need for additional research to improve scientifically based decision-making when siting wind energy facilities, evaluating impacts on wildlife and habitats, and testing the efficacy of mitigation measures. More extensive studies are needed to further elucidate patterns and test hypotheses regarding possible solutions to wildlife and wind energy impacts.

It is in the interests of wind developers and wildlife agencies to improve these assessments to better mitigate the impacts of wind energy development on wildlife and their habitats. Research can provide data on operational factors (e.g. wind speed, weather conditions) that are likely to result in fatalities. It could also include studies of cumulative impacts of multiple wind energy projects, or comparisons of different methods for assessing avian and bat activity relevant to predicting risk. Monitoring and research should be designed and conducted to ensure unbiased data collection that meets technical standards such as those used in peer review. Research projects may occur at the same time as project-specific Tier 4 and Tier 5 studies.

Research would usually result from collaborative efforts involving appropriate stakeholders, and is not the sole or primary responsibility of any developer. Research partnerships (e.g., Bats and Wind Energy Cooperative (BWEC[9], Grassland and Shrub Steppe Species Collaborative (GS3C)[10]) involving diverse players will be helpful for generating common goals and objectives and adequate funding to conduct studies (Arnett and Haufler 2003). The National Wind Coordinating Collaborative (NWCC)[11], the American Wind Wildlife Institute (AWWI)[12], and the California Energy Commission (CEC)'s Public Interest Energy Research Program[13] all support research in this area.

Study sites and access will be necessary to design and implement research, and developers are encouraged to participate in these research efforts when possible. Subject to appropriations, the Service also should fund priority research and promote collaboration and information sharing among research efforts to advance science on wind energy-wildlife interactions, and to improve these Guidelines.

Service - State Coordination and Cooperation

The Service encourages states to increase compatibility between state guidelines and these voluntary Guidelines, protocols, data collection methods, and recommendations relating to wildlife and wind energy. States that desire to adopt, or those that have formally adopted, wind energy siting, permitting, or environmental review regulations or guidelines are encouraged to cooperate with the Service to develop consistent state level guidelines. The Service may be available to confer, coordinate and share its expertise with interested states when a state lacks its own guidance or program to address wind energy-wildlife interactions. The Service will also use states' technical resources as much as possible and as appropriate.

The Service will explore establishing a voluntary state/federal program to advance cooperation and compatibility between the Service and interested state and local governments for coordinated review of projects under both federal and state wildlife laws. The Service, and interested states, will consider using the following tools to reach agreements to foster consistency in review of projects:

- Cooperation agreements with interested state governments.
- Joint agency reviews to reduce duplication and increase coordination in project review.
- A communication mechanism:
  - To share information about prospective projects
  - To coordinate project review
  - To ensure that state and federal regulatory processes, and/or mitigation requirements are being adequately addressed

[9] www.batsandwind.org
[10] www.nationalwind.org
[11] www.nationalwind.org
[12] http://www.awwi.org
[13] http://www.energy.ca.gov/research

  - To ensure that species of concern and their habitats are fully addressed

- Establishing consistent and predictable joint protocols, data collection methodologies, and study requirements to satisfy project review and permitting.

- Designating a Service management contact within each Regional Office to assist Field Offices working with states and local agencies to resolve significant wildlife-related issues that cannot be resolved at the field level.

- Cooperative state/federal/ industry research agreements relating to wind energy -wildlife interactions.

The Service will explore opportunities to:

- Provide training to states.

- Foster development of a national geographic data base that identifies development-sensitive ecosystems and habitats.

- Support a national database for reporting of mortality data on a consistent basis.

- Establish national BMPs for wind energy development projects.

- Develop recommended guidance on study protocols, study techniques, and measures and metrics for use by all jurisdictions.

- Assist in identifying and obtaining funding for national research priorities.

Service - Tribal Consultation and Coordination

Federally-recognized Indian Tribes enjoy a unique government-to-government relationship with the United States. The United States Fish and Wildlife Service (Service) recognizes Indian tribal governments as the authoritative voice regarding the management of tribal lands and resources within the framework of applicable laws. It is important to recall that many tribal traditional lands and tribal rights extend beyond reservation lands.



Wind turbine in California.. Credit: NREL

The Service consults with Indian tribal governments under the authorities of Executive Order 13175 "Consultation and Coordination with Indian Tribal Governments" and supporting DOI and Service policies. To this end, when it is determined that federal actions and activities may affect a Tribe's resources (including cultural resources), lands, rights, or ability to provide services to its members, the Service must, to the extent practicable, seek to engage the affected Tribe(s) in consultation and coordination.

Tribal Wind Energy Development on Reservation Lands

Indian tribal governments have the authority to develop wind energy projects, permit their development, and establish relevant regulatory guidance within the framework of applicable laws.

The Service will provide technical assistance upon the request of Tribes that aim to establish regulatory guidance for wind energy development for lands under the Tribe's jurisdiction. Tribal governments are encouraged to strive for compatibility between their guidelines and these Guidelines.

Tribal Wind Energy Development on Lands that are not held in Trust

Indian tribal governments may wish to develop wind energy projects on lands that are not held in trust status. In such cases, the Tribes should coordinate with agencies other than the Service. At the request of a Tribe, the Service may facilitate discussions with other regulatory organizations. The Service may also lend its expertise in these collaborative efforts to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols.

Non-Tribal Wind Energy Development – Consultation with Indian Tribal Governments

When a non-Tribal wind energy project is proposed that may affect a Tribe's resources (including cultural resources), lands, rights, or ability to govern or provide services to its members, the Service should seek to engage the affected Tribe(s) in consultation and coordination as

early as possible in the process. In siting a proposed project that has a federal nexus, it is incumbent upon the regulatory agency to notify potentially affected Tribes of the proposed activity. If the Service or other federal agency determines that a project may affect a Tribe(s), they should notify the Tribe(s) of the action at the earliest opportunity. At the request of a Tribe, the Service may facilitate and lend its expertise in collaborating with other organizations to help determine the extent to which tribal resource management plans and priorities can be incorporated into established regulatory protocols or project implementation. This process ideally should be agreed to by all involved parties.

In the consultative process, Tribes should be engaged as soon as possible when a decision may affect a Tribe(s). Decisions made that affect Indian Tribal governments without adequate federal effort to engage Tribe(s) in consultation have been overturned by the courts. See, e.g., Quechan Tribe v. U.S. Dep't of the Interior, No. 10cv2241 LAB (CAB), 2010 WL 5113197 (S.D. Cal. Dec. 15, 2010). When a tribal government is consulted, it is neither required, nor expected that all of the Tribe's issues can be resolved in its favor. However, the Service must listen and may not arbitrarily dismiss concerns of the tribal government. Rather, the Service must seriously consider and respond to all tribal concerns. Regional Native American Liaisons are able to provide in-house guidance as to government-to-government consultation processes. (See Service - State Coordination and Cooperation, above).

Non-Governmental Organization Actions

If a specific project involves actions at the local, state, or federal level that provide opportunities for public participation, non-governmental organizations (NGOs) can provide meaningful contributions to the discussion of biological issues associated with that project, through the normal processes such as scoping, testimony at public meetings, and comment processes. In the absence of formal public process, there are many NGOs that have substantial scientific capabilities and may have resources that could contribute productively to the siting of wind energy projects. Several NGOs have made significant contributions to the understanding of the importance of particular geographic areas to wildlife in the United States. This work has benefited and continues to benefit from extensive research efforts and from associations with highly qualified biologists. NGO expertise can – as can scientific expertise in the academic or private consulting sectors – serve highly constructive purposes. These can include:

- Providing information to help identify environmentally sensitive areas, during the screening phases of site selection (Tiers 1 and 2, as described in this document)
- Providing feedback to developers and agencies with respect to specific sites and site and impact assessment efforts
- Helping developers and agencies design and implement mitigation or offset strategies
- Participating in the defining, assessing, funding, and implementation of research efforts in support of improved predictors of risk, impact assessments and effective responses
- Articulating challenges, concerns, and successes to diverse audiences

Non-Governmental Organization Conservation Lands

Implementation of these Guidelines by Service and other state agencies will recognize that lands owned and managed by non-government conservation organizations represent a significant investment that generally supports the mission of state and federal wildlife agencies. Many of these lands represent an investment of federal conservation funds, through partnerships between agencies and NGOs. These considerations merit extra care in the avoidance of wind energy development impacts to these lands. In order to exercise this care, the Service and allied agencies can coordinate and consult with NGOs that own lands or easements which might reasonably be impacted by a project under review.

Appendix A: Glossary

Accuracy – The agreement between a measurement and the true or correct value.

Adaptive management – An iterative decision process that promotes flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Comprehensively applying the tiered approach embodies the adaptive management process.

Anthropogenic – Resulting from the influence of human beings on nature.

Area of interest – For most projects, the area where wind turbines and meteorological (met) towers are proposed or expected to be sited, and the area of potential impact.

Avian – Pertaining to or characteristic of birds.

Avoid – To not take an action or parts of an action to avert the potential effects of the action or parts thereof. First of three components of "mitigation," as defined in Service Mitigation Policy. (See mitigation.)

Before-after/control-impact (BACI) – A study design that involves comparisons of observational data, such as bird counts, before and after an environmental disturbance in a disturbed and undisturbed site. This study design allows a researcher to assess the effects of constructing and operating a wind turbine by comparing data from the "control" sites (before and undisturbed) with the "treatment" sites (after and disturbed).

Best management practices (BMPs) – Methods that have been determined by the stakeholders to be the most effective, practicable means of avoiding or minimizing significant adverse impacts to individual species, their habitats or an ecosystem, based on the best available information.

Buffer zone – A zone surrounding a resource designed to protect the resource from adverse impact, and/or a zone surrounding an existing or proposed wind energy project for the purposes of data collection and/or impact estimation.

Community-scale – Wind energy projects greater than 1 MW, but generally less than 20 MW, in name-plate capacity, that produce electricity for off-site use, often partially or totally owned by members of a local community or that have other demonstrated local benefits in terms of retail power costs, economic development, or grid issues.

Comparable site – A site similar to the project site with respect to topography, vegetation, and the species under consideration.

Compensatory mitigation – Replacement of project-induced losses to fish and wildlife resources. Substitution or offsetting of fish and wildlife resource losses with resources considered to be of equivalent biological value.

- **In-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.

- **Out-of-kind** – Providing or managing substitute resources to replace the value of the resources lost, where such substitute resources are physically or biologically different from those lost. This may include conservation or mitigation banking, research or other options.

Cost effective – Economical in terms of tangible benefits produced by money spent.

Covariate – Uncontrolled random variables that influence a response to a treatment or impact, but do not interact with any of the treatments or impacts being tested.

Critical habitat – For listed species, consists of the specific areas designated by rule making pursuant to Section 4 of the Endangered Species Act and displayed in 50 CFR § 17.11 and 17.12.

Cumulative impacts – See impact.

Curtailment – The act of limiting the supply of electricity to the grid during conditions when it would normally be supplied. This is usually accomplished by cutting-out the generator from the grid and/or feathering the turbine blades.

Cut-in Speed – The wind speed at which the generator is connected to the grid and producing electricity. It is important to note that turbine blades may rotate at full RPM in wind speeds below cut-in speed.

Displacement – The loss of habitat as result of an animal's behavioral avoidance of otherwise suitable habitat. Displacement may be short-term, during the construction phase of a project, temporary as a result of habituation, or long-term, for the life of the project.

Distributed wind – Small and mid-sized turbines between 1 kilowatt and 1 megawatt that are installed and produce electricity at the point of use to off-set all or a portion of on-site energy consumption.

Ecosystem – A system formed by the interaction of a community of organisms with their physical and chemical environment. All of the biotic elements (i.e., species, populations, and communities) and abiotic elements (i.e., land, air, water, energy) interacting in a given geographic area so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles. Service Mitigation Policy adopted definition from E. P. Odum 1971 Fundamentals of Ecology.

Edge effect – The effect of the juxtaposition of contrasting environments on an ecosystem.

Endangered species – See listed species.

Extirpation – The species ceases to exist in a given location; the species still exists elsewhere.

Fatality – An individual instance of death.

Fatality rate – The ratio of the number of individual deaths to some parameter of interest such as megawatts of energy produced, the number of turbines in a wind project, the number of individuals exposed, etc., within a specified unit of time.

Feathering – Adjusting the angle of the rotor blade parallel to the wind, or turning the whole unit out of the wind, to slow or stop blade rotation.

Federal action agency – A department, bureau, agency or instrumentality of the United States which plans, constructs, operates or maintains a project, or which reviews, plans for or approves a permit, lease or license for projects, or manages federal lands.

Federally listed species – See listed species.

Footprint – The geographic area occupied by the actual infrastructure of a project such as wind turbines, access roads, substation, overhead and underground electrical lines, and buildings, and land cleared to construct the project.

G1 (Global Conservation Status Ranking) Critically Imperiled – At very high risk of extinction due to extreme rarity (often five or fewer populations), very steep declines, or other factors.

G2 (Global Conservation Status Ranking) Imperiled – At high risk of extinction or elimination due to very restricted range, very few populations, steep declines, or other factors.

G3 (Global Conservation Status Ranking) Vulnerable – At moderate risk of extinction or elimination due to a restricted range, relatively few populations, recent and widespread declines, or other factors.

Guy wire – Wires used to secure wind turbines or meteorological towers that are not self-supporting.

Habitat – The area which provides direct support for a given species, including adequate food, water, space, and cover necessary for survival.

Habitat fragmentation – Habitat fragmentation separates blocks of habitat for some species into segments, such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area.

Impact – An effect or effects on natural resources and on the components, structures, and functioning of affected ecosystems.

- **Cumulative** – Changes in the environment caused by the aggregate of past, present and reasonably foreseeable future actions on a given resource or ecosystem.
- **Direct** – Effects on individual species and their habitats caused by the action, and occur at the same time and place.
- **Indirect impact** – Effects caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts include displacement and changes in the demographics of bird and bat populations.

Infill – Add an additional phase to the existing project, or build a new project adjacent to existing projects.

In-kind compensatory mitigation – See compensatory mitigation.

Intact habitat – An expanse of habitat for a species or landscape scale feature, unbroken with respect to its value for the species or for society.

Intact landscape – Relatively undisturbed areas characterized by maintenance of most original ecological processes and by communities with most of their original native species still present.

Lattice design – A wind turbine support structure design characterized by horizontal or diagonal lattice of bars forming a tower rather than a single tubular support for the nacelle and rotor.

Lead agency – Agency that is responsible for federal or non-federal regulatory or environmental assessment actions.

Lek – A traditional site commonly used year after year by males of certain species of birds (e.g., greater and lesser prairie-chickens, sage and sharp-tailed grouse, and buff-breasted sandpiper), within which the males display communally to attract and compete for female mates, and where breeding occurs.

Listed species – Any species of fish, wildlife or plant that has been determined to be endangered or threatened under section 4 of the Endangered Species Act (50 CFR §402.02), or similarly designated by state law or rule.

Local population – A subdivision of a population of animals or plants of a particular species that is in relative proximity to a project.

Loss – As used in this document, a change in wildlife habitat due to human activities that is considered adverse and: 1) reduces the biological value of that habitat for species of concern; 2) reduces population numbers of species of concern; 3) increases population numbers of invasive or exotic species; or 4) reduces the human use of those species of concern.

Megawatt (MW) – A measurement of electricity-generating capacity equivalent to 1,000 kilowatts (kW), or 1,000,000 watts.

Migration – Regular movements of wildlife between their seasonal ranges necessary for completion of the species lifecycle.

Migration corridor – Migration routes and/or corridors are the relatively predictable pathways that a migratory species travel between seasonal ranges, usually breeding and wintering grounds.

Migration stopovers – Areas where congregations of wildlife assemble during migration. Such areas supply high densities of food or shelter.

Minimize – To reduce to the smallest practicable amount or degree.

Mitigation – (Specific to these Guidelines) Avoiding or minimizing significant adverse impacts, and when appropriate, compensating for unavoidable significant adverse impacts.

Monitoring – 1) A process of project oversight such as checking to see if activities were conducted as agreed or required; 2) making measurements of uncontrolled events at one or more points in space or time with space and time being the only experimental variable or treatment; 3) making measurements and evaluations through time that are done for a specific purpose, such as to check status and/or trends or the progress towards a management objective.

Mortality rate – Population death rate, typically expressed as the ratio of deaths per 100,000 individuals in the population per year (or some other time period).

Operational changes – Deliberate changes to wind energy project operating protocols, such as the wind speed at which turbines "cut in" or begin generating power, undertaken with the object of reducing collision fatalities. Considered separately from standard mitigation measures due to the fact that operational changes are considered as a last resort and will rarely be implemented if a project is properly sited.

Passerine – Describes birds that are members of the Order Passeriformes, typically called "songbirds."

Plant communities of concern –Plant communities of concern are unique habitats that are critical for the persistence of highly specialized or unique species and communities of organisms. Often restricted in distribution or represented by a small number of examples, these communities are biological hotspots that significantly contribute to the biological richness and productivity of the entire region. Plant communities of concern often support rare or uncommon species assemblages, provide critical foraging, roosting, nesting, or hibernating habitat, or perform vital ecosystem functions. These communities often play an integral role in the conservation of biological integrity and diversity across the landscape. (Fournier et al. 2007) Also, any plant community with a Natural Heritage Database ranking of S1, S2, S3, G1, G2, or G3.

Population – A demographically and genetically self-sustaining group of animals and/or plants of a particular species.

Practicable – Capable of being done or accomplished; feasible.

Prairie grouse – A group of gallinaceous birds, includes the greater prairie-chicken, the lesser prairie-chicken, and the sharp-tailed grouse.

Project area – The area that includes the project site as well as contiguous land that shares relevant characteristics.

Project commencement – The point in time when a developer begins its preliminary evaluation of a broad geographic area to assess the general ecological context of a potential site or sites for wind energy project(s). For example, this may include the time at which an option is acquired to secure real estate interests, an application for federal land use has been filed, or land has been purchased.

Project Site – The land that is included in the project where development occurs or is proposed to occur.

Project transmission lines – Electrical lines built and owned by a project developer.

Raptor – As defined by the American Ornithological Union, a group of predatory birds including hawks, eagles, falcons, osprey, kites, owls, vultures and the California condor.

Relative abundance – The number of organisms of a particular kind in comparison to the total number of organisms within a given area or community.

Risk – The likelihood that adverse effects may occur to individual animals or populations of species of concern, as a result of development and operation of a wind energy project. For detailed discussion of risk and risk assessment as used in this document see Chapter One - General Overview.

Rotor – The part of a wind turbine that interacts with wind to produce energy. Consists of the turbine's blades and the hub to which the blades attach.

Rotor-swept area – The area of the circle or volume of the sphere swept by the turbine blades.

Rotor-swept zone – The altitude within a wind energy project which is bounded by the upper and lower limits of the rotor-swept area and the spatial extent of the project.

S1 (Subnational Conservation Status Ranking) Critically Imperiled – Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 (Subnational Conservation Status Ranking) Imperiled – Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.

S3 (Subnational Conservation Status Ranking) Vulnerable – Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.

Sage grouse – A large gallinaceous bird living in the sage steppe areas of the intermountain west, includes the greater sage grouse and Gunnison's sage grouse.

Significant – For purposes of characterizing impacts to species of concern and their habitats, "significance" takes into account the duration, scope, and intensity of an impact. Impacts that are very brief or highly transitory, do not extend beyond the immediate small area where they occur, and are minor in their intensity are not likely to be significant. Conversely, those that persist for a relatively long time, encompass a large area or extend well beyond the immediate area where they occur, or have substantial consequences are almost certainly significant. A determination of significance may include cumulative impacts of other actions. There is probably some unavoidable overlap among these three characteristics, as well as some inherent ambiguity in these terms, requiring the exercise of judgment and the development of a consistent approach over time.

Species of concern – For a particular wind energy project, any species which 1) is either a) listed as an endangered, threatened or candidate species under the Endangered Species Act, subject to the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act; b) is designated by law, regulation, or other formal process for protection and/or management by the relevant agency or other authority; or c) has been shown to be significantly adversely affected by wind energy development, and 2) is determined to be possibly affected by the project.

Species of habitat fragmentation concern—Species of concern for which a relevant federal, state, tribal, and/or local agency has found that separation of their habitats into smaller blocks reduces connectivity such that the individuals in the remaining habitat segments may suffer from effects such as decreased survival, reproduction, distribution, or use of the area. Habitat fragmentation from a wind energy project may create significant barriers for such species.

String – A number of wind turbines oriented in close proximity to one another that are usually sited in a line, such as along a ridgeline.

Strobe – Light consisting of pulses that are high in intensity and short in duration.

Threatened species – See listed species.

Tubular design – A type of wind turbine support structure for the nacelle and rotor that is cylindrical rather than lattice.

Turbine height – The distance from the ground to the highest point reached by the tip of the blades of a wind turbine.

Utility-scale – Wind projects generally larger than 20 MW in nameplate generating capacity that sell electricity directly to utilities or into power markets on a wholesale basis.

Voltage (low and medium) – Low voltages are generally below 600 volts, medium voltages are commonly on distribution electrical lines, typically between 600 volts and 110 kV, and voltages above 110 kV are considered high voltages.

Wildlife – Birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent.

Wildlife management plan – A document describing actions taken to identify resources that may be impacted by proposed development; measures to mitigate for any significant adverse impacts; any post-construction monitoring; and any other studies that may be carried out by the developer.

Wind turbine – A machine for converting the kinetic energy in wind into mechanical energy, which is then converted to electricity..

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U.S. Fish & Wildlife Service
http://www.fws.gov

March 2012



BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

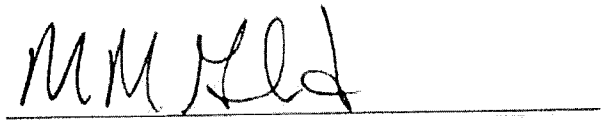
Exhibit ACC-5

Pattern

STATEMENT OF ENVIRONMENTAL VALUES

Pattern Energy Group is committed to protecting the environment and this commitment plays a fundamental role in achieving our business objectives. As a renewable wind energy and transmission company, we naturally serve as active stewards of the environment. We believe that renewable energy sources are fundamental to producing energy in a way that respects the integrity of our environment. We consider it our responsibility to produce and transport clean, renewable energy to consumers with the least amount of natural impact. We recognize that our business has potential environmental impacts that are both positive and negative. Our objective is to exceed industry standards and be a leader in the advancement of best practices for the identification, assessment, and mitigation of our environmental impacts. To this end, Pattern strives to:

- Identify and assess potential environmental impacts at all stages of the life cycle of our projects, incorporate them in our decision making, and explore creative mitigations to minimize any adverse impacts.
- Comply with all environmental laws and regulations. Where there are limited regulations, we apply our own more stringent standards.
- Engage relevant stakeholders, including community representatives and national resource agencies, during the planning of our projects.
- Site and design our projects in such a manner as to respect wildlife and their habitat.
- Construct & operate our projects using best practices to prevent pollution and conserve our natural resources.
- Work to continually improve our overall environmental performance and ensure we are stewards of the environment.



Michael M. Garland
Chief Executive Officer

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

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JOINT APPLICANTS.	)	

Exhibit ACC-6

Building Wildlife-Friendly Wind

As a renewable energy company, Pattern Energy is committed to protecting the environment. We consider it our responsibility to provide renewable energy with the least amount of impact to the environment, especially when it comes to wildlife.

Pattern Energy follows in-depth wildlife protection protocols at all of our wind farms. In fact, we are one of the industry leaders in promoting environmentally-friendly wind energy, while conserving and protecting wildlife. Take a look at some of what we do to ensure that we build wildlife-friendly wind energy.

1. Identify Potential Impacts From the Start

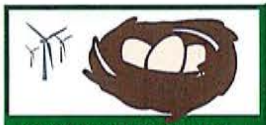
With every new wind farm, we study and identify the wildlife that could potentially be affected by our activities before we move forward with any project.

2. Build Wisely

Once we've selected a specific location to build a wind farm, our team begins conducting studies, consulting with regulatory agencies and other stakeholders, and working with other departments at key stages of development to ensure that we:

A. Avoid Impact

If there are certain areas of a site that could significantly affect wildlife, we will try to avoid that area and build around it.



Example: *If there's an eagle nest nearby, Pattern Energy will try to site project turbines away from that nest.*

B. Minimize Impact

When avoidance isn't feasible, we try to minimize impacts.



Example: *If project areas contain native prairie grassland, we will try to micrositе turbines in already disturbed areas such as cropland. This helps to preserve the intact habitat that could be utilized by grouse species like prairie chickens, which are species of habitat fragmentation concern.*

C. Mitigate Impact

When avoidance and minimization isn't enough to reduce significant adverse impacts, we provide compensatory mitigation.



Example: *If impacts are unavoidable, Pattern may provide compensatory mitigation such as the purchase and management of prime habitat for at risk wildlife in the area.*



Example: *If we're in an area where there are endangered bats, we will employ various mitigation measures such as cave gating and operate our turbines in a manner that reduces impacts to bats during crucial migration periods.*

3. Monitor the Area

Our work of protecting wildlife doesn't stop once the site is up and running. We make sure that all on-site employees are mindful of local wildlife and train them in the proper protocol to avoid, minimize and mitigate impacts.

Monitoring is different and specialized for each location. Whether it's sending a bi-omonitor out to make sure we aren't affecting nearby endangered lizards or physically relocating species so they aren't impacted by the turbines, we employ a diverse set of tools to address specific issues of each project.

At Pattern Energy, we believe that it is fundamental to produce energy in a way that respects the integrity of our natural environment. Through our protocols, we work to continually improve our overall environmental performance so we can protect the environment, especially wildlife, at all of our wind farms.

To learn more about our environmental protocol, contact Rene Braud at rene.braud@patternenergy.com today.

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
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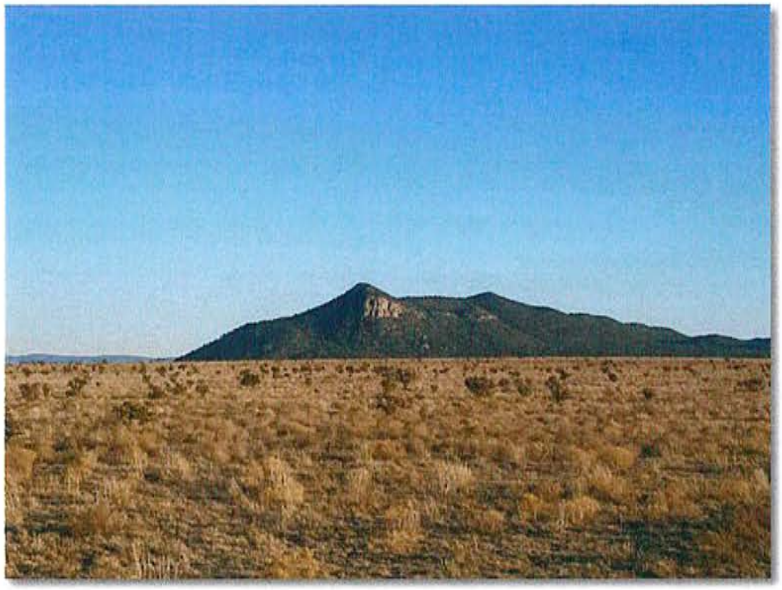
JOINT APPLICANTS.	)	

Exhibit ACC-7

FINAL

Supplemental Avian Protection Plan and Risk Assessment for the Extended Corona 345kV Gen-tie System Corona Wind Projects Torrance County, New Mexico



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December 12, 2019

Confidential Business Information

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Appendix A. Avian Collision Risk Assessment Results within 1 Mile (1.6 Kilometer) of the Alignment of the Extended Corona 345kV Gen-tie Transmission Line

Acronyms and Abbreviations

AOU	American Ornithologists Union
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
BBS	Breeding Bird Survey
BISON-M	Biota Information System of New Mexico
BFD	Bird Flight Diverter
BGEPA	Bald and Golden Eagle Protection Act
CBC	Christmas Bird Count
CFR	Code of Federal Regulations
CIA	Critical Issues Analysis
cm	centimeters
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	foot
gen-tie system	generator-tie transmission line
IBA	Important Bird Area
in	inch
km	kilometer
kph	kilometers per hour
kV	kilovolt
m	meter
MBTA	Migratory Bird Treaty Act
mi	mile
mph	miles per hour
NESC	National Electrical Safety Code
NHD	National Hydrography Geodatabase
NMDGF	New Mexico Department of Game and Fish
NWI	National Wetland Inventory
OHGW	overhead ground wire
OPGW	optical ground wire

Pattern	Pattern Energy Group 2 LP
ROW	right-of-way
SFD	Swan Flight Diverter
TNC	The Nature Conservancy
US	United States
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
USGS 3DEP	US Geological Survey 3D Elevation Program
USGS PAD-US	US Geological Survey Protected Areas Database of the United States
UV	ultra-violet
WEST	Western EcoSystems Technology, Inc.
WIRS	Wildlife Incident Reporting System

1.0 OVERVIEW

1.1 Introduction

Pattern SC Holdings LLC requested Western EcoSystems Technology, Inc. (WEST) supplement the avian risk assessment and project-specific Avian Protection Plan (APP) initially developed for the Ancho Wind, Cowboy Mesa, Duran Mesa, Gallinas Mountain Wind, Red Cloud Wind, Tecolote Wind, and Viento Loco Projects (collectively the "Corona Wind Projects") located in Guadalupe, Lincoln, and Torrance counties, New Mexico (Nielsen and Gardner 2018). Pattern SC Holdings LLC is a wholly owned subsidiary of Pattern Energy Group 2 LP (Pattern) and the Corona Wind Projects are being developed by Pattern.

The original analysis examined the Corona Gen-tie System, an 81-mile (mi; 130kilometer [km]) 345-kilovolt (kV) transmission line system, relative to potential avian risks from power line operation. This supplemental risk assessment and APP examines a new, exended 30.2-mi (48.6-km) alignment of a 345kV transmission line that connects the Corona Gen-tie System to the Western Spirit Transmission Project in Torrance County (Figure 1.1). The same bird risk parameters initially examined in March 2018 (Nielsen and Gardner 2018) were applied to this supplemental APP and subsequent risk assessment.

For the purposes of this supplemental assessment, the overall "Project" or "Project Area" is defined as more regional, encompassing the Updated Corona Wind Project Area and surrounding areas. The "Study Area" is more specific to Extended Corona Gen-tie System's 345kV transmission line alignment and associated 1-mi-wide (1.6-km-wide) buffer (the Extended Corona Gen-tie System Corridor). The goals of the avian power line risk assessment were to compare proposed line design and operation to potential interactions with both resident and migratory birds, relative to the guidance outlined by the Avian Power Line Interaction Committee (APLIC).

APLIC is comprised of a consortium of large and small utilities across the United States (US) and Canada that have developed and refined guidelines or suggested practices to minimize interactions between birds and power lines. The US Fish and Wildlife Service (USFWS) is a partner with APLIC in developing these guidelines and furthering utility orientation and education. The APLIC guidelines are voluntary and not regulatory driven, but are structured to provide guidance for adhering to the Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection Act (BGEPA), and Endangered Species Act (ESA).

WEST worked with Pattern to develop this project-specific APP and risk assessment to proactively plan for and minimize potential avian interactions with the Extended Corona Gen-tie System, referencing applicable portions of APLIC and USFWS (2005) *Avian Protection Plan Guidelines*, and incorporating APLIC (2006) *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* and APLIC (2012) *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. This document incorporates Pattern's commitment with APLIC's guidance and WEST's experience and professional expertise in these areas.

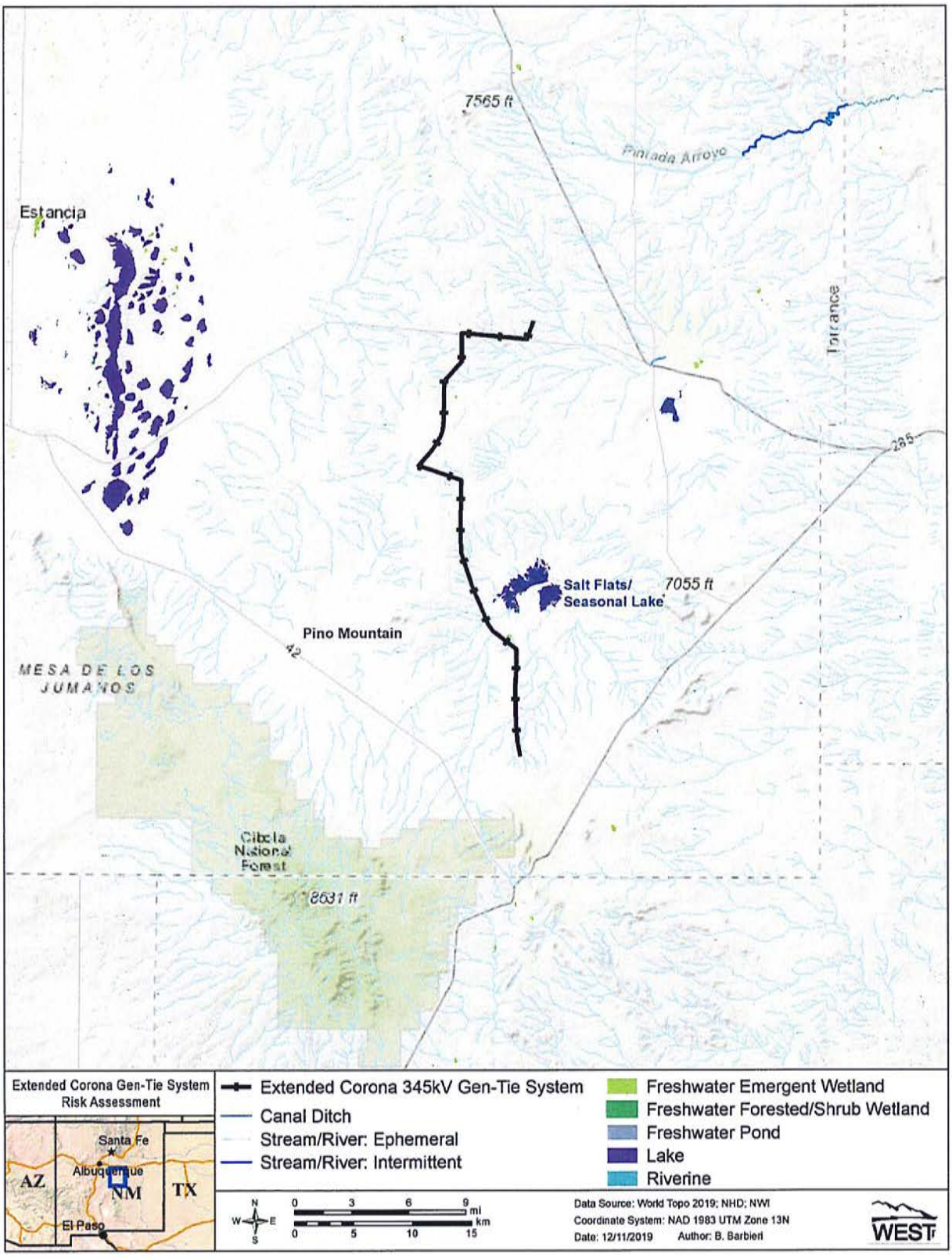

Figure 1.1. Extended Corona 345kV Gen-tie System Alignment.

1.2 Corporate Programs and Policy

1.2.1 Corporate Statement of Environmental Values

Pattern has an established corporate-wide *Statement of Environmental Values*, outlining the company's commitment to protecting the environment, which plays a fundamental role in this APP. Pattern considers it a company responsibility to produce and transport clean, renewable energy to consumers with the least amount of natural impact. Business actions may have potential environmental impacts that are both positive and negative, with the company's objective to exceed industry standards and lead the advancement of best practices for the identification, assessment, and mitigation of potential environmental impacts.

Toward this end, Pattern strives to:

- Identify and assess potential environmental impacts at all stages of a Project's cycle, incorporate them into the decision making, and explore creative mitigations to minimize potential adverse impacts.
- Comply with environmental laws and regulations, applying more stringent standards in the event regulations are limited.
- Engage relevant stakeholders, including community representatives and national resource agencies, during the planning of Pattern's projects.
- Site and design projects to account for wildlife and their habitats.
- Construct & operate projects, using best practices to prevent pollution and conserve natural resources.
- Work to continually improve overall environmental performance as environmental stewards.

1.2.2 Environmental Training and Incident Reporting

On behalf of Pattern, WEST has assisted in developing an environmental training and orientation for field personnel and contractors, focusing on federally and state-protected species that may be encountered within the Corona Wind Project region in addition to other sensitive plant and wildlife species. Environmental orientation includes ensuring awareness of the applicable laws and regulations, identification of various plant and wildlife species of concern, recommended procedures to avoid or minimize potential impacts to these species, and personnel avoidance measures for potentially harmful wildlife. Pattern also maintains a Wildlife Incident Reporting System (WIRS) that outlines the appropriate data recording needs and incident reporting procedures. A final component incorporated into this program involves adaptive management procedures, where applicable.

1.3 Federal and State Regulations

1.3.1 Federal Regulations

Three primary federal laws protect the majority of the birds and their nests in the US. These regulations include:

- Migratory Bird Treaty Act
- Bald and Golden Eagle Protection Act
- Endangered Species Act

Migratory Bird Treaty Act

Under the MBTA[1], it is illegal for anyone (including individuals, companies, or agencies) to "pursue, hunt, take, capture, kill, possess, sell, barter, purchase, ship, export, or import any migratory birds alive or dead, or any part, nests, eggs, or products thereof" except under the terms of a valid permit issued pursuant to federal regulations. Migratory bird species protected by the MBTA are listed in 50 Code of Federal Regulations (CFR) Parts 10 and 21[2]. The majority of bird species in the US are protected under the MBTA except for non-native species (which includes the house sparrow [*Passer domesticus*], European starling [*Sturnus vulgaris*], rock pigeon [*Columba livia*], Eurasian collared-dove [*Streptopelia decaocto*], monk parakeet [*Myiopsitta monachus*], and mute swan [*Cygnus olor*]) and non-migratory species, such as game birds (e.g., turkey, grouse, quail).

Bald and Golden Eagle Protection Act

The two species of eagles native to the US (bald eagle [*Haliaeetus leucocephalus*] and golden eagle [*Aquila chrysaetos*]) have additional protection under the BGEPA (50 CFR Part 22)[3], which states "no person shall take, possess, sell, purchase, barter, offer for sale, transport, export, or import any bald [or golden eagle] alive or dead, or any part, nests or eggs, thereof" without a valid permit to do so. The definition of "take" under BGEPA encompasses "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturb" is defined as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle; 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior"[4].

Endangered Species Act

Under the ESA (50 CFR Part 17) it is illegal to "import, export, take, transport, sell, purchase, or receive in interstate or foreign commerce any living or dead species federally listed as either

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[1] https://www.fws.gov/birds/policies-and-regulations/laws-legislations/migratory-bird-treaty-act.php

[2] https://www.fws.gov/migratorybirds/pdf/policies-and-regulations/MBTAListofBirdsFinalRule.pdf

[3] http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=9a2c074a271d17db16c4a0fa4ca3d2ba&tpl=/ecfrbrowse/Title50/50cfr22_main_02.tpl

[4] https://www.fws.gov/midwest/midwestbird/eaglepermits/bagepa.html

threatened or endangered." "Endangered" is defined as a species that is in danger of extinction throughout all or a significant portion of its range. "Threatened" is defined as a species that is likely to become endangered within the foreseeable future[5]. The list of federally listed species in the US is provided by the USFWS[6]. The ESA has an established process to assess potential effects to federally listed species, and the project type and location should dictate the type of process that should apply.

1.3.2 State Regulations

States typically have statutes and regulations that broadly protect native wildlife species. In addition to protecting federally listed species within their borders, many states maintain a list for state-listed threatened or endangered species. Note: although upland game birds, such as wild turkey and quail, are not protected under the MBTA, they are regulated by state wildlife laws.

Fish and wildlife in New Mexico are protected under New Mexico Statutes, Chapter 17. New Mexico has the New Mexico Wildlife Conservation Act (NM ST § 17-2-37), which is voluntary and operated through landowner cooperation. Additionally, the New Mexico Department of Game and Fish (NMDGF) maintains a list of state threatened or endangered species at the Biota Information System of New Mexico (BISON-M 2017).

1.4 Avian Interactions with Power Lines

As a foundation for this avian risk assessment, WEST has outlined the basic premises specific to bird interactions with overhead power lines, since not all power lines or structures pose a risk to birds. Risks to birds for both electrocution and collision are generally defined by the line's voltage, structure configurations, at-risk bird species potentially present, line or structure location, habitat types in proximity to the line, and other human-related influences in the vicinity of the lines and structures.

1.4.1 Avian Electrocution Risk with Overhead Power Lines

The electrocution risk to birds on power line structures is directly related to the line's voltage, structure configuration, and clearances between structure components, combined with biological and site-specific factors. Other factors that influence avian electrocution risk include line or pole location, bird size, age of a bird, social behavior, habitats (e.g., open versus forested), weather (e.g., precipitation, sun/heat, wind), aerial contaminants (e.g., salt, dust), prey abundance, and propensity of certain bird species to perch or nest on power line structures.

Raptors often use power line structures for hunting perches (Olendorff et al. 1981) and nesting (Boeker and Nickerson 1975; Benson 1981; APLIC 2006), particularly in open habitats. Benson (1981) reported perch height and increased topography are important to eagles and can contribute to the frequency of eagle electrocutions. Birds that commonly forage in and near water, such as bald eagles, ospreys (*Pandion haliaetus*), and great blue herons (*Ardea herodias*), may be at increased risk of electrocution on structures with insufficient clearances. Since water

[5] https://www.fws.gov/endangered/laws-policies/index.html

[6] https://www.fws.gov/endangered/species/us-species.html

increases conductivity, wet outer primary feathers on a bird significantly increases its electrocution risk. Similarly, a saturated wood pole can become grounded, resulting in an increased electrocution risk for birds.

A bird's dimensions are integral in assessing the potential for it to make phase-to-phase (i.e., energized-to-energized) or phase-to-ground (i.e., energized-to-ground or to a neutral) contact with power line infrastructure. These dimensions encompass the horizontal distance between the fleshy part of a bird's wrists on the wings and its height from head to the fleshy part of the tail. Established guidelines to minimize the electrocution risk or exposure to large, perching birds in the US have delineated clearances on power line structures for at-risk bird species. Between potential contact points, a minimum of 60 inches (in; 152 centimeters [cm]) horizontal clearance and 40 in (102 cm) vertical clearance have been recognized for distribution voltages (12.47/7.2kV and 24.9/14.4kV) and sub-transmission voltages (34.5kV to 60kV; APLIC 2006; Figure 1.2). Increased clearances on a power line structure increase the distances between potential contact points, thereby reducing the relative avian electrocution risk.

Power line structure configurations across the landscape are not equal in electrocution risk to birds and can disproportionately affect avian electrocution risk. As an example for distribution voltages in northwestern Colorado, Harness and Wilson (2001) documented 24% of all structures were deadend units within an area that contained 51% of the overall detected raptor mortality, and 17% of all units were transformer banks that reflected 22% of detected raptor mortality. Therefore, two at-risk configurations (totaling 41% of all structure units) resulted in 73% of all raptor fatalities in one study.

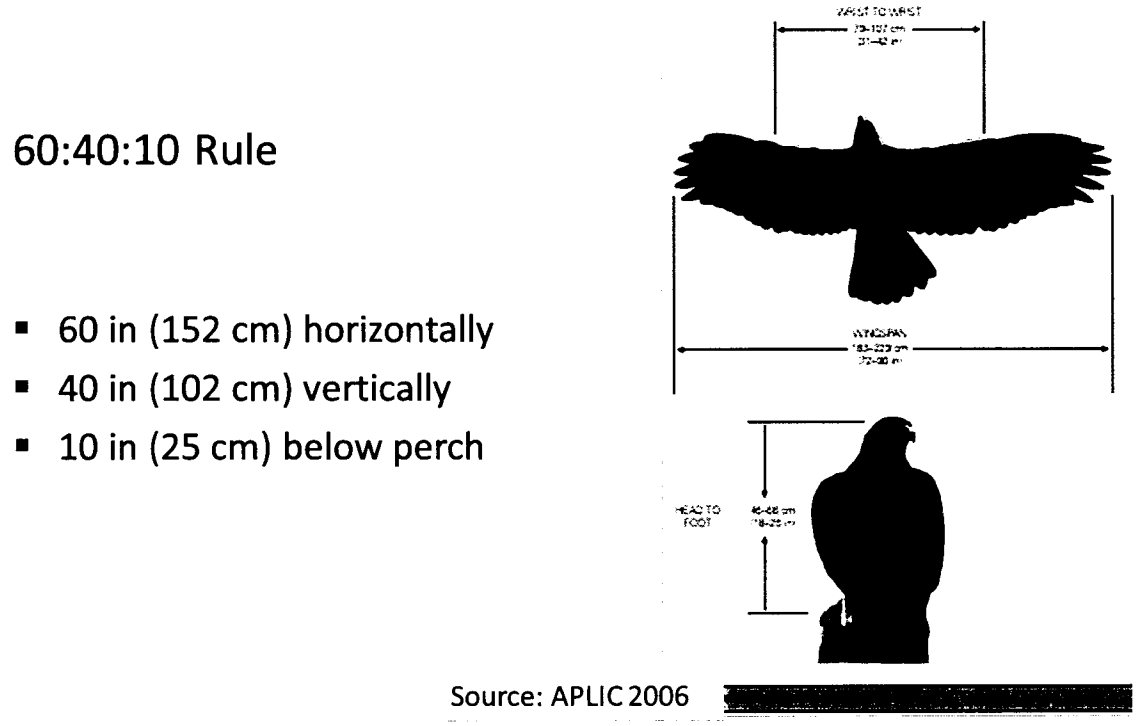

Figure 1.2. Standard recommended clearances for birds on power lines less than 69kV.

As voltage increases over 60kV, additional clearances are necessary beyond the 60 in (152 cm) horizontally and 40 in (102 cm) vertically defined for distribution and sub-transmission voltages to minimize exposure to perching birds (APLIC 2006). Table 1.1 summarizes the recommended phase-to-phase and phase-to-ground clearance for voltages up to 345kV. Power lines ≥161kV typically maintain sufficient distances between phase-to-phase and phase-to-ground contact points, based on clearances established by the National Electrical Safety Code (NESC). Avian electrocution risk <161kV depends on the structure configuration relative to the size of potential bird species present.

Table 1.1. Recommended avian clearances by voltage for phase-to-phase and phase-to-ground contact points.

Phase-to-Phase (+0.2 in [0.5 cm] x 1kV >60kV)			Phase-to-Ground (Phase-to-Phase Voltage/1.732) (+0.2 in [0.5 cm] x 1kV >60kV)		
Line Voltage (kV)	Horizontal Spacing in (cm)[1]	Vertical Spacing in (cm)[1]	Nominal Voltage (kV)	Horizontal Spacing in (cm)[1]	Vertical Spacing in (cm)[1]
≤60	60 (152)	40 (102)	35	60 (152)	40 (102)
69	62 (157)	42 (107)	40	60 (152)	40 (102)
115	71 (180)	51 (130)	66	61 (155)	41 (105)
120	72 (182)	52 (132)	69	62 (157)	42 (107)
138	76 (191)	56 (141)	80	64 (162)	44 (112)
230	94 (237)	74 (187)	133	75 (189)	55 (139)
345	117 (295)	97 (245)	199	88 (222)	68 (172)

Sources: APLIC 2006; WEST (L. Nielsen and S. Ehmke, pers. comm.) 2019.

[1]Applied formulas versus straight conversion to metric.

In = inches; cm = centimeters; kV = kilovolt.

1.4.2 Avian Collision Risk with Overhead Power Lines

Avian collision risk with overhead lines is not uniform, and determining the relative risk or exposure is generally governed by the type of electrical infrastructure in proximity to bird species or bird groups potentially present, the way birds use the surrounding habitats, and level of human influences (Olendorff and Lehman 1986, Bevanger and Brøseth 2001, Harness et al. 2003, Mojica et al. 2009, APLIC 2012). Site-specific factors include which bird species may be present that are more susceptible to colliding with overhead lines, specific line design, line orientation and placement, topography, surrounding habitats, weather, bird morphology, flight characteristics, and patterns of human use.

Biological variables that influence a bird species' susceptibility to line collision includes bird size and maneuverability, flight characteristics, vision, and behavior (Anderson 1978; Beaulaurier et al. 1982; Faanes 1987; Bevanger 1994; Janss 2000; Bevanger and Brøseth 2001; Harness et al. 2003; Mojica et al. 2009; Rollan et al. 2010; APLIC 2012). Morphological characteristics also influence a bird species' collision risk. For example, birds with high wing loading (ratio of body weight to wing area or how much weight is supported by the wing) are more susceptible to collisions with overhead lines than birds with low wing loading. Additionally, birds with low aspect ratios (ratio of the wing breadth divided by wing length) are more prone to collision than birds with high aspect ratios (APLIC 2012).

Flight characteristics include a bird's altitude and flight speed when approaching an overhead line, which can be important in defining the risk of birds colliding with the lines (Beaulaurier et al. 1982). Species flying low and/or fast have a higher risk of colliding with power lines (Thompson 1978; Meyer and Lee 1979; Faanes 1987), particularly if the birds are preoccupied (e.g., territorial defense, courtship, prey pursuit, predator avoidance; Olendorff and Lehman 1986). Flying in flocks restricts visibility and maneuverability, increasing collision risk (APLIC 2012).

The altitude of migratory birds (several hundred to several thousand feet above the ground) is typically far greater than the height of even the largest transmission line structures in the US (i.e., less than 200 feet [ft; 61 meters (m)]; APLIC 2012). However, the orientation and location of power lines to stopover habitats used by migratory birds, weather, and local habitats all are important (Heck 2007, APLIC 2012). Lines that bisect bird movement corridors between roosting and foraging habitats may increase the avian collision risk or potential exposure (Bevanger 1994, APLIC 2012), particularly near areas that attract migrating waterfowl or waterbirds, such as wetlands, lakes, playas, and rivers.

Proximity of power lines to locations where birds are landing or taking off is important in assessing the potential collision risk or exposure (Faanes 1987, Stehn and Wassenich 2008). During daily movements and migratory stopovers, crossing power lines at low altitudes several times a day puts birds at a greater exposure for potential line collision (Willard 1978), as does flying in low light or during inclement weather (Faanes 1987, Morkill and Anderson 1991, APLIC 2012).

Human activities near power lines may directly affect bird collision rates in areas where the two overlap. Roosting or foraging birds may flush from human presence, particularly pedestrian activities in an area, increasing the collision risk and bird mortality in areas with distribution or transmission power lines (James and Haak 1979; APLIC 2012; Heck et al. 2016). Land use also plays a factor in determining bird use and movement within an area, including locations of infrastructure and human-related activities on the landscape.

Other factors important in assessing avian collision risk include power line configuration. Vertical vs. horizontal conductor design determines the number of horizontal planes flying birds may need to navigate. The smaller-diameter overhead ground wires (OHGW) and/or optical ground wire (OPGW) on transmission structures increases bird collision risk from a reduced visibility to birds.

Based on these factors, species of large, heavy-bodied birds with large wing spans and lower maneuverability have been shown to be more susceptible to power line collisions, such as cranes, herons, swans, pelicans, and geese. Other susceptible species are represented by smaller, heavy-bodied birds that are fast fliers with short, wide wings, such as ducks, rails, coots, and grebes (APLIC 2012).

Limited studies have documented eagles and other raptors colliding with overhead power lines. Raptors are adept flyers and raptor collision incidents with overhead lines occur with much less frequency than collision incidents with other bird species (Bevanger 1994). Raptors possess high-

accuracy eyesight, are agile fliers, and typically do not exhibit behavioral or flight characteristics that would increase collision risk with overhead lines; although, they may be more susceptible to overhead line collision when preoccupied or distracted (Olendorff and Lehman 1986, Harness et al. 2003). Although there is a limited number of anecdotal accounts of bald and golden eagle collisions with overhead lines in the US, two studies have documented bald eagle collisions with distribution lines. One study reported bald eagle collisions near a fish cannery in Alaska (Harness et al. 2003); the second study confirmed 21 bald eagle collisions over a 22-year period along approximately 932 mi (1,500 km) of three-phase distribution lines on the Aberdeen Providing Grounds in Maryland (Mojica et al. 2009).

A two-year, pre- and post-construction study of diurnal-migrating raptors crossing the Kittatinny Ridge in New Jersey, within a prominent raptor migration corridor of the Atlantic Flyway, reported a 23% increase in the proportion of raptors flying above the height above ground relative to a 500/230kV transmission line post-construction, with two species (turkey vulture [*Cathartes aura*] and sharp-shinned hawk [*Accipiter striatus*]) showing a significant increase in altitude during the post-construction surveys. These results infer that the line's conductors and marked overhead shield wire were more visually apparent to the migrating raptors and the birds adjusted their flight altitude accordingly (Luzenski et al. 2016).

2.0 EXTENDED CORONA GEN-TIE SYSTEM

The Extended Corona Gen-tie System is a proposed 30.2-mi (48.6-km) single- and double-circuit 345kV transmission line, located in Torrance County that would connect the Corona Gen-tie System to the Western Spirit Transmission Project. The 1-mi (1.6-km) Study Area buffer surrounding the Extended Corona Gen-tie System defines the Extended Corona Gen-tie System Corridor, which is shown in Figure 2.1. As discussed in Chapter 4.0, *Methods and Metrics*. This 1-mi (1.6-km) study buffer was used for the risk analysis, based on a number of studies that have documented bird fatalities along power lines, extending from 197 ft (60 m) to 1 mi (1.6-km) from the power line right-of-way (ROW; Brown et al. 1984, 1987; Faanes 1987; Stehn and Wassenich 2008; Murphy et al. 2009; APLIC 2012).

Representative transmission structures are shown in Figures 2.2 and 2.3. Figure 2.2 depicts a single-circuit 345kV transmission structure with braced-post insulator array and two OPGWs for facility communications supported on davit arms. Figure 2.3 depicts a double-circuit 345kV transmission structure, also with braced-post insulator arrays and two OPGWs. Both horizontal and vertical dimensions are shown for both structure types.

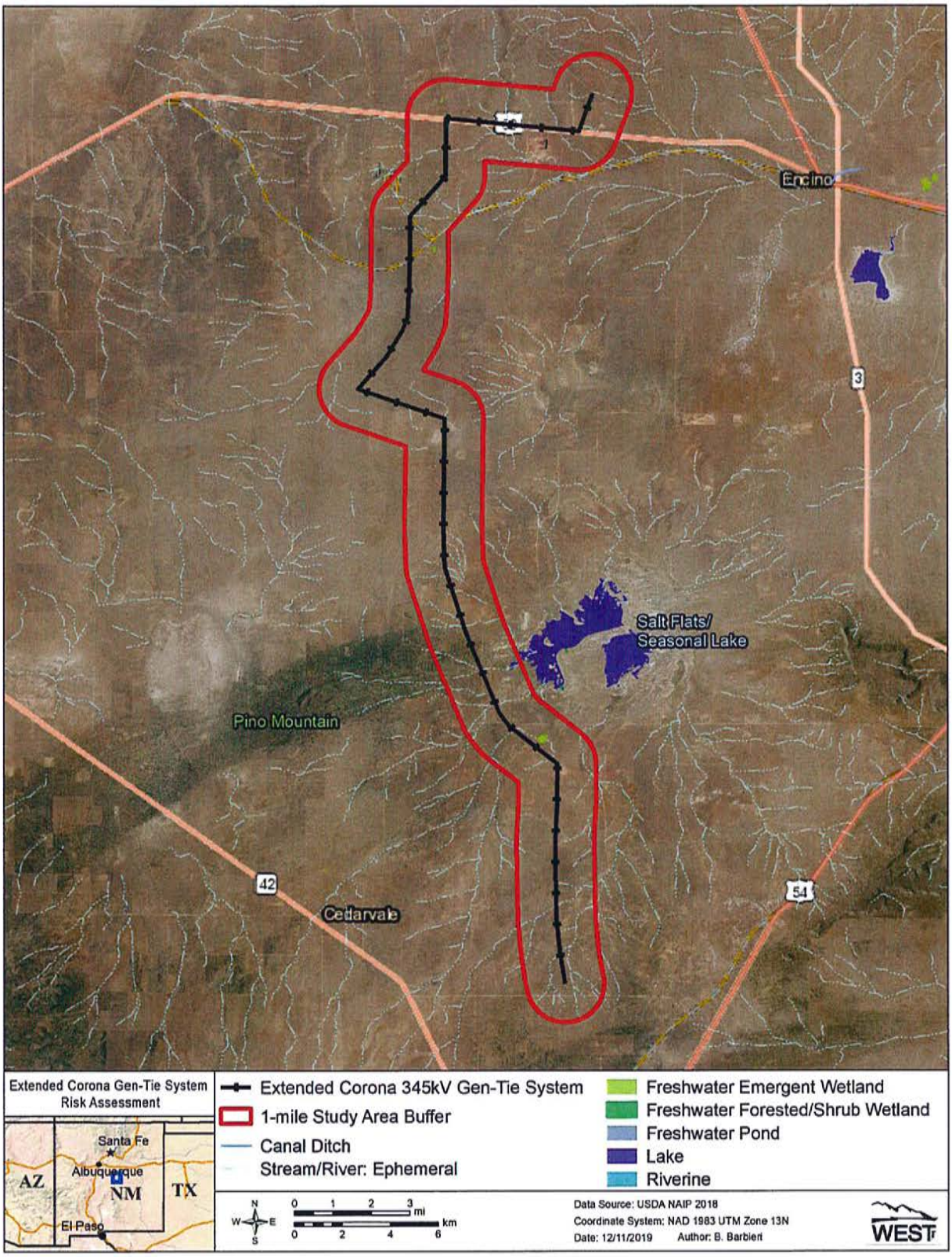

Figure 2.1. Extended Corona 345kV Gen-tie System Corridor with 1-mile (1.6-kilometer) Study Area buffer.

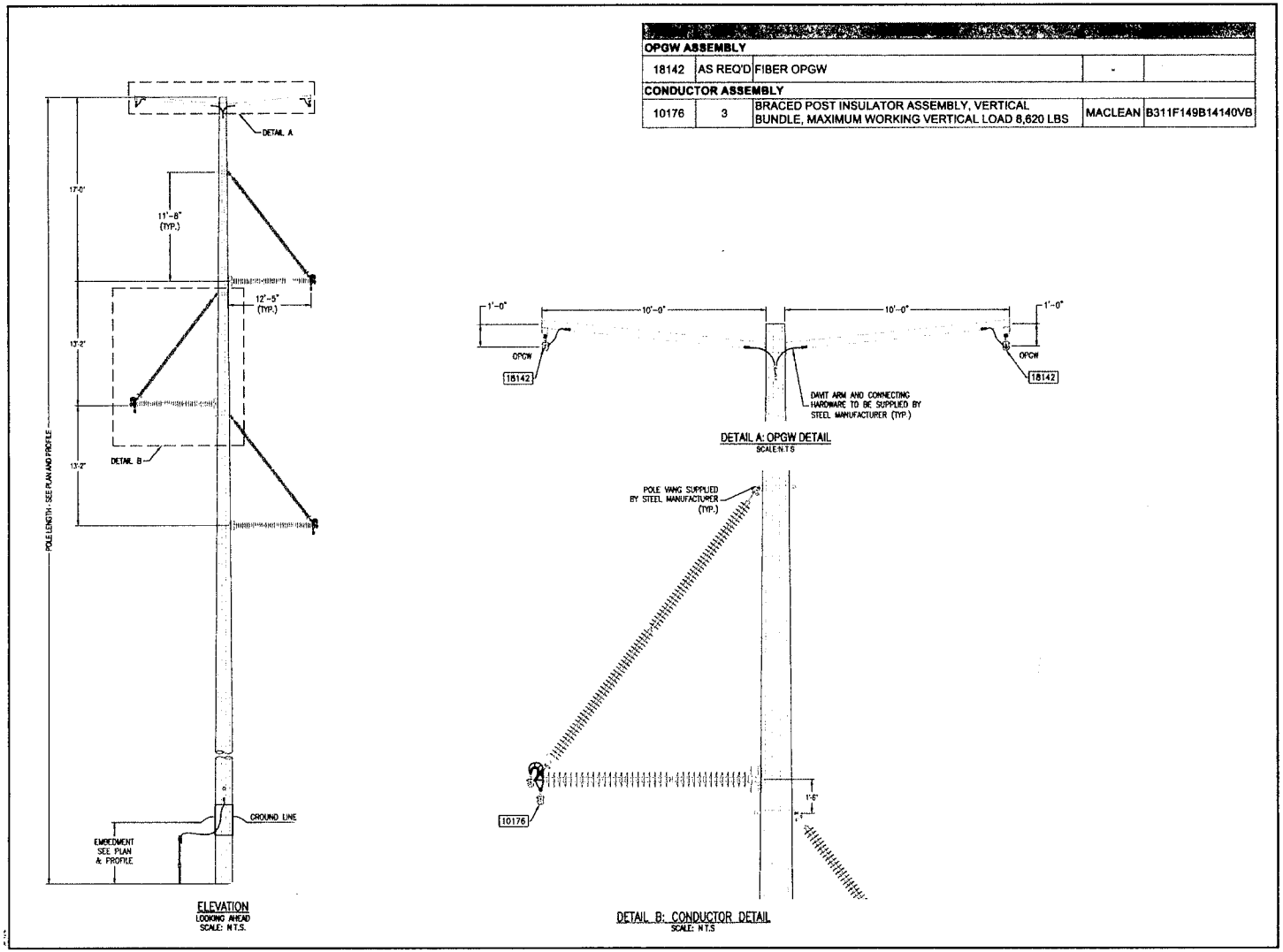

Figure 2.2. Representative single-circuit 345kV transmission tangent structure with braced-post insulator array and two Optical Ground Wires.

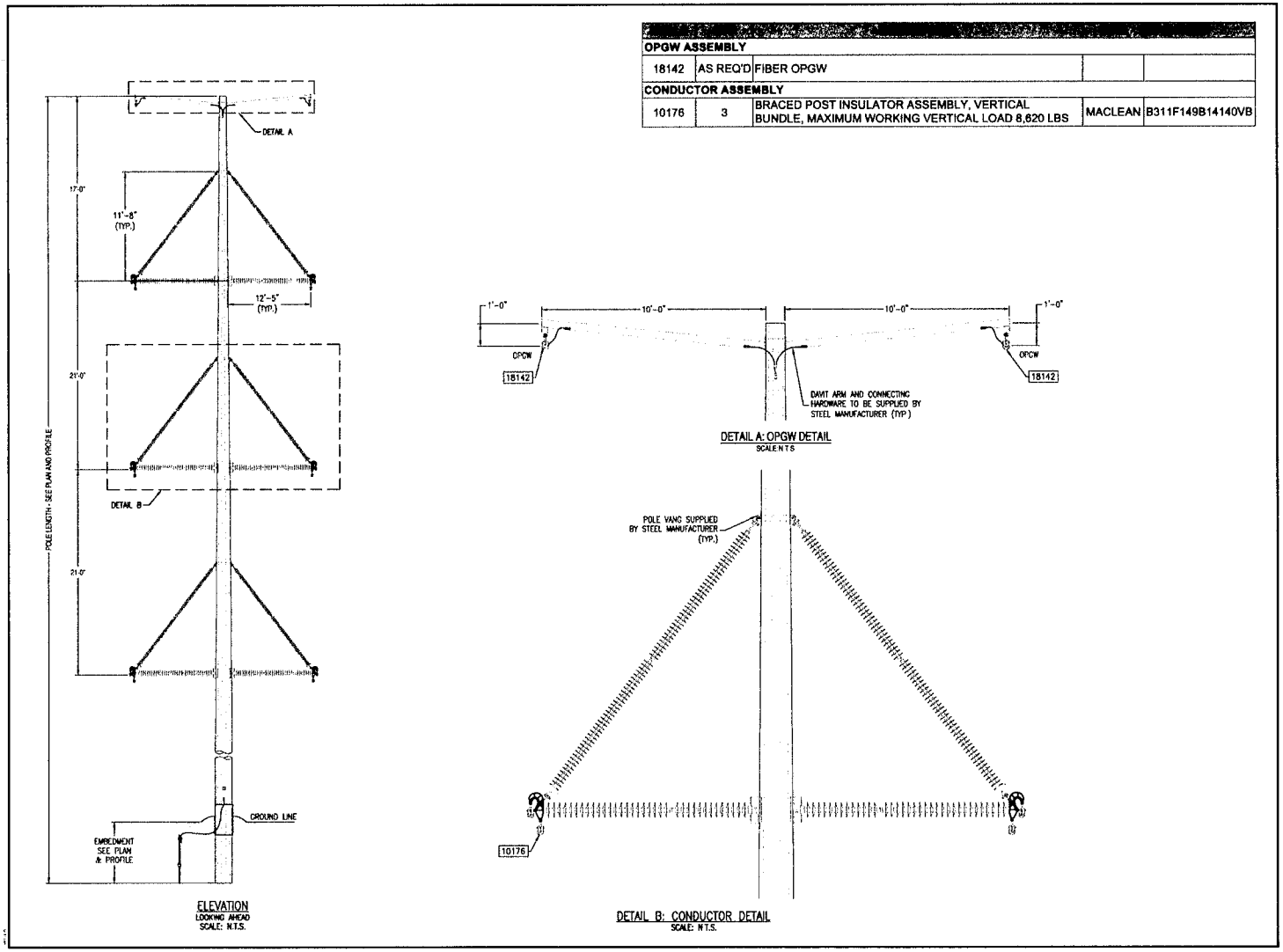

Figure 2.3. Representative double-circuit 345kV transmission tangent structure with braced-post insulator arrays and two Optical Ground Wires.

3.0 PROJECT AND STUDY AREA

3.1 Habitats and Land Use

The Corona Wind Projects and associated Extended Corona 345kV Gen-tie System (connecting the Corona Gen-tie System to the Western Spirit Transmission Project) are located in a relatively flat arid landscape with short grasslands and shrub/scrub interspersed with rocky outcrops, ridgelines, ephemeral drainages, and scattered playas. The Study Area is located within the Southwestern Tablelands Ecoregion (US Environmental Protection Agency [EPA] 2016), with common vegetation including grama grasses (*Bouteloua gracilis*), buffalo grass (*Bouteloua dactyloides*), junipers (*Juniperus* spp), piñon pine *(Pinus edulis*), and Gambel oak (*Quercus gambelii*). Land use is primarily open range livestock grazing. Representative photos of these regional habitats and topography are provided in Figures 3-1 through 3-4.

3.2 Avian Species Assessed

A Critical Issues Analysis (CIA) was prepared for each of the Corona Wind Projects. These CIA reports characterized regional biological resources, with applicable information incorporated into this risk assessment for the Extended Corona Gen-tie System, where applicable. Based on historical documentation of bird species more susceptible to power line interactions (APLIC 2006, 2012) and to ensure federally and state-listed species are addressed, the following section and summary tables focus on waterbirds, waterfowl, vultures, raptors, corvids, and special status species identified for this region.

Avian studies for the Corona Wind Projects have been conducted in the overall Project Area from January 2017 through November 2019, encompassing the Western Spirit Wind Project. Table 3.1 presents a list of bird species originally identified for the Corona Wind Projects' CIA studies that may potentially occur in the Project Area. Table 3.2 lists the species of waterbirds, waterfowl, vultures, raptors, and corvids (typically examined relative to potential interaction with overhead power lines) documented during the initial field surveys for the Corona Wind Projects in 2017 and the Western Spirit Wind Project from January 2017 through November 2019. These survey data help to characterize potential bird use within the regional Project Area and along the Extended Corona Gen-tie System Corridor, based on species' distribution, known occurrences, and habitat associations.

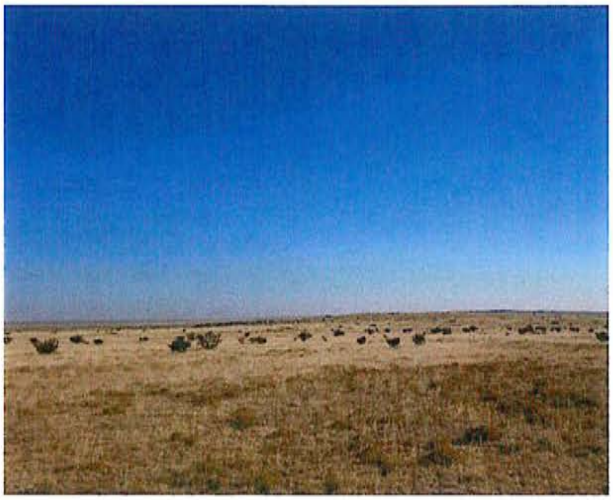

Figure 3.1. Representative flat grassland habitat.

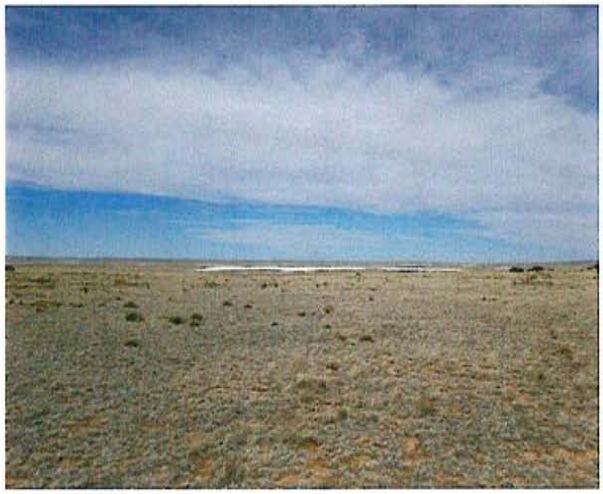

Figure 3.2. Representative ephemeral playa wetland within grassland habitat.

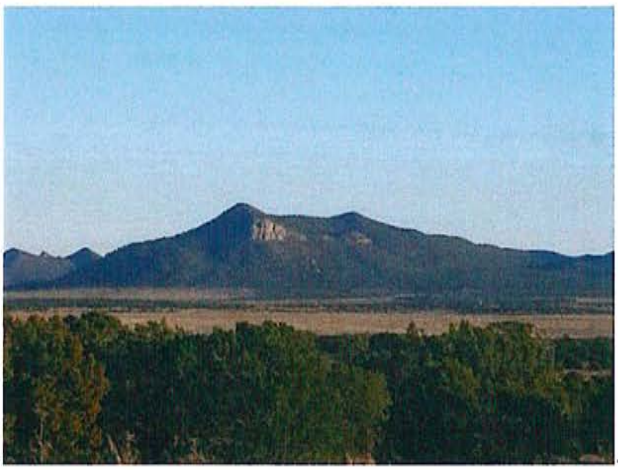

Figure 3.3. Representative piñon-juniper interface with grasslands and forested hills and cliff habitats.



Figure 3.4. Representative ridgeline within grassland and shrub-scrub habitats.

Table 3.1. Avian species including diurnal and nocturnal raptors, vultures, and federally and state-listed species with the potential to occur in or near the Extended Corona Gen-tie System Corridor.

Common Name	Scientific Name	Status[1]	Potential to Occur Along Extended Corona Gen-tie System Corridor[2]
Waterbirds			
Brown pelican	*Pelecanus occidentalis*	SE	NL y
Vultures			
Turkey vulture	*Cathartes aura*		L sp, su, f
Diurnal Raptors			
Osprey	*Pandion haliaetus*		P sp, su, f
Bald eagle	*Haliaeetus leucocephalus*	ST, BGEPA	L w
Golden eagle	*Aquila chrysaetos*	BGEPA	P y
Northern harrier	*Circus cyaneus*		P w
Sharp-shinned hawk	*Accipiter striatus*		P y
Cooper's hawk	*Accipiter cooperii*		P y
Northern goshawk	*Accipiter gentilis*		P y
Common Black hawk	*Buteogallus anthracinus*	ST	NL sp, su
Harris's hawk	*Parabuteo unicinctus*		P y
Zone-tailed hawk	*Buteo albonotatus*		P sp, su
Red-tailed hawk	*Buteo jamaicensis*		P y
Swainson's hawk	*Buteo swainsoni*		P sp, su, f
Rough-legged hawk	*Buteo lagopus*		P w
Ferruginous hawk	*Buteo regalis*		P y
American kestrel	*Falco sparverius*		P y
Merlin	*Falco columbarius*		P w
Prairie falcon	*Falco mexicanus*		P y
Peregrine falcon	*Falco peregrinus*	ST	L y
Nocturnal Raptors			
Barn owl	*Tyto alba*		P y
Great-horned owl	*Bubo virginianus*		P y
Mexican spotted owl	*Strix occidentalis lucida*	FT	P y
Cuckoos and Roadrunners			
Yellow-billed cuckoo	Coccyzus americanus	FT	NL sp, f
Passerines			
Sprague's pipit[3]	*Anthus spragueii*		P sp, f, w
Gray vireo	*Vireo vicinior*	ST	P sp, su
Baird's sparrow	*Ammodramus bairdii*	ST	P sp, f
Southwestern willow flycatcher	*Empidonax traillii extimus*	FE, SE	NL sp, f
Broad-billed hummingbird	*Cynanthus latirostris*	ST	NL sp, su

Sources: Garber and Young 2005, Sibley 2014, BISON-M 2017, LeBeau et al. 2017a, 2017b, 2017c.

[1]Federally endangered (FE), federally threatened (FT), state-endangered (SE), state-threatened (ST), Bald and Golden Eagle Protection Act (BGEPA); all species protected under Migratory Bird Treaty Act (MBTA).

[2]Potential to occur: Likely (L), Possible (P), Not Likely (NL); Seasonality: spring (sp), summer (su), fall (f), winter (w), year-round (y).

[3]At the time the Critical Issues Analyses were generated for the Corona Wind Projects, the Sprague's pipit was a candidate species for federal listing; however, on April 5, 2016, the Sprague's pipit was removed from the federal candidate list.

Table 3.2. Avian species including waterbirds, waterfowl, vultures, raptors, and corvids observed during fixed point bird counts for the Corona Wind Projects and Western Spirit Wind Project from January 2017 through November 2019.

Bird Species	Scientific Name	Corona Wind Projects No. Individuals	Western Spirit Wind Project No. Individuals (Groups)
Waterbirds			
Sandhill crane	*Antigone canadensis*	385	378 (17)
Great blue heron	*Ardea herodias*	1	1 (1)
Least sandpiper	*Calidris minutilla*		1 (1)
Long-billed curlew	*Numenius americanus*	92	38 (10)
Waterfowl			
Green-winged teal	*Anas crecca*	7	2 (2)
Mallard	*Anas platyrhynchos*		2 (1)
Canada goose	*Branta canadensis*		2 (1)
Unidentified duck		8	
Vultures			
Turkey vulture	*Cathartes aura*	915	1,432 (842)
Diurnal Raptors			
Osprey	*Pandion haliaetus*	1	2 (2)
Northern harrier	*Circus hudsonius*	30	60 (60)
Golden eagle	*Aquila chrysaetos*	34	42 (42)
Bald eagle	*Haliaeetus leucocephalus*		2 (2)
Ferruginous hawk	*Buteo regalis*	2	3 (3)
Red-tailed hawk	*Buteo jamaicensis*	122	164 (156)
Swainson's hawk	*Buteo swainsoni*	92	184 (161)
Zone-tailed hawk	*Buteo albonotatus*		1 (1)
Rough-legged hawk	*Buteo lagopus*	2	
Unidentified buteo		6	1 (1)
Prairie falcon	*Falco mexicanus*	10	6 (6)
American kestrel	*Falco sparverius*	112	175 (167)
Merlin	*Falco columbarius*	1	2 (2)
Cooper's hawk	*Accipiter cooperii*	4	8 (8)
Sharp-shinned hawk	*Accipiter striatus*	5	9 (8)
Nocturnal Raptors			
Great-horned owl	*Bubo virginianus*	2	7 (3)
Burrowing owl	*Athene cunicularia*	18	1 (1)
Corvids			
Chihuahuan raven	*Corvus cryptoleucus*	3	5 (3)
Common raven	*Corvus corax*	2,501	3,161 (1,822)

3.3 Bird Species Examined for Collision Risk Assessment

Of the bird species summarized in Tables 3.1 and 3.2, a number of these species are not emphasized as part of this supplemental APP and risk assessment for the Extended Corona Gen-tie System. Specific to electrocution risk, no bird electrocution risk applies to operation of a 345kV transmission line, because of the phase-to-phase and phase-to-ground clearances that far exceed bird dimensions (see Chapter 5.0, *Results*). The following discussions focus on those bird species that may be more at risk of colliding with the overhead lines based on historical studies and reports' if the overhead lines bisect established movement corridors or use areas (APLIC 2012). These groups would include waterbirds, waterfowl, eagles, and federally and state-listed

bird species. Important habitats would include those used by either resident birds for nesting or foraging or by migratory birds for stopover foraging or roosting, particularly habitat types and topography that may concentrate bird use and movement.

Most migrating birds in North America tend to migrate in a "broad front" pattern (Greenberg and Marra 2005). Within the Project Area and overall region, habitats that may attract nesting, foraging, and roosting birds would include piñon-juniper woodlands, woodland-grassland interface, ridgelines, rock outcrops, and scattered ephemeral water sources (i.e., drainages, wetlands, freshwater ponds, salt flats, seasonal lakes, playas). The proposed 345kV transmission structures also could provide perch and nesting sites for roosting, foraging, and breeding birds (e.g., golden eagles, other raptors, vultures, corvids), particularly within the grassland and grassland-woodland interface. Migrating birds moving through the area would likely use ephemeral water resources as stopover habitats when seasonally inundated, the native grasslands and shrublands, and scattered woodlands for both foraging and roosting.

Habitats located in or near the Gen-tie System Study Area that may concentrate migratory bird activity would primarily include seasonal water sources and trending ridgelines. The only large water body that occurs in or near the Extended Corona Gen-tie System Study Area is the over 2,000-acre seasonal lake and associated salt flats identified by the USFWS NWI database (USFWS NWI 2019) located on State lands and extending 1-4 mi (1.6-6.5 km) east of the Corona Expansion Gen-tie System Corridor (see Figures 1.1 and 2.1 and Appendix A). Potential use by waterbirds, waterfowl, raptors, and songbirds likely would be limited to the intermittent seasonal wet periods, when the basin is inundated, particularly during spring migration.

3.3.1 Waterbirds and Waterfowl

As shown in Table 3.2, large numbers of sandhill cranes (*Antigone canadensis*) and long-billed curlews (*Numenius americanus*) were recorded moving through the Project Area. Sandhill crane observations were primarily recorded during the fall migration (i.e., October), indicating concentrated migratory movements through the Project Area. Crane flight heights ranged from approximately 60 ft (18 m) to 200 ft (61 m) above the ground. Long-billed curlews also were observed primarily during the fall period.

Sandhill cranes can be susceptible to overhead line collisions, based on their body size, mass, and flight behavior (Brown et al. 1987, Faanes 1987, Stehn and Wassenich 2008, APLIC 2012). However, the risk of colliding with power lines for many waterbirds and waterfowl primarily entails the orientation and location of the lines to high-use areas, such as lakes, wetlands, wet meadows, playas, and agricultural grain fields. The potential for either of these waterbird species to occur along the Gen-tie System Study Area during migration would depend on the level of inundation of regional ephemeral wetlands, freshwater ponds, playas, and seasonal lakes during wet seasons. During wet spring or fall seasons, the likelihood of occurrence could be moderate to high; whereas, during dry seasons, the likelihood of occurrence may be low to none.

The brown pelican (*Pelecanus occidentalis*), a state-endangered species in New Mexico (BISON-M 2017), is not likely to occur in the Project Area or Gen-tie System Study Area (Table 3.1). This

species breeds from California and the Mid-Atlantic states southward to South America (American Ornithologists Union [AOU] 1998). The species typically occurs in marine habitats in warmer water where it feeds exclusively on fish, and rarely occurs inland. In New Mexico, brown pelicans are rare yet consistent visitors to the state. Through May of 2012, over 112 reports involving 127 individual birds have been made from 20 of New Mexico's 33 counties, including Lincoln County to the south, with most of the observations reported at large lakes and along major rivers (NMDGF 2012). Observations have been reported year-round; however, they are most frequent in summer through fall. Due to the species' rarity in New Mexico, little is currently known about its habits within the state.

The only water body sufficiently large to attract potential brown pelicans would be the seasonal lake that may encompass over 2,000 acres when inundated (see Figures 1.1 and 2.1 and Appendix A). Although there may be a potential for migratory brown pelicans to use this seasonal lake as a stopover habitat for roosting during migration, the overall potential for brown pelican to occur in this area would be low, only occurring during wet spring or fall seasons, when the lake is inundated.

3.3.2 Vultures

Only one vulture species, the turkey vulture (*Cathartes aura*) occurs in the overall region and Study Area. Although the CIAs identified this species as a low likelihood of occurrence during the spring, summer, and fall for the Corona Wind Projects, a significant number of individuals were documented during the Corona Wind Projects' and Western Spirit Wind Project's fixed point bird count surveys (Table 3.2). A number of international vulture species have been shown to be susceptible to collisions or electrocutions with power line infrastructure; however, few reports of turkey vulture collisions have been documented in the US (APLIC 2012). The potential for turkey vultures to occur within the Study Area would be high, based on documented occurrences of this species in the project region. Given the lack of natural perches in some areas, vultures may also use the transmission line structures for perching.

3.3.3 Raptors

Bald Eagle

The bald eagle is listed as a state-threatened species in New Mexico and also is protected under the BGEPA. Bald eagles are listed as potentially occurring within the region as an occasional winter visitor (Stahlecker and Walker 2010; Table 3.1). Christmas Bird Count (CBC) data reported 62 bald eagles at the Ruidoso CBC location, which occurs approximately 65 mi (104 km) south of the Study Area. Additionally, three bald eagles were reported at the Five Points CBC location, which occurs approximately 60 mi (96 km) west and northwest of the Study Area (Audubon 2017). A review of eBird (2017) data for Torrance County reported a total of 12 bald eagles observed during the late summer, fall, and winter. No bald eagles were observed during the Corona Wind Projects' fixed point count surveys; two bald eagles were recorded during the surveys for the Western Spirit Wind Project (Table 3.2).

Bald eagles most commonly forage near large open lakes, reservoirs, and rivers; however, individuals also may forage over open upland grasslands, woodlands, and woodland edges and

along wetlands and livestock ponds, where they may opportunistically prey upon secondary food sources, such as carrion and small- to medium-sized mammals (Buehler 2000). Based on historical occurrence data and habitat associations common to bald eagles, the potential to occur in or near the Gen-tie System Study Area would be low and most likely in the late fall or winter potentially foraging within the dry, upland habitats or along ephemeral wetlands during seasonal inundations and wet periods. The highest likelihood of occurrence would be centered on the large seasonal lake and salt flats located on State lands 1-4 mi (1.6-6.5 km) east of the Corona Expansion Gen-tie System Corridor (see Figures 1.1 and 2.1 and Appendix A) where migratory eagles may be attracted to concentrations of waterfowl or waterbirds as potential prey when the lake contains surface water.

Golden Eagle

The golden eagle also is protected under BGEPA. Golden eagles are listed as possibly occurring in the Study Area year-round. Golden eagles breed within the region, as breeding territories have been historically documented in every county in New Mexico except Lea County in the southeast (Stahlecker et al. 2010). Breeding Bird Survey (BBS) data from the nearby Claunch BBS route (approximately 9 mi [14 km] southwest of the Corona Expansion Gen-tie System Corridor) included four observations of golden eagles over 18 years of surveys (Sauer et al. 2014). Known golden eagle nest sites are shown in Map 1 of 4 in Appendix A.

Golden eagles also winter and migrate through New Mexico (Stahlecker et al. 2010). A review of CBC data from 20 years of surveys reported three golden eagle observations at the Ruidoso CBC location, approximately 65 mi (104 km) south of the Study Area, and 57 golden eagle observations at the Five Points location, approximately 60 mi (96 km) west and northwest of the Study Area (Audubon 2017). eBird (2017) data reviewed at the county level included approximately 115 golden eagle observations within Torrance County, with observations occurring year-round but more concentrated in late summer, fall, and winter. During the avian point count surveys conducted for the Corona Wind Projects and Western Spirit Wind Project, a total of 34 and 42 golden eagles were observed and recorded, respectively (Table 3.2).

Based on this information and documented observations, the potential for golden eagles to occur within the Study Area would be moderate to high year-round, with individuals likely using rocky ridges and outcrops for foraging and transmission structures for perching. Nesting by eagles on the structures would not be likely, given the 345kV structure designs, using a monopole design with the braced-post insulator array (Figures 2.2 and 2.3).

Common Black Hawk

The common black hawk is listed as state-threatened in New Mexico (BISON-M 2017). This neotropical raptor reaches the northern geographic limits of its range in the southwestern US. In New Mexico, the common black hawk is considered an uncommon but regular summer resident (NMDGF 2012). Historically, the species was largely restricted to the San Francisco, Gila, and Mimbres drainages, but, although rare, it is increasing east to the middle Rio Grande Valley, the Hondo Valley, and the middle and lower Pecos Valley (NMDGF 2012). In the Southwest, breeding common black hawks require mature, well-developed riparian forest stands (e.g., cottonwood

bosque) that are located near permanent streams where the principal prey of fish, amphibians, and reptiles is available (Schnell 1994).

The common black hawk has been documented as occurring in Lincoln County to the south (BISON-M 2017), and eBird (2017) records show a total of 26 observations in Lincoln County. However, no black hawks were observed during the Projects' fixed point count surveys (Table 3.2). Based on the lack of suitable breeding and primary foraging habitats and historical trends in observations, the potential for the black hawk to occur within the Gen-tie System Study Area would be low to very low.

Peregrine Falcon

The peregrine falcon is a state-threatened species (BISON-M 2017) and is listed as likely to occur in the overall Project Area as an occasional year-round visitor (Table 3.1). Peregrines are known to nest on south-facing cliffs on Carrizo Peak, located approximately 45 mi (72 km) southwest of the Study Area (L. Cordova pers. comm.) and along the Sacramento escarpment above La Luz and Alamogordo, approximately 96 mi (154 km) south of the Study Area. Approximately 80 peregrine falcon observations for Torrance County have been submitted to eBird, with most observations recorded in late summer and fall (eBird 2017).

Peregrine falcons are associated with habitats from sea level to 13,000 ft (4,000 m), including plains, grasslands, shrublands, forests, and deserts (Cade 1982). Peregrine falcons show little preference for specific ecological communities, but their hunting behavior makes them most adapted to open or partially wooded habitats (Ratcliffe 1988). In New Mexico these birds typically nest on cliffs and flat mesas and may hunt in grassland and woodland habitats, but generally these birds occupy areas near bodies of water where concentrations of waterfowl and shorebirds, primary prey species, occur (Garber and Young 2005).

Although no suitable nesting habitat for the peregrine falcon occurs in or near the Extended Corona Gen-tie System Corridor, potential foraging habitat may be associated with the over 2,000-acre seasonal lake and salt flats located 1-4 mi (1.6-6.5 km) east of the 345kV transmission ROW (see Figures 1.1 and 2.1 and Appendix A). Concentrations of migratory waterfowl and waterbirds, when present, may attract foraging peregrine falcons within the region. No peregrine falcons were recorded during the Projects' avian fixed point surveys from January 2017 through November 2019 (Table 3.2).

Mexican Spotted Owl

The Mexican spotted owl (*Strix occidentalis lucida)* is federally listed as threatened and shown to possibly occur year-round within forested mountains and rocky and forested canyons in New Mexico (USFWS 2015). This species occurs from southern Utah and Colorado, south through Arizona, New Mexico, and west Texas into the mountains of central Mexico, typically at elevations between 4,100-9,000 ft (1,250-2,743 m; USFWS 2017). Mexican spotted owls have been known to migrate between 5-31 mi (8-50 km) for short periods over the winter season (USFWS 2017).

The USFWS designated critical habitat for the Mexican spotted owl in Lincoln National Forest (Habitat Unit BR-E-4; USFWS 2004), approximately 40 mi (64 km) south of the Study Area. The USFWS also designated critical habitat in Cibola National Forest in western Torrance County (Habitat Unit BR-E-5) approximately 40 mi (65 km) west of the Study Area (USFWS 2004). However, the Extended Corona Gen-tie System Study Area occurs outside the elevational and ecological range for this species. Based on occurrence data and habitats, there is no potential for the Mexican spotted owl to occur in or near the Gen-tie System Study Area or along the Project Corridor. Additionally, this species is not commonly found on or near power line infrastructure (APLIC 2012).

Other Raptor Species

Substantial numbers of other raptor species were recorded in the Project Area and near the Extended Corona Gen-tie System Study Area. Northern harriers (*Circus hudsonius*), red-tailed hawks (*Buteo jamaicensis*), Swainson's hawks (*Buteo swainsoni*), and American kestrels (*Falco sparverius*) were all relatively common during the Projects' point count surveys conducted January 2017 through November 2019 (Table 3.2). These four species, as well as other raptors, such as great horned owl (*Bubo virginianus*) are relatively common to the overall region but are not known to be susceptible to colliding with overhead power lines (APLIC 2012).

3.3.4 Corvids

Two corvid species (Chihuahuan raven [*Corvus cryptoleucus*] and common raven [*Corvus corax*]) were recorded during the Corona Wind Projects' avian point county surveys conducted from January 2017 through November 2019 (Table 3.2). Of note is the 2,501 and 3,161 common ravens recorded during the Corona Wind Projects' and Western Spirit Wind Project surveys, respectively, which reflect the more arid habitats in and near the Project Area and Extended Corona Gen-tie System Study Area.

3.3.5 Other Federally or State-listed Species

Six other special status species were identified in Table 3.1, one cuckoo and five passerines. However, none of these six bird species is known to be susceptible to colliding with overhead power lines (APLIC 2012). These six species include: the yellow-billed cuckoo (*Coccyzus americanus*), Sprague's pipit (*Anthus spragueii*), gray vireo (*Vireo vicinior*), Baird's sparrow (*Ammodramus bairdii*), southwestern willow flycatcher (*Empidonax traillii extimus*), and broad-billed hummingbird (*Cynanthus latirostris*).

4.0 METHODS AND METRICS

Potential risk factors associated with avian interactions with power lines were applied to the Extended Corona Gen-tie System to assess project-specific risks to birds in both the short term and long term and for both resident and migratory species. WEST conducted a desktop risk assessment, focusing on potential collision risk to specific bird species with the Extended Corona Gen-tie System. As stated, no electrocution risk is associated with a 345kV transmission line, which is discussed further in Chapter 5.0, *Results*.

A primary component of assessing collision risks to birds from power line operation is to compare the engineering components (i.e., line design, line location, voltage class), the biological components (i.e., species likely present, species use, known or potential for bird concentrations, habitat types, topography), and existing human influences (e.g., roads, land uses, development, land ownership). Engineering design and line location for the Gen-tie System were provided by Pattern's Engineering personnel. Existing biological data were used to complete this analysis, encompassing Project-specific reports, regional data, and examination of current and historic aerial imagery. Existing human influences were examined relative to these other components also using current aerial imagery.

4.1 Landscape Features and Habitats

Data layers used to overlay with the aerial imagery and 345kV transmission line alignment of the Gen-tie System included:

- National Wetland Inventory (NWI) data (USFWS NWI 2019)
- National Hydrography Geodatabase (NHD; US Geological Survey [USGS] USGS NHD 2019)
- Existing Roads (US Census Bureau 2019)
- Topography (USGS 3D Elevation Program [USGS 3DEP] 2017)
- Land Ownership (USGS Protected Areas Database of the United States [PAD-US] 2019)
- US Department of Agriculture (USDA) National Agricultural Statistics Service Cropland Data Layer (USDA 2019)
- The Nature Conservancy (TNC) Wildlife Habitat Features Dataset (TNC 2019)

Additional land features were identified during the desktop assessment, based on historical and current imagery, including rocky outcrops, ridgelines, piñon-juniper woodland corridors, ephemeral wetland basins, freshwater ponds, and stock ponds. Historical imagery provided a record of landscape changes important to bird use, such as encroachment of shrub-scrub (i.e., piñon-juniper) into open grasslands or shallow ephemeral wetland basins. Habitats were delineated and ranked in and adjacent to the Corona Expansion Gen-tie System Corridor (1-mi [1.6-km] Study Area along the 345kV ROW alignment).

4.2 Ranking Overhead Collision Risk

Daily movements where birds cross power lines at low altitudes, birds ascending and descending to roost or forage, and birds flying during inclement weather all increase the potential exposure or risk to birds colliding with overhead lines, depending on where the line is located relative to potential bird use areas (Willard 1978, Faanes 1987, Morkill and Anderson 1991, Stehn and Wassenich 2008, APLIC 2012). Specific to the Gen-tie System Study Area, the avian collision risk analysis focused on the proximity and orientation of the transmission ROW to areas of potential bird concentrations; low-altitude movement corridors; and where birds may be landing, taking off, or soaring.

Bird collision risk with overhead lines is based on the relative exposure of birds and will vary among line segments. Although bird collision risk will never be 0%, risk can be ranked by line segments, relative to habitats and land use in proximity to segments and potential for at-risk bird species to use movement paths between potential roosting and foraging areas (i.e., daily movement, migratory stopover but not migratory overflights). As discussed in Section 1.4.2, *Avian Collision Risk with Overhead Power Lines*, the typical altitude of migratory birds is generally several hundred to several thousand feet above the ground during migratory flight. Therefore, the focus for migrating birds is the potential for individuals landing and taking off in proximity to the Extended Corona Gen-tie System Corridor or where low-altitude flights may intersect with the line.

The following ranking categories were applied to the avian collision risk reviews:

- **Rank 1:** line span relative to areas with high habitat quality and/or areas of anticipated high bird use
- **Rank 2:** line span relative to (a) areas of moderate habitat quality or (b) areas of high habitat quality and anticipated moderate bird use
- **Rank 3:** line span relative to (a) disturbed areas or areas of a high level of human influences with areas of moderate to high bird use or (b) moderate habitat quality with areas of anticipated moderate bird use

5.0 RESULTS

5.1 Avian Electrocution Risk

Figures 2.3 and 2.4 depict the single- and double-circuit tangent structure configurations and associated insulator arrays proposed for the 345kV transmission line. As shown in these figures, the dimensions of the 345-transmission line far exceed the clearances needed for 345kV, at 117 in (10 ft; 3 m) horizontal and 97 in (8 ft; 2.5 m) vertical phase-to-phase and 88 in (7.5 ft; 2.2 m) horizontal and 68 in (5.7 ft; 1.7 m) vertical phase-to-ground (see Table 1.1). Therefore, no electrocution risk to perching birds would apply to the 345kV transmission line operation as part of the Extended Corona Gen-tie System.

5.2 Avian Collision Risk

The majority of the 345kV study area is located within The Nature Conservancy's (TNC) delineated "Intact Habitats" for wildlife, based on regional habitat features and agency input, inferring good contiguous wildlife habitat and few cumulative human effects have affected habitats and associated habitat values in this region. In addition to relative habitat value, eagle and other raptor areas also are identified in the region by the TNC (2019; see Appendix A), based on habitat types, historical occurrences, and likelihood to occur.

No designated "critical habitat" or "protected areas;" known bird concentration areas (e.g., foraging, roosting, stopover, wintering); or Important Bird Areas (IBA) are known to occur within 10.0 mi (16.0 km) of the proposed Extended Corona Gen-tie System Corridor. The avian collision risk focused on landscape features and habitats in and adjacent to the Gen-tie System's Study Area. Table 5.1 summarizes the two areas identified and ranked by risk along the ROW. Details for these areas are provided below, relative to the recorded risk factors.

Table 5.1. Results of avian collision risk assessment for Extended Corona Gen-tie System.

Ref. Area No.	Map No.[1]	Rank	Segment Length	Landscape Feature	Comments
1	2 of 3	**3**	1.3 mi (2.1 km)	Lake, salt flats, rolling woodland, Pino Mountain	Line crosses rolling topography with piñon-juniper woodland, bisecting potential bird movement corridor between >2,000-acre lake and salt flats on State lands, extending 1-4 mi (1.6-6.5 km) east of the ROW, and Pino Mountain and eagle/raptor area located 4 mi (6.5 km) west of the ROW.
2	3 of 3	**3**	0.4 mi (0.6 km)	Lake, salt flats, rolling woodland, Pino Mountain	Line crosses State land, bisecting area between series of small, linear rock outcrops extending 0.8 mi (1.3 km) to the west and 30-acre freshwater emergent wetland located 1.6 mi (0.26 km) to the northeast of the ROW.

[1]See Appendix A, including overview maps.

5.2.1 Reference Area Number 1 – Rank 3

This line segment crosses the eastern edge of an east-west trending ridge of rolling topography and piñon-juniper woodland (see Maps 2 and 3 of 4 in Appendix A). An ephemeral lake (>2,000 acres; USFWS NWI 2019) and associated salt flats extend from 1 to 4 mi (1.6 to 6.5 km) east of the ROW (see Figures 1.1 and 2.1 and Appendix A), showing consistent and historical inundation through Google Earth aerial imagery from 1997 through 2016. The piñon-juniper woodland extends from the ROW west for over 45 mi (70 km), with Pino Mountain located approximately 4 mi (6.5 km) west of the transmission line ROW (see Figure 2.1 and Appendix A). Surrounding Pino Mountain, is an area designated as eagle / other raptor habitat by the TNC (2019; see overview maps in Appendix A).

In the spring of 2019, an aerial reconnaissance conducted over this seasonal lake by WEST and Pattern showed a large number of waterfowl on the lake surface. Based on the lake's size and location and associated salt flats, it is assumed this area could attract and concentrate a substantive number of waterfowl, waterbirds, and songbirds during the spring or fall, and possible winter. Additionally, eagles and other raptor species may be attracted to this area for foraging.

The transmission line bisecting these habitats may potentially increase collision risk to area birds, particularly given the extent of the ephemeral lakes, salt flats, and woodland habitats connecting the native habitats from east to west. However, the lower risk of Rank 3 was assigned, based on the distance of the line from potential surface water areas and the arid nature of the habitats immediately surrounding the ROW.

5.2.2 Reference Area Number 2 – Rank 3

The 345kV transmission line ROW crosses a parcel of State land, bisecting a series of small, linear rock outcrops with scattered piñon-juniper, with the ridges extending 0.8 mi (1.3 km) to the west (see Maps 2 and 4 of 4 in Appendix A) and a 30-acre freshwater emergent wetland (USFWS NWI 2019) located 1.6 mi (0.26 km) to the northeast of the ROW (see Appendix A). During wet periods, this ephemeral wetland may attract concentrations of migrant and resident birds (e.g., waterbirds, raptors, songbirds). Birds moving between the playa and the rocky ridges and other habitats to the west may increase collision risk, as birds descend to or ascend from the playa. However, the historical imagery of the surface water for this ephemeral wetland or playa shows surface inundation may have been decreasing since 1997, with a trend toward reduced water availability over the 20-year period. Based on these factors, the risk would be bird collision risk is considered to be low.

6.0 DISCUSSION

6.1 Extended Corona Gen-tie System Avian Protection Plan Implementation

APLIC's suggested practices to minimize bird interactions with electrical infrastructure (2006, 2012) are voluntary, and it is Pattern's prerogative in determining how best to implement this APP and avian risk assessment, in accordance with the company's *Statement of Environmental Values*. Implementing an APP is a balance of proactive program planning, reactive actions on an as-needed basis, and new construction engineering design standards. Because site-specific factors will vary across geographic areas and voltage classes, engineering review and authorization for any potential mitigation approach are integral to successful APP implementation. These recommendations provide Pattern with both short- and long-term planning options to assess where best to mitigate or reduce potential collision risks. WEST has outlined optional mitigation approaches to minimize risks to birds from operation of the Extended Corona 345kV Gen-tie System for Pattern's consideration.

6.2 Relative Risk and Mitigation Options

6.2.1 Relative Risk

As stated, no electrocution risk would apply to a 345kV transmission line, given the NESC clearance standards required.

Bird collision risks with overhead transmission line segments will vary, based on a number of site-specific variables. Although avian collision risk with overhead power lines cannot be totally eliminated (APLIC 2012), assessing the relative exposure of or risk to birds from line operation, given the suite of engineering, environmental, and landscape variables, helps to measure and compare the risks to at-risk bird species potentially present.

Historical imagery examined as part of the desktop assessment provided a record of landscape changes (e.g., reduced surface water inundation in smaller playas) and landscape values (e.g., periodic but consistent surface water availability in the over 2000-acre ephemeral lake located east of the ROW). Incorporating both types of trends into long-term Project planning is important for APP implementation, in order to minimize potential future long-term risks to birds from transmission operation.

The 2,000-acre seasonal lake and associated salt flats identified by the USFWS NWI database (USFWS NWI 2019) located 1-4 mi (1.6-6.5 km) east of the ROW would provide the greatest regional value to birds when inundated with surface water (see Figures 1.1 and 2.1 and Appendix A). Although potential use by waterbirds, waterfowl, raptors, and songbirds likely would be limited to the intermittent seasonal wet periods, when the basin is inundated, a large number of birds may periodically use this area for foraging and roosting, particularly during migratory stopover.

6.2.2 Mitigating Long-term Bird Risk

Retrofitting or modifying existing facilities may be warranted when a structure or line segment is determined to have higher avian mortality risk, through either risk assessment results or procedures implemented if a bird fatality is found on the system. One approach to reduce avian collision risk is to mark the overhead shield wire (i.e., OHGW, OPGW) on transmission lines. Although the efficacy of marking devices varies based on a wide range of studies and statistical analyses, increasing a line profile and its visibility has been shown to reduce bird collision risk anywhere from 29% to 96% (Morkill and Anderson 1991, Alonso et al. 1994, Janss and Ferrer 1998, Crowder 2000, Frost 2008, Yee 2008, Murphy et al. 2009, Stake 2009, Ventana Wildlife Society 2009, APLIC 2012, Sporer et al., 2013). APLIC (2012) states spacing intervals of 16-98 ft (5-30 m) are the most commonly used and recommended for line marking devices. Jenkins et al. (2010) further states any line marking device that increases the line appearance 8 in (20.3 cm) in diameter, 4-8 in (10.2-20.3 cm) in length, and spaced 16-32 ft (4.9-9.8 m) apart can reduce the avian collision rate by 50% to 80%. However, site-specific applications of markers to line segments generally depend on the line voltage, configuration, and at-risk bird species potentially present.

The objectives of remedial actions are to reduce the avian mortality risks, while also reducing or preventing system outages and faults caused by bird interactions with electrical infrastructure. Retrofitting to minimize bird risk is determined on a case-by-case basis, depending on site-specific variables and engineering, and ultimately this decision is the prerogative of Pattern, based on engineering considerations, corporate policy, and costs. Retrofit approaches also must meet safety and operational requirements, and potential limitations should be identified (e.g., ice and wind loading, insects, contaminants, tracking on devices).

WEST has provided the following information on line marking options as a potential tool to minimize long-term collision risks. By ranking the two segments identified for the Extended Corona Gen-tie System (Rank 3 level, which is defined as an overall low risk of collision; see Table 5.1), Pattern can determine whether applicable mitigation approaches are warranted, depending on environmental and engineering considerations.

If Pattern determines through their environmental and engineering reviews that line marking is warranted, marking the applicable segments of the Extended Corona Gen-tie System would entail staggered marking of the two overhead shield wires on the 345kV transmission line (i.e., OPGWs; Figure 6.1) by a qualified helicopter crew. Device spacing would be determined on a site-specific basis, given span length, engineering considerations, and which at-risk bird species or group may be present.

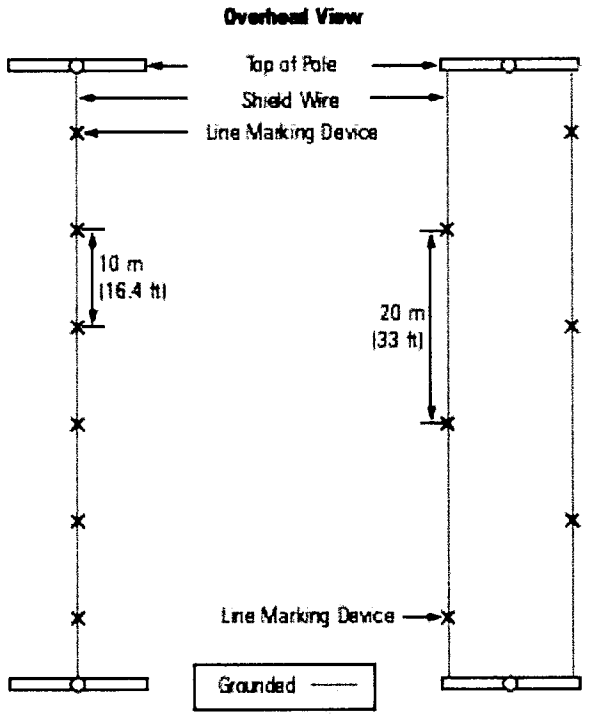

Figure 6.1. Example of line marking on a single overhead shield wire or staggered on two parallel overhead shield wires (source APLIC 2012).

6.2.3 Line Marking Options

A variety of devices are available for line marking, specific to birds and reducing bird collision risk with these overhead lines, including "static," "dynamic," and "hybrid" devices. Dynamic devices contain moving parts (e.g., suspension swivels); static devices do not. Hybrid devices do not contain moving parts, but may move in the wind (e.g., rocking motion).

For marking overhead shield wires on a 345kV transmission line, WEST would recommend static or hybrid marking devices that do not contain moving parts, particularly given the line size, line access, and rural areas that may be prone to vandalism (e.g., target shooting). However, as with any line operational decision, wire-marking devices should be assessed based on their respective properties (e.g., static, dynamic, glow-in-the-dark), bird species potentially present (e.g., federally listed species, bird concentrations), and device durability (e.g., wind, ice, ultra-violet [UV] light).

Line marking devices:

- Static or hybrid devices are recommended for a 345kV transmission line's overhead shield wires (including the OPGWs).

- Some OPGW manufacturers restrict devices with clamps for marking OPGW, indicating the warranty will be voided. However, other clamp manufacturers and some research infer damage to the fiber optic cable would not occur. Correct device installation is integral. WEST recommends consulting with the individual OPGW vendors to ensure the device chosen is appropriate for the OPGW cable operation.
- Recommended spacing of line markers vary, depending on anticipated bird species, environmental conditions, line configuration, wire diameter or size, line location, and engineering specifications (e.g., wind and ice loading).

Power Line Sentry - Bird Flight Diverter

The Power Line Sentry Bird Flight Diverter (BFD) is both dynamic and static (i.e., hybrid device) and provides 24-hour glow-in-the-dark properties. Figures 6.2 and 6.3 illustrate both the device and device placement on overhead lines for the Power Line Sentry BFD.

Specifications

- UV resistant
- Florescent reflective yellow prism tap; 24-hour glow tape for improved dawn, dusk, and night visibility
- Withstands over 100 miles per hour (mph; over 161 kilometers per hour [kph]) winds for sustained periods
- Patented "V" shape design for maximum contrast at all angles
- Hotstick or Extended Stick application
- Size: .08-in thick x 6-in wide x 4-in tall (0.2-cm thick x 15-cm wide x 10-cm wide)
- Weight: 4.7 ounces (133 grams)
- Sheds ice
- Will not void OPGW warranty
- To date, devices are known to stay in place and not abrade cable
- Helicopter installation has been shown to be faster than spiral device installation



Figure 6.2. Power Line Sentry Bird Flight Diverter.

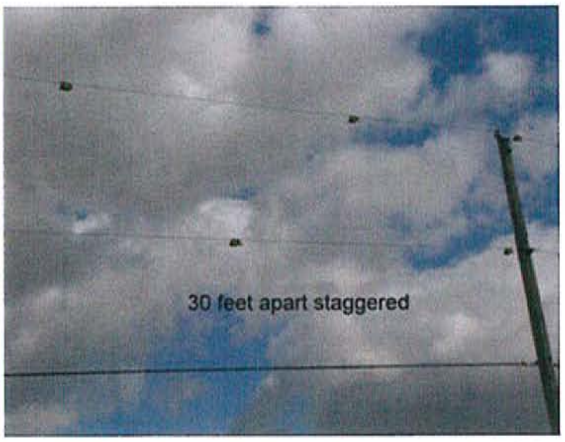

Figure 6.3. Power Line Sentry Bird Flight Diverter installed on overhead lines.

Preformed Products - Swan Flight Diverter

- The Swan Flight Diverter (SFD) is "static" and remains in place on the wire
- Good longevity
- Applications have shown the SFD holds up well to UV; yellow color may fade to gray in time
- SFDs also are advertised to shed ice by rotating with the weight

Specifications:

- Increased conductor profile
- Minimal wind resistance
- Manufactured from gray or yellow high impact PVC with UV protection
- Will not void OPGW warranty
- Engineering review is important
- Helicopter installation is a proven installation method

Figures 6.4 and 6.5 illustrate both the device and device placement on overhead lines for the Preformed SFD.



Figure 6.4. Preformed Swan Flight Diverter.

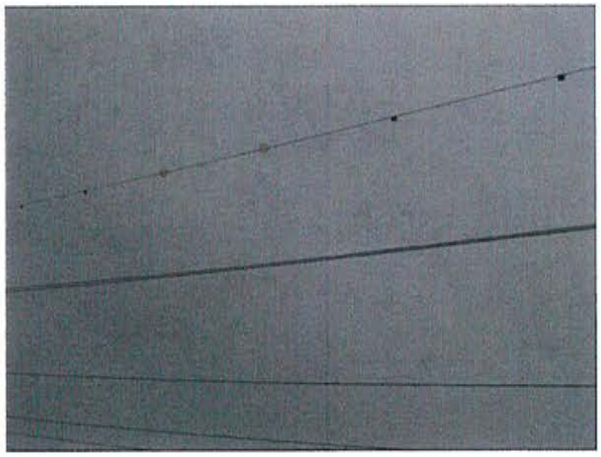

Figure 6.5. Preformed Swan Flight Diverter installed on overhead lines with alternating Power Line Sentry Bird Flight Diverter.

Table 6.1 compares engineering testing conducted on both the Preformed SFD and the Power Line Sentry BFD-075.

Table 6.1. Engineering Testing Results: Preformed SFD versus Power Line Sentry BFD (BFD-075)[1]

Test	SFD (lbs)	BFD-075 (lbs)
Ice loading at 1.2 inches (3 centimeters; vertical)	13.1	1.0
Wind loading at 102 miles per hour (transverse)	10.4	5.0
Average 31 markers vertical ice load	406	31
Average 31 markers transverse wind load	322	155

Source: American Transmission Company.
[1]Metric equivalents not included in table.
lbs = pounds; SFD = Swan Flight Diverter; BFD = Bird Flight Diverter.

6.2.4 Summary

This project-specific APP and avian risk assessment focused on potential bird collision with the overhead wires from operation of the Extended Corona 345kV Gen-tie System. The focus of this APP was to conduct a desktop risk assessment, comparing the proposed Extended Corona Gen-tie System design and location to biological and landscape features for potential interactions with both resident and migratory birds. This risk assessment was conducted according to suggested practices outlined by APLIC (2006, 2012) and per WEST's experience and professional expertise in this area.

No electrocution risk to perching birds would apply to the Extended Corona Gen-tie System, given the phase-to-phase and phase-to-ground clearances for 345kV transmission. As part of the avian collision risk assessment, WEST examined a suite of engineering, environmental, and landscape variables, identifying two Rank 3 line segments that reflect a relatively low collision risk to area birds, depending on environmental factors (e.g., precipitation, seasonal, prey base, etc.).

Because APLIC suggested practices for minimizing avian collision risk with overhead power lines are voluntary (APLIC 2012), WEST provided mitigation options for Pattern's consideration to potentially mark applicable line segments and reduce potential collision risks. Ultimately, it is Pattern's prerogative on how to implement this APP, and if Pattern determines through their environmental and engineering reviews that line marking is warranted along applicable segments of the Extended Corona Gen-tie System, this would entail staggered marking of the two overhead shield wires (OPGWs) by a qualified helicopter crew. Marker spacing would be determined, based on engineering considerations and target bird species.

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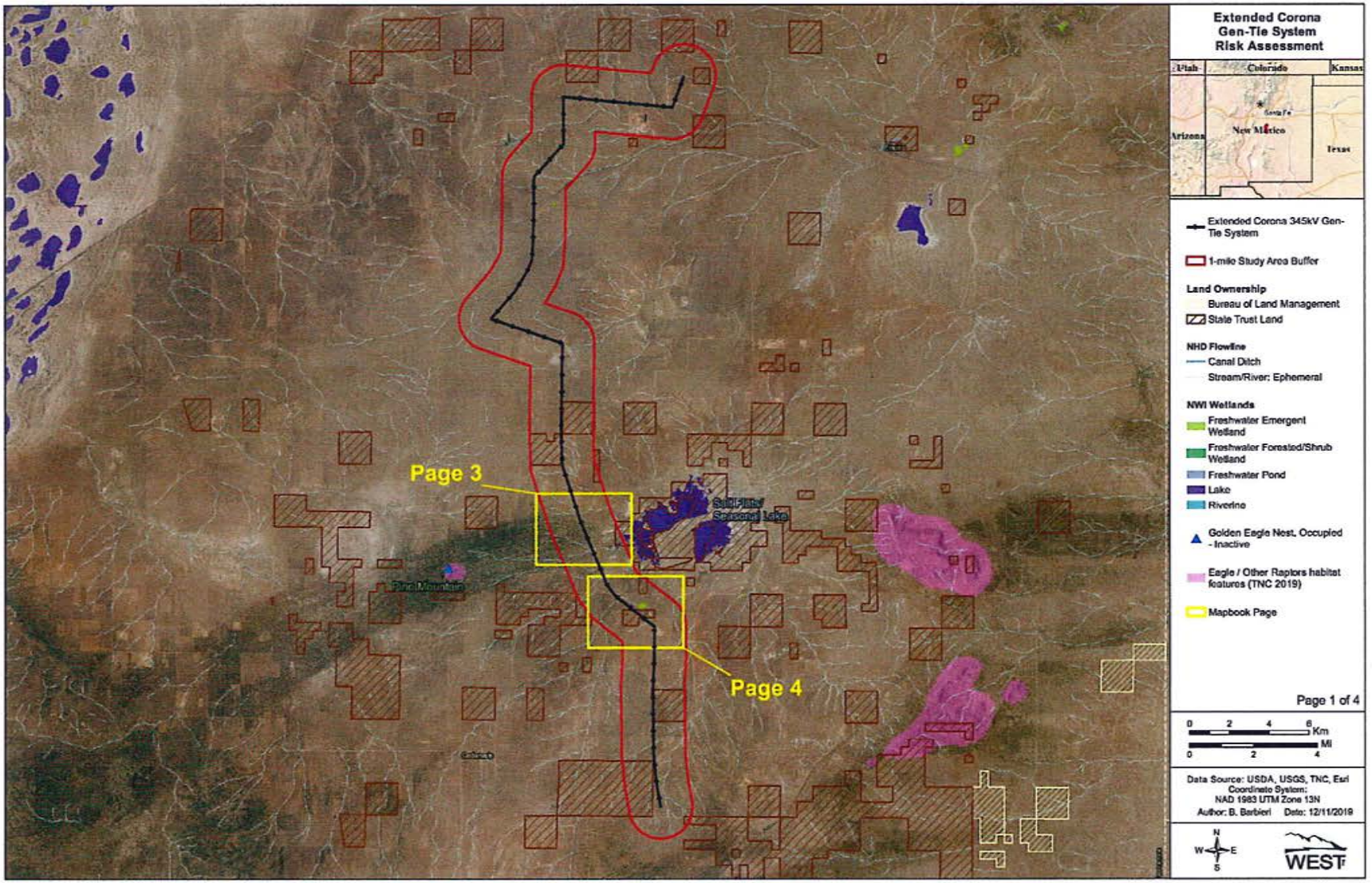
Appendix A. Avian Collision Risk Assessment Results within 1 Mile (1.6 Kilometer) of the Alignment of the Extended Corona 345kV Gen-tie Transmission Line


Extended Corona
Gen-Tie System
Risk Assessment
Utah
Colorado
Kansas
Arizona
New Mexico
Texas
Extended Corona 345kV Gen-Tie System
1-mile Study Area Buffer
Land Ownership
Bureau of Land Management
State Trust Land
NHD Flowline
Canal Ditch
Stream/River: Ephemeral
NWI Wetlands
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Golden Eagle Nest, Occupied - Inactive
Eagle / Other Raptors habitat features (TNC 2019)
Mapbook Page
Page 3
Page 4
Salt Flats Seasonal Lake
Pine Mountain
Page 1 of 4
0 2 4 6 Km
0 2 4 MI
Data Source: USDA, USGS, TNC, Esri
Coordinate System:
NAD 1983 UTM Zone 13N
Author: B. Barbieri Date: 12/11/2019
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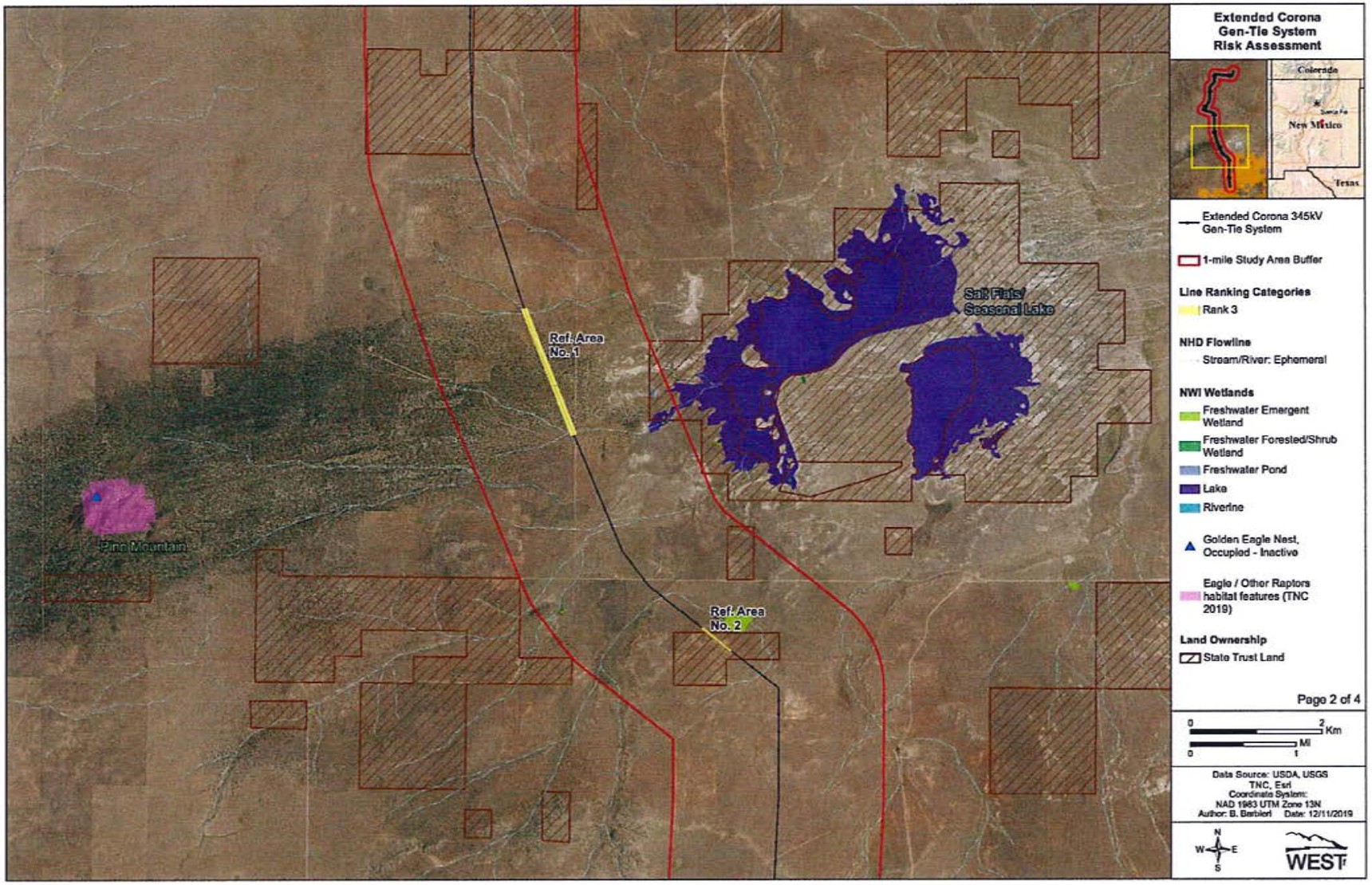
Extended Corona
Gen-Tie System
Risk Assessment
Colorado
Santa Fe
New Mexico
Texas
Extended Corona 345kV Gen-Tie System
1-mile Study Area Buffer
Line Ranking Categories
Rank 3
NHD Flowline
Stream/River: Ephemeral
NWI Wetlands
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Golden Eagle Nest, Occupied - Inactive
Eagle / Other Raptors habitat features (TNC 2019)
Land Ownership
State Trust Land
Salt Flats/ Seasonal Lake
Ref. Area No. 1
Ref. Area No. 2
Pine Mountain
Page 2 of 4
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Data Source: USDA, USGS TNC, Esri
Coordinate System: NAD 1983 UTM Zone 13N
Author: B. Barbieri Date: 12/11/2019
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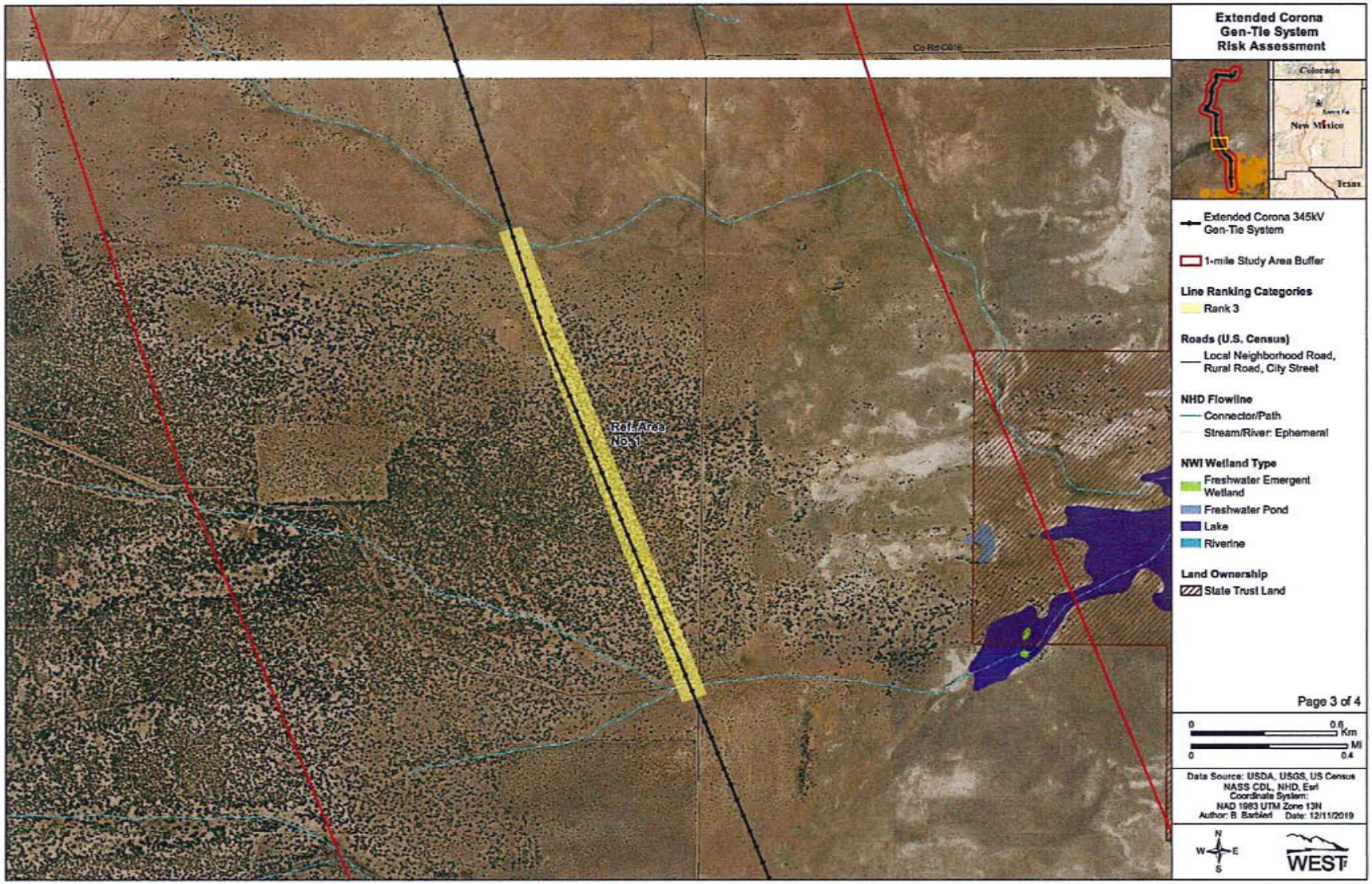
Co Rd C015
Ref. Area No. 1
Extended Corona Gen-Tie System Risk Assessment
Colorado
New Mexico
Texas
Extended Corona 345kV Gen-Tie System
1-mile Study Area Buffer
Line Ranking Categories
Rank 3
Roads (U.S. Census)
Local Neighborhood Road, Rural Road, City Street
NHD Flowline
Connector/Path
Stream/River: Ephemeral
NWI Wetland Type
Freshwater Emergent Wetland
Freshwater Pond
Lake
Riverine
Land Ownership
State Trust Land
Page 3 of 4
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Km
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Data Source: USDA, USGS, US Census
NASS CDL, NHD, Esri
Coordinate System:
NAD 1983 UTM Zone 13N
Author: B Barbieri Date: 12/11/2019
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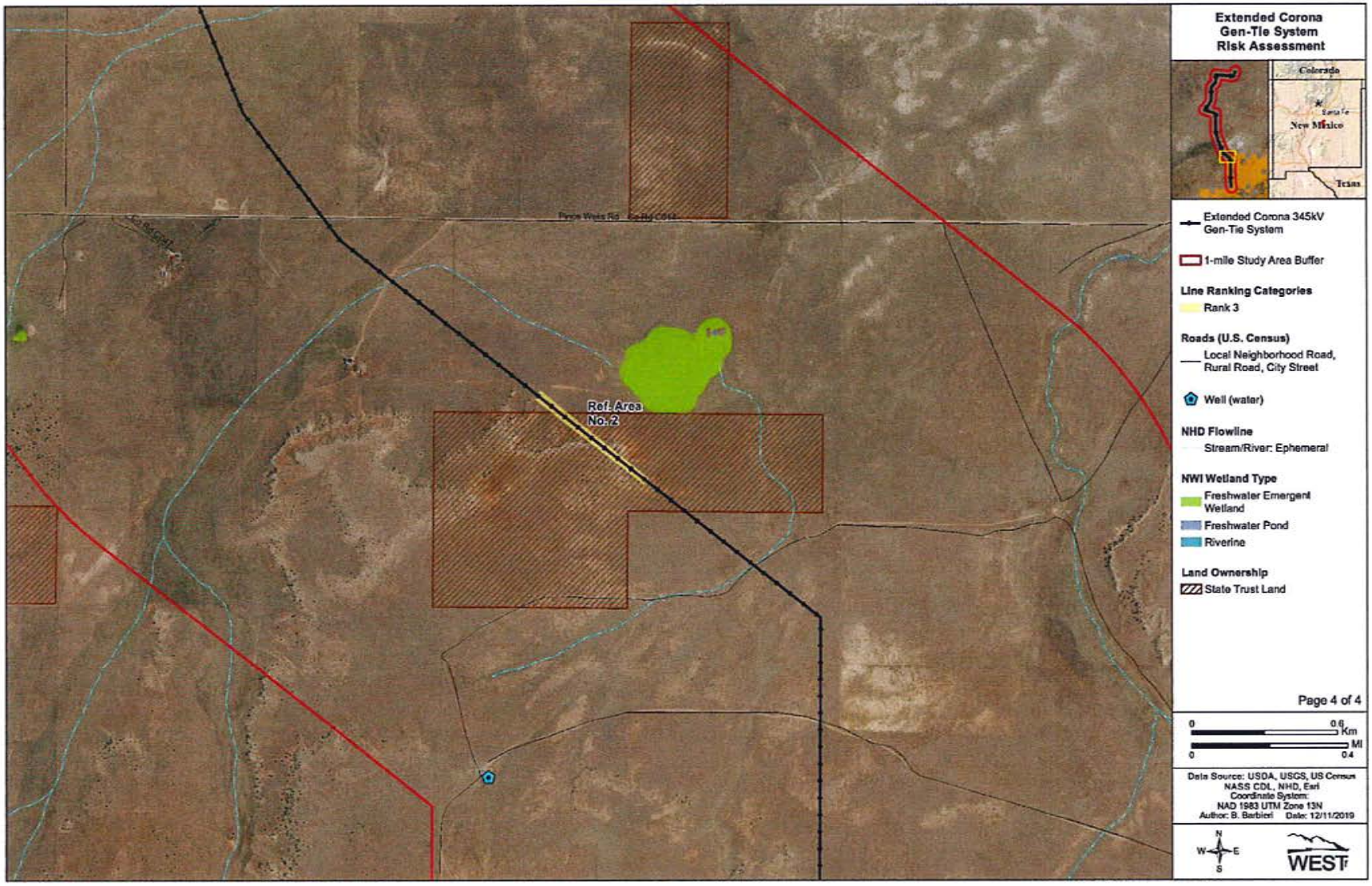
WEST


Ref. Area No. 2
Extended Corona Gen-Tie System Risk Assessment
Colorado
New Mexico
Texas
Extended Corona 345kV Gen-Tie System
1-mile Study Area Buffer
Line Ranking Categories
Rank 3
Roads (U.S. Census)
Local Neighborhood Road, Rural Road, City Street
Well (water)
NHD Flowline
Stream/River: Ephemeral
NWI Wetland Type
Freshwater Emergent Wetland
Freshwater Pond
Riverine
Land Ownership
State Trust Land
Page 4 of 4
0
0.6
Km
MI
0.4
Data Source: USDA, USGS, US Census
NASS CDL, NHD, Esri
Coordinate System:
NAD 1983 UTM Zone 13N
Author: B. Barbieri Date: 12/11/2019
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BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

Exhibit ACC-8

Corona Wind Projects - Project Agency Consultation Table
U.S. Fish and Wildlife Agency
U.S. Army Corps of Engineers
U.S. Bureau of Land Management
U.S. Department of Defense
New Mexico State Lands Office
New Mexico Environment Department, Air Quality Bureau
New Mexico Department of Game and Fish
New Mexico Attorney General's Office

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

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JOINT APPLICANTS.	)	

Exhibit ACC-9

EXHIBIT A

LEGAL DESCRIPTION OF REAL PROPERTY OWNED BY BLANCHARD CORONA RANCH, LLC IN LINCOLN COUNTY FORCONDITIONAL INCLUSION IN THE PROPOSED CORONA WIND PROJECTS

Legal Description:

PARCEL 1:

TOWNSHIP 1 SOUTH, RANGE 14 EAST, N.M.P.M., Lincoln County, New Mexico

Section 9:	S/2SE/4
Section 10:	S/2, NE/4, S/2NW/4, NE/4NW/4
Section 11:	ALL
Section 12:	NW/4NE/4, S/2NE/4, SE/4, S/2SW/4
Section 13:	ALL
Section 14:	E/2, SW/4, S/2NW/4, NE/4NW/4
Section 15:	ALL
Section 17:	N/2, N/2S/2
Section 22:	SW/4NE/4, SE/4
Section 23:	ALL
Section 24:	NW/4, N/2SW/4, SE/4, S/2NE/4, NW/4NE/4
Section 25:	ALL
Section 36:	ALL

TOWNSHIP 1 SOUTH, RANGE 15 EAST, N.M.P.M., Lincoln County, New Mexico

Section 7:	S/2N/2, S/2
Section 8:	W/2
Section 17:	ALL
Section 18:	ALL
Section 19:	NE/4, N/2SE/4, E/2NW/4, NE/4SW/4, Lots 1, 2 and 3
Section 20:	W/2, W/2SE/4
Section 21:	SW/4
Section 28:	ALL
Section 29:	E/2, E/2W/2, NW/4NW/4
Section 31:	E1/2SW/4, SE/4, Lots 3 and 4

PARCEL 2:

A non-exclusive easement along the existing roadway across Section 3, Township 1 South, Range14 East, N.M.P.M., Lincoln County, New Mexico, being 25 feet in width, 12.5 feet on either side of the following described centerline:

BEGINNING at the most Northerly point of this easement, a point on thc New Mexico Base Line, where an aluminum cap at the section corner common to Sections 3 and 4, T1S, R14E, N.M.P.M. of the U.S.G.L.O. Surveys bears N 89°52'57" W, a distance of 802.26 feet;

THENCE from the point of beginning and leaving thc base line S 6°21'33" W, 281.74 feet to an angle point;

THENCE S 16°21'29" W, 518.27 feet to an angle polnl;

THENCE S 7°46'40" W, 608.72 feet to an angle point;

THENCE S 6°07'10" E, 276.89 feet to an angle point;

THENCE S 0°13'41" W, 268.13 feet to an angle point;

THENCE S 7°48'25" E, 589.07 feet to an angle point;

THENCE S 19°34'06" E, 761.32 feet to an angle point;

THENCE S 11°15'20" E, 355.74 feet to an angle point;

THENCE S 22°02'48" E, 586.09 feet to an angle point;

THENCE S 27°49'08" E, 1233.78 feet to the South llnc of Section 3, and the end of thls easement, whence an aluminum cap for the section corner common to Sections 3, 4, 9 and 10, T1S, R14E, bears S 89°55'19" W, a distance of 1763.24 feet.

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

AFFIDAVIT OF ADAM CERNEA CLARK

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	**Case No. 18-00065-UT**
JOINT APPLICANTS.	)	

AFFIDAVIT OF ADAM CERNEA CLARK

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I have read the foregoing Direct Testimony, and it is true and accurate based on my own knowledge and belief.

SUBSCRIBED and sworn to before me this 19 day of December 2019.

NOTARY PUBLIC

February 27, 2022
My Commission Expires

PAMELA MARTINEZ NOTARY PUBLIC STATE OF NEW MEXICO

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

DIRECT TESTIMONY OF

GREG PARENT

ON BEHALF OF THE CORONA WIND COMPANIES

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	Case No. 18-00065-UT
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

DIRECT TESTIMONY OF

GREG PARENT

ON BEHALF OF THE CORONA WIND COMPANIES

December 20, 2019

Q PLEASE STATE YOUR NAME.

A. Greg Parent, P.E., S.E. The P.E. stands for licensed Professional Engineer and the S.E. stands for licensed Structural Engineer.

Q. BY WHOM AND IN WHAT CAPACITY ARE YOUR EMPLOYED?

A. I am employed by Ulteig Engineers, Inc. as a Senior Engineer in the Transmission and Distribution Department. My business address is 5575 DTC Parkway, Suite 200, Greenwood Village, CO 80111.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. I am providing testimony on behalf of the Corona Wind Companies, who are the Joint Applicants in this proceeding. I support the Joint Applicants' contention that the necessary right-of-way ("ROW") width for the modified portions of the Corona Gen-Tie System should be 180-feet. In NMPRC Case No. 18-00065-UT the Joint Applicants were granted location approval for the Corona Gen-Tie System with a 180-foot ROW. I testified in support of that approval and conducted the necessary analysis to demonstrate that the 180-foot ROW is both necessary and desirable from a technical and safety perspective. The Commission and all the parties who took a position agreed.

I now understand that the Joint Applicants have made a determination that the original approved route for the Corona Gen-Tie System needs to be modified ("Reconfigured Corona Gen-Tie System") and extended 35 miles ("Extended Corona Gen-Tie System"). Together I refer to this overall modification as the "Updated Corona Gen-Tie System." My testimony presents my analysis of the Updated Corona Gen-Tie System and the conclusion that the necessary ROW width continues to be 180 feet.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL AND WORK EXPERIENCE.

A. I have a Master of Science in Structural Engineering from Lehigh University. I am a licensed P.E. in 17 states and am also a licensed Structural Engineer in New Mexico, Illinois, Hawaii, Nevada and Utah. I have more than a decade of transmission line design experience and have designed approximately 700 miles of transmission line.

Q. HAVE YOU PREVIOUSLY SUBMITTED TESTIMONY IN ANY OTHER PROCEEDING?

A. Yes. As noted previously, I have appeared before the Commission in NMPRC Case No. 18-00065-UT. I also submitted testimony in NMPRC Case No. 19-00139-UT on behalf of the Clines Corners Wind Farm LLC.

Q. ARE YOU FAMILIAR WITH THE PROPOSED TRANSMISSION LINE FACILITES WHICH ARE THE SUBJECT OF THIS JOINT APPLICATION?

A. Yes. I worked closely with Pattern personnel in the design of this Corona Wind Farms Project. More specifically, the ROW width requirement calculation for the Corona Gen-Tie Transmission System was performed by Ulteig Engineers, Inc. I supervised this work and met in person and by phone with the Commission Staff's engineers to review my work and calculations that concluded that a 180-foot ROW width was appropriate for this transmission line.

Q. HAVE YOU BEEN INVOLVED WITH THE DEVELOPMENT OF THE UPDATED CORONA GEN-TIE SYSTEM?

A. Yes. I was retained to review the modifications that resulted in the Reconfigured Corona Gen-Tie System and determined that even with some alterations in the original route it is still appropriate for the Commission to approve a 180-foot ROW. Additionally, I have reviewed the proposed route for the Extended Corona Gen-Tie System and again concluded

that this roughly 35-mile extension should have the same 180 ROW as the rest of the Corona Gen-Tie System.

Q. CAN YOU ELABORATE ON THE BASIC DESIGN CONDITIONS YOU EVALUATED IN DETERMINING THAT A 180-FOOT ROW WAS REQUIRED FOR THE UPDATED CORONA GEN-TIE SYSTEM?

A. Yes. Preliminary design considerations include geotechnical soil studies, topographical surveys and wind and weather conditions to determine a range of preliminary specifications for equipment and infrastructure for the proposed location for the proposed transmission and interconnection facilities. The loading conditions for the transmission lines follow the requirements stated in the National Electric Safety Code (NESC-2017). We analyzed the required ROW width for the following load cases:

1. NESC 234.C.1.a (At Rest)
    a. 0 psf wind pressure acting perpendicular to the conductor
    b. 60 deg Fahrenheit ambient temperature.
2. NESC 234.C.1.b (6 psf Wind)
    a. 6 psf wind pressure acting perpendicular to the conductor
    b. 60 deg Fahrenheit ambient temperature
3. NESC 250B – Heavy Loading District Loading without load factors (This region of the country is technically a NESC 250B – Medium loading district but Pattern has instructed Ulteig to perform preliminary designs to satisfy the requirements of the Heavy loading district because Pattern would like a higher level of reliability that the minimum code requirements.
    a. 4 psf wind pressure acting perpendicular to the conductor
    b. ½" of radial ice
    c. 0 deg Fahrenheit ambient temperature

4. NESC 250C – Extreme Wind. The wind load map in NESC 250C matches the basic wind speed map in the American Society of Civil Engineers – Minimum Design Loads for Building and Other Structures - ASCE 7-05. The Corona Wind Project extends over a large region. The extreme wind speed varies over this region. Part of the Corona Wind project is in the 90-mph wind speed region but also extends into a "Special Wind Region". These special wind regions experience higher wind speeds than 90mph. Pattern has determined that the extreme wind speed for these special wind regions should be set at 100mph. For consistency the extreme wind speed for the entire project has been set to 100mph whether it is inside or outside the special wind regions.

    a. 100 mph wind speed (25.6psf) acting perpendicular to the conductor

    b. 60 deg Fahrenheit ambient temperature

Under these conditions, and the aforementioned considerations, we evaluate the clearances, conductor movement, and structure deflection to calculate span lengths and structure types and configurations.

Q. DO YOU BELIEVE THAT THE CRITERIA YOU RELIED UPON IN DETERMINING THE NECESSITY FOR A 180-FOOT ROW REASONABLE?

A. Yes. These criteria are appropriate and consistent with the accepted practice within the industry. I have designed over fifteen (15) 345kV transmission lines and the right of way widths for those projects ranged between 150ft – 200ft. The variations in right of way width for these projects depended on design spans, structure types and audible noise requirements that were used on each line.

Q. DO YOU HAVE EXHIBITS SUPPORTING YOUR CALCULATIONS THAT WARRANT THE 180-FOOT ROW WIDTH THAT THE JOINT APPLICANTS' REQUEST IN THIS PROCEEDING?

A. Yes. Please see the attached exhibit titled GP-1.

Q. PLEASE EXPLAIN THE INFORMATION CONTAINED IN EXHIBIT GP-1.

A. Page 1 of this exhibit provides the calculations for the NESC required horizontal clearances from the transmission line conductor to building structures for NESC Rules 234B1a, 234B1b. Also provided is the recommended horizontal clearance when the transmission line is subject to 100mph wind speed. The above clearances have been adjusted for an altitude of 7100ft. The following pages of this Exhibit GP-1 illustrate the results of the blowout analysis for three different structure types. The three structure types are as follows:

- Double Circuit Steel Monopole,
- Single Circuit Steel Monopole
- Single Circuit Wood H-Frame.

The actual structure types that will be used on this project have not yet been determined and will depend on material lead times, material costs and construction cost of the different structure types. At the time of this revised testimony, 12-12-19, steel pole lead times have lengthened significantly over the last year. Current quoted lead times are as far out as 26 weeks from the date of order. Unlike the steel poles, the wood poles that are used in the wood H-Frame structures, currently have lead times of 6-8 weeks. Tight construction schedules may require using wood H-Frame structures and therefore, it is critical to have a ROW width that wide enough to accommodate a wood H-Frame structure type.

The final conductor sizes are still being determined. However, for the different types of the conductor sizes investigated in the preliminary design, it was found that the conductor that exhibits the most blowout and highest audible noise is a bundled (2) 954kcmil ACSR

"Cardinal" conductor per phase. Therefore, to determine conductor blowouts and pole deflections each structure type was modeled using a bundled (2) 954kcmil ASCR "Cardinal" conductor per phase. A 1300 ft design span between structures was assumed. Actual design spans could vary depending on the topography. A design span of 1300ft would likely be a maximum design span. Pole heights were determined to provide adequate vertical clearance under the conductor during maximum operating temperature at mid-span assuming flat terrain.

Each structure type was analyzed under the following four different load cases:

1. NESC Rule 234B1a – [At Rest Condition, 0 psf wind, 60 degF]
2. NESC Rule 234B1b – [6psf Condition, 6 psf wind, 60 degF]
3. NESC Rule 250B – Heavy Region [4psf wind, ½" Radial Ice, 0 degF]
4. NESC Rule 250C – Extreme Wind [100 mph (25.6 psf), 60 degF]

To determine the conductor blowouts and pole deflections, each structure type and each load case was modeled in the transmission line design software PLS-CADD. The results of the required right of way width are illustrated in Exhibit GP-1. The controlling structure type and load case were the single circuit wood H-Frame under NESC Rule 250C – Extreme Wind [100 mph (25.6 psf), 60 degF]. This structure type and load case would require a minimum right of way width approximately 177'-5" wide, which is just shy of the requested 180'-0" Right of Way width. A detailed analysis of the H-Frame structure under the 250C – Extreme Wind case is provided in the last (4) pages of Exhibit GP-1. This structure and load case control the Right of Way width.

Another calculation that was performed was the audible noise volume that would be heard at the edge of the right of way. In 1974, the Environmental Protection Agency (EPA)

published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* in which the EPA set 55dBA as the outdoor noise threshold that would prevent activity interference or annoyance. Many utilities I have worked with have a 50dBA noise threshold limit at the edge of the right of way. Audible noise is inversely related to conductor diameter. Therefore, the smaller the diameter, the higher the audible noise. Once again, the conductor that was analyzed for audible noise was the 954kcmil ACSR "Cardinal" because, the "Cardinal" has the smallest diameter of the conductor sizes that were analyzed. Page 14 of Exhibit GP-1 shows the calculations of the audible noise for the Single Circuit Wood H-Frame structure. In this analysis the audible noise produced by the transmission line would be 49.61 dBA 90ft from the transmission line center line (90ft x 2 = 180ft ROW). With the transmission line centered in a right of way width of 180ft the audible noise produced is just under the recommended 50dBA limit.

From the analysis performed to determine required ROW widths, it is my opinion that a right of way of 180ft is appropriate for this line.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

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JOINT APPLICANTS.	)	

Exhibit GP-1

Ulteig Engineering
Project Name: Corona Wind Farm Project
Required NESC Horizontal Clearances - Rule 234B1a & 234B1b
Engineer: Greg Parent
Date: 12-18-2019

Ulteig
We listen. We solve.™

(VN) = Nominal Opperating Voltage Phase-Phase (kV) $V_N := 345\ kV$

(VM) = Max Transient Overvoltage Phase-Phase (kV) $V_M := 1.05 \cdot V_N = 362.25\ kV$

(Elev) = Design Elevation (ft) $Elev := 7100\ ft$

(CHAR) = Required Horizontal Clearance At Rest (ft) NESC RULE 234B1a

(CH@6psf) = Required Horizontal Clearance under 6psf (ft) NESC RULE 234B1b

(CH@100mph) = Recomended Horizontal Clearance under 100mph

$$CH_{AR} := 7.5\ ft + ((50\ kV - 22\ kV)) \cdot \left(\frac{0.4\ \frac{in}{kV}}{12\ \frac{in}{ft}} \right) + \left(\left(\frac{V_M}{\sqrt{3}} - 50\ kV \right) \cdot \left(\frac{0.4\ \frac{in}{kV}}{12\ \frac{in}{ft}} \right) \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}} \right)$$

$$CH_{AR} = 14.369\ ft$$

$$CH_{@6psf} := 4.5\ ft + ((50\ kV - 22\ kV)) \cdot \left(\frac{0.4\ \frac{in}{kV}}{12\ \frac{in}{ft}} \right) + \left(\left(\frac{V_M}{\sqrt{3}} - 50\ kV \right) \cdot \left(\frac{0.4\ \frac{in}{kV}}{12\ \frac{in}{ft}} \right) \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}} \right)$$

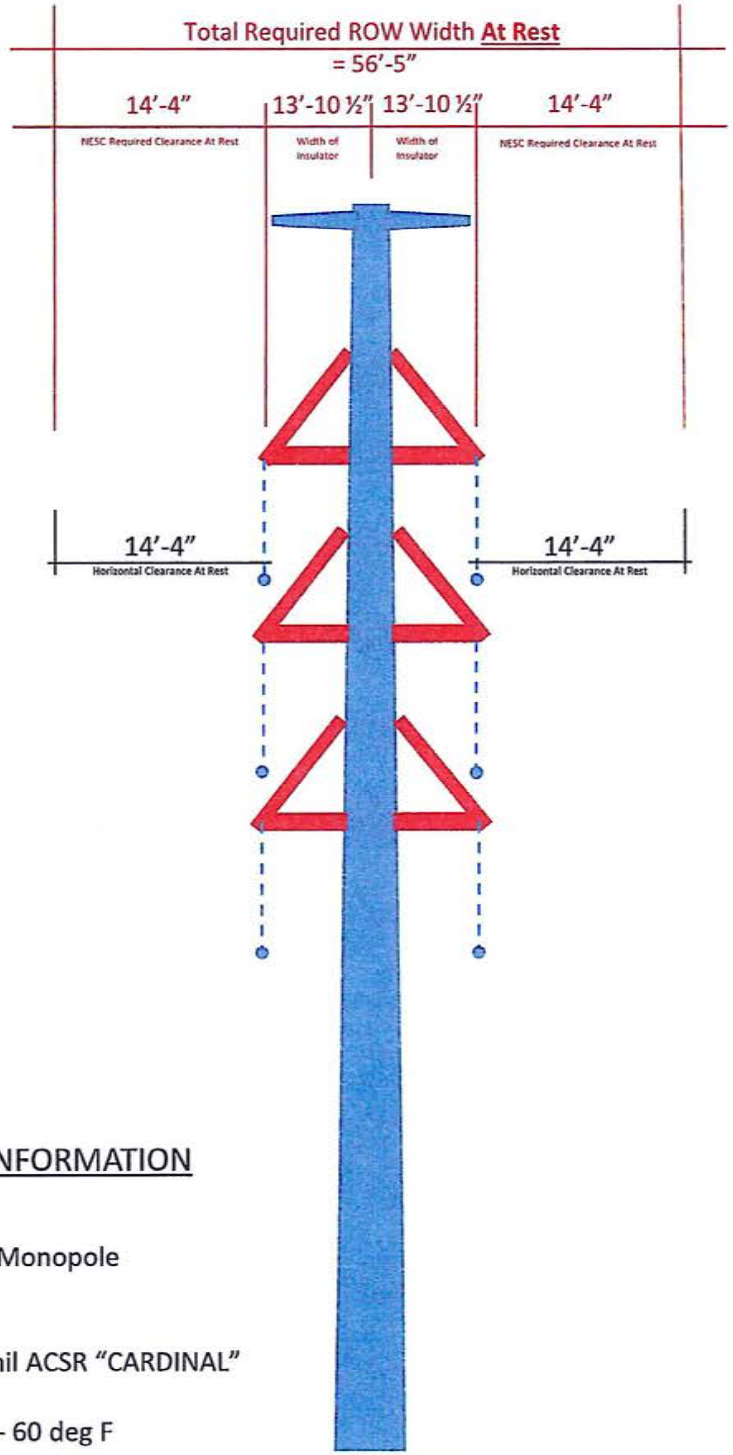
$$CH_{@6psf} = 11.369\ ft$$

$$CH_{@100mph} := 345\ kV \cdot \frac{0.1\ \frac{in}{kV}}{12\ \frac{in}{ft}} \cdot 1.03^{\frac{Elev - 3300\ ft}{1000\ ft}}$$

Assuming 10kV per inch dielectric constant for air

$$CH_{@100mph} = 3.217\ ft$$

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER



SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Double Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 234B1a
Weather Condition Displayed = 0 PSF - 60 deg F

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER

CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

Rev	Date	Description	By
A	04-19-2019	ROW EXHIBITS	LKT
B	12-18-2019	UPDATED CORONA GEN-TIE ROW	LKT

PATTERN ENERGY GROUP
4225 EXECUTIVE SQUARE
LA JOLLA, CA 92037

Pattern

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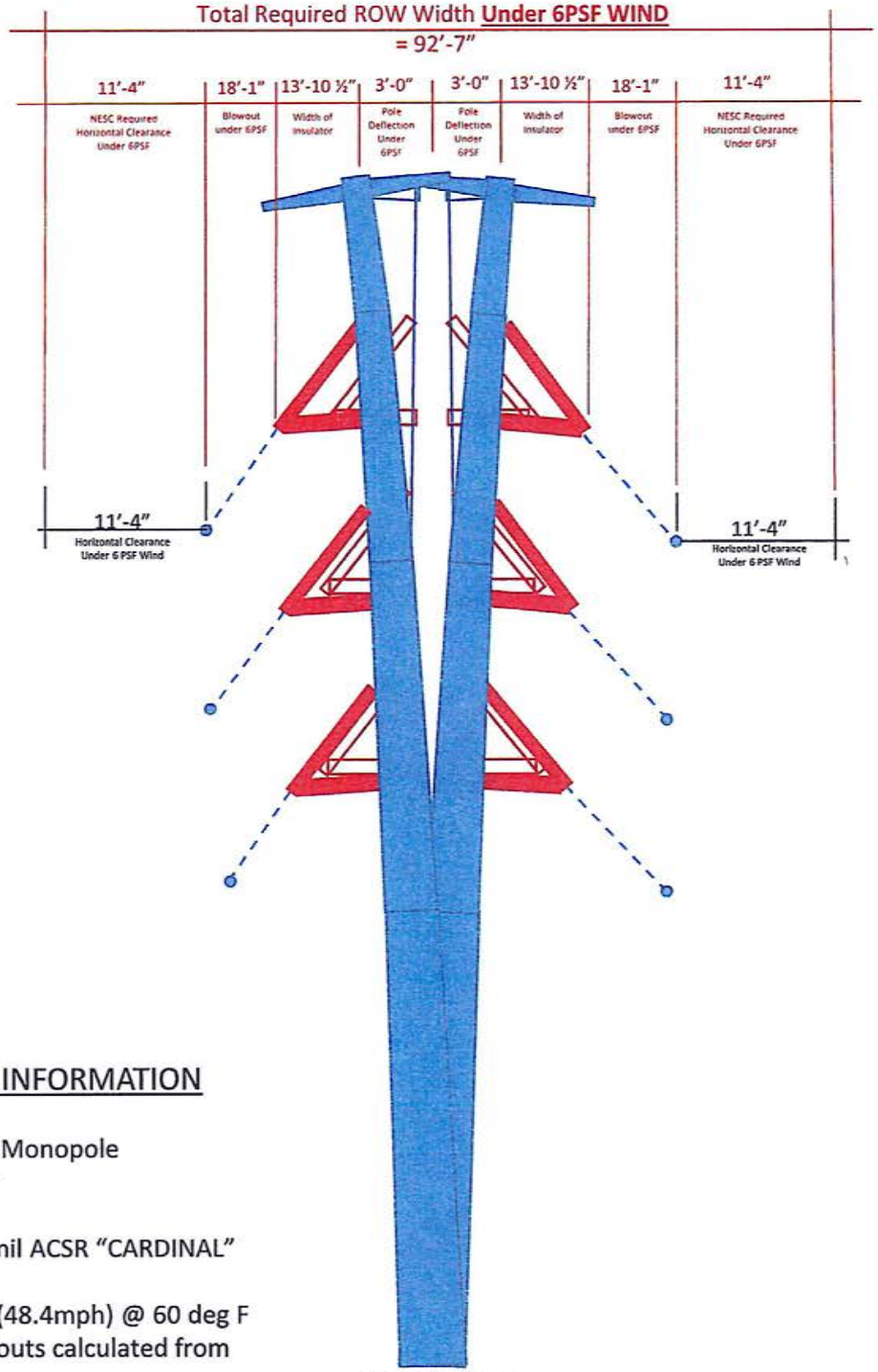
Fax: 701.237.3191
www.ulteig.com
Bismarck - Denver - Detroit Lakes - Fargo - Sioux Falls - St. Paul

Design By:
Drawn By:
Approved By:
Project Number:

ROW WIDTH EXHIBITS
DC STEEL MONOPOLE

REVISION:
B
COR-TLO-E-ROW-001



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STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Double Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 234B1b
Weather Condition Displayed = 6 psf (48.4mph) @ 60 deg F
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

GREG C. PARENT
NEW MEXICO
24890
12-18-18
PROFESSIONAL ENGINEER

CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

Rev.	Date	Description	By
A	04-19-2018	ROW EXHIBITS	LEI
B	12-18-2018	UPDATED CORONA GEN-TIE ROW	LEI

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LA JOLLA, CA 92037

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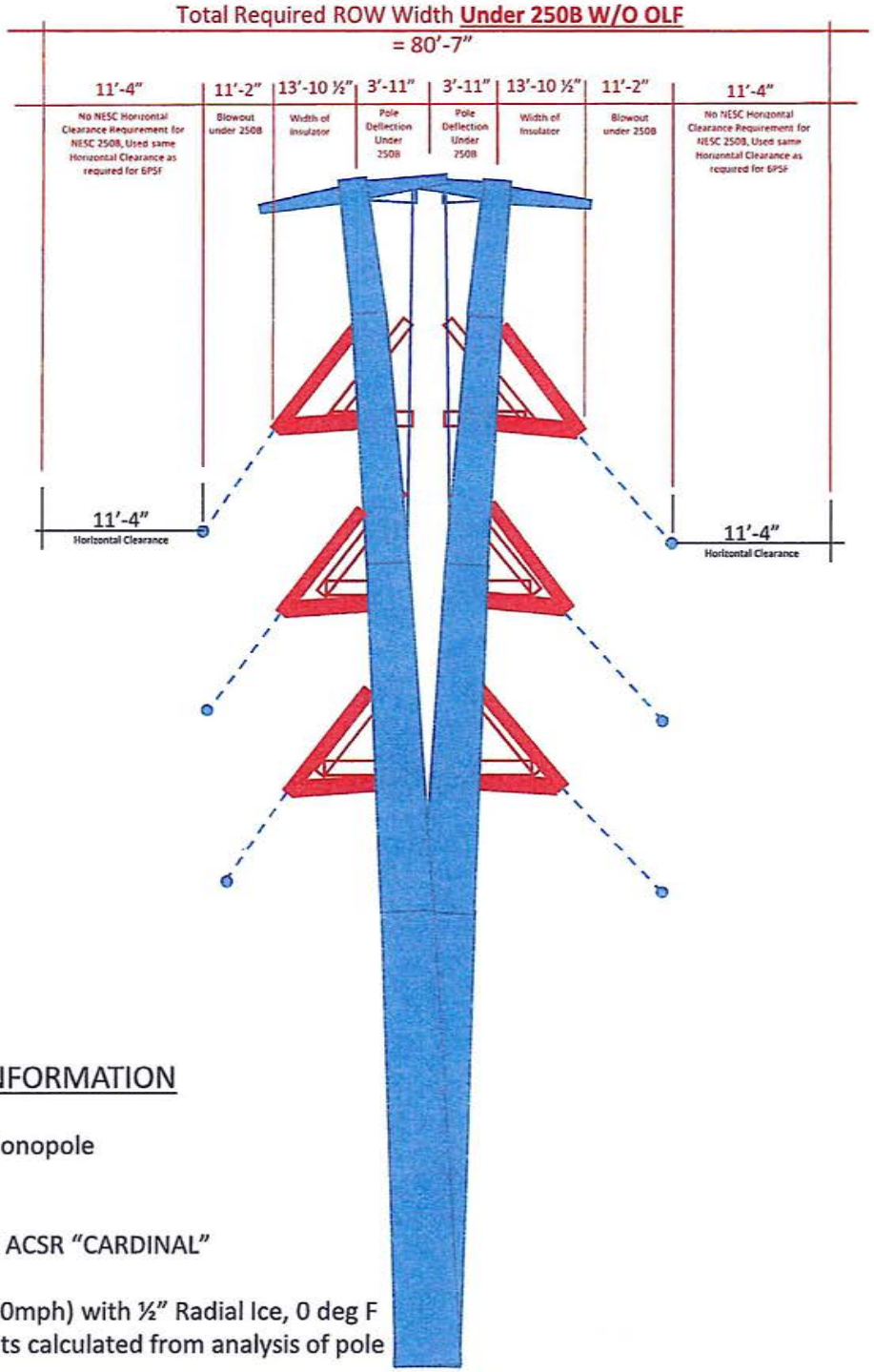
Design By:
Drawn By:
Approved By:
Project Number:

ROW WIDTH EXHIBITS
DC STEEL MONOPOLE

REVISION
B
COR-TLO-E-ROW-002



STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Double Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 250B W/O OLF
Weather Condition Displayed = 4 PSF (40mph) with ½" Radial Ice, 0 deg F
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

SCALE: NTS

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER

CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

Rev.	Date	Description	By
A	04-19-2018	ROW EXHIBITS	UEI
B	12-18-2018	UPDATED CORONA GEN-TIE ROW	UEI

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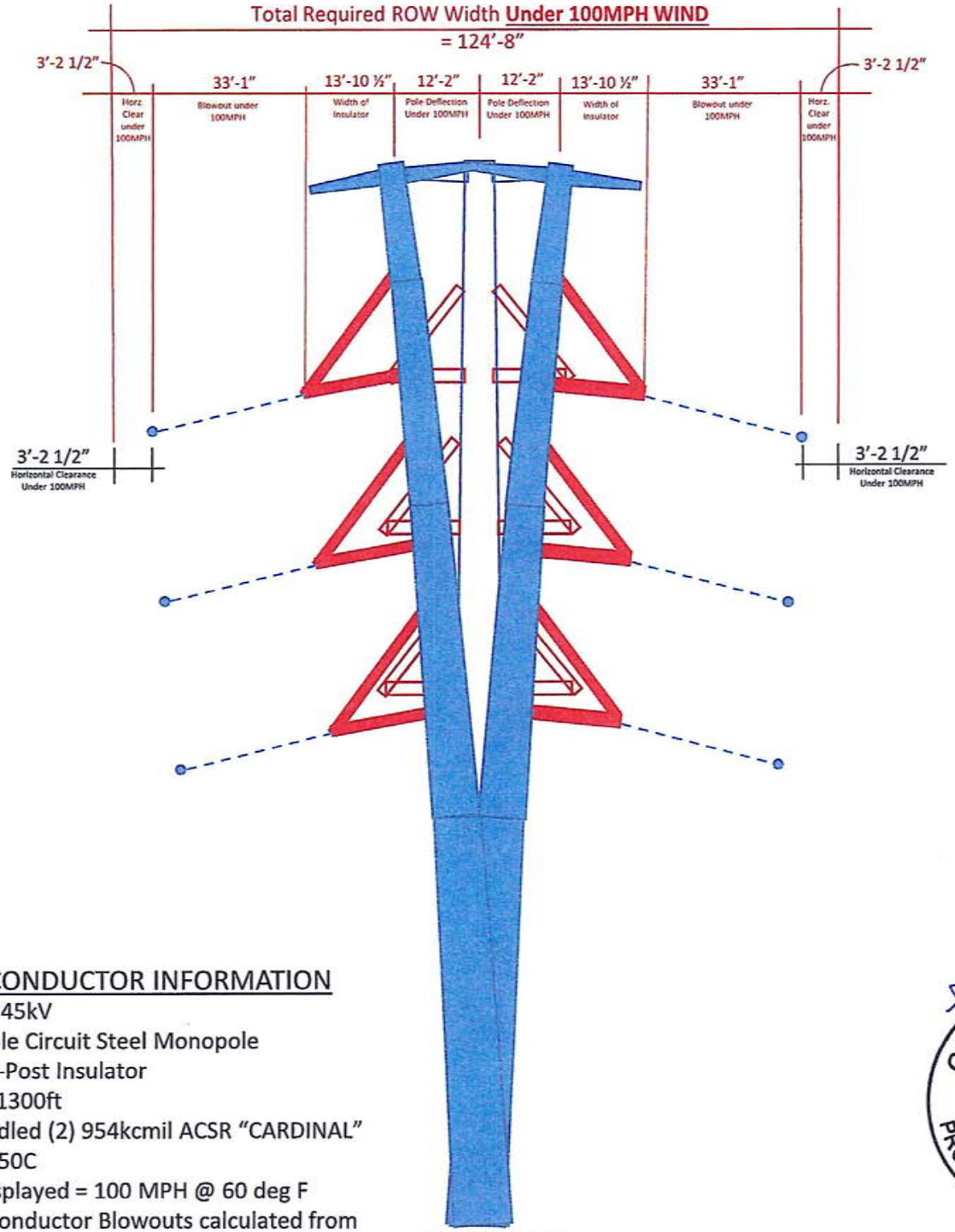
Design By:
Drawn By:
Approved By:
Project Number:

ROW WIDTH EXHIBITS
DC STEEL MONOPOLE

REVISION
B
COR-TLO-E-ROW-003



STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Double Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 250C
Weather Condition Displayed = 100 MPH @ 60 deg F
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

SCALE: NTS

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER

CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

Rev	Date	Description	By
A	04-15-2019	ROW EXHIBITS	LEI
B	12-18-2019	UPDATED CORONA CEN TIE ROW	LEI

PATTERN ENERGY GROUP
4225 EXECUTIVE SQUARE
LA JOLLA, CA 92037

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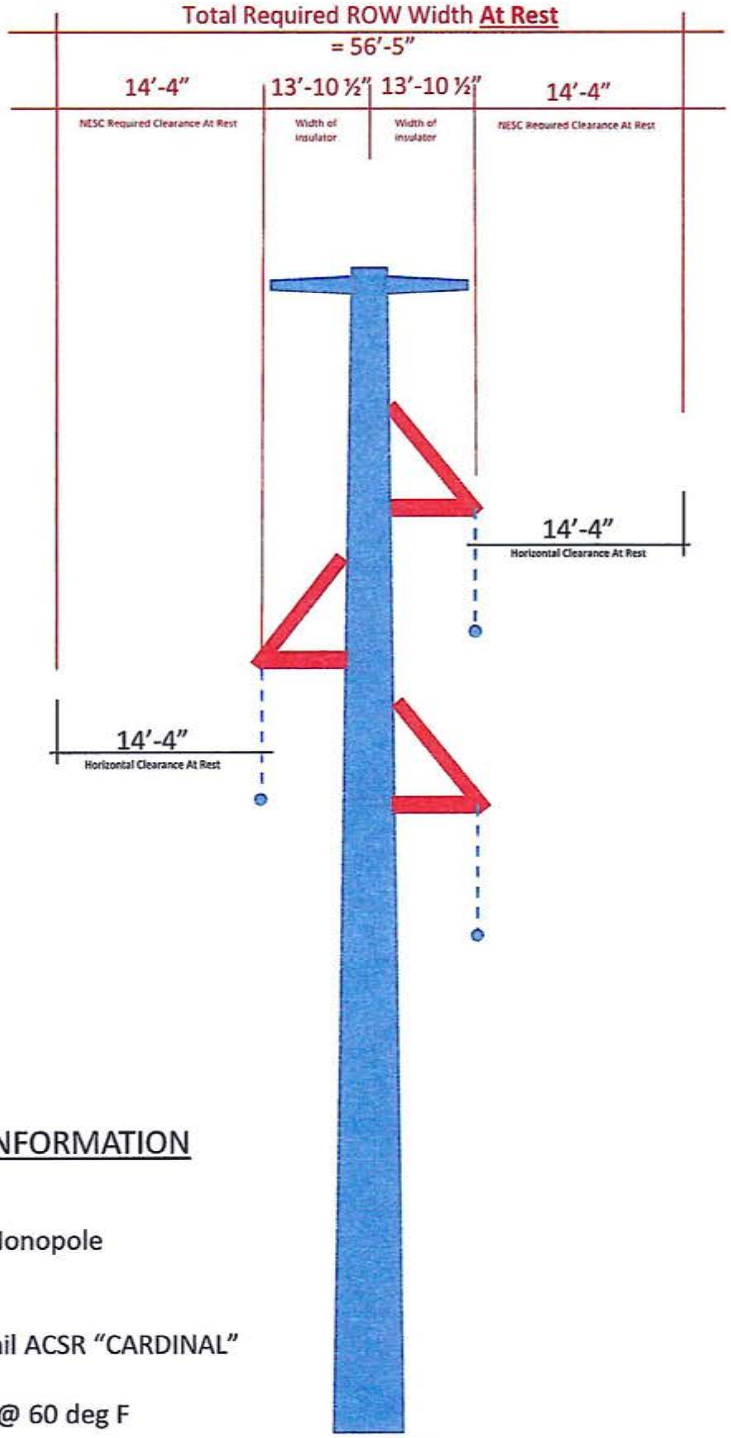
Design By:
Drawn By:
Approved By:
Project Number:

ROW WIDTH EXHIBITS
DC STEEL MONOPOLE

REVISION:
B

COR-TLO-E-ROW-004



SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 234B1a
Weather Condition Displayed = 0 PSF @ 60 deg F

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER

CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

Rev.	Date	Description	By
A	04.19.2018	ROW EXHIBITS	UEI
B	12-18-2018	UPDATED CORONA GEN-TIE ROW	UEI

PATTERN ENERGY GROUP
4225 EXECUTIVE SQUARE
LA JOLLA, CA 92037

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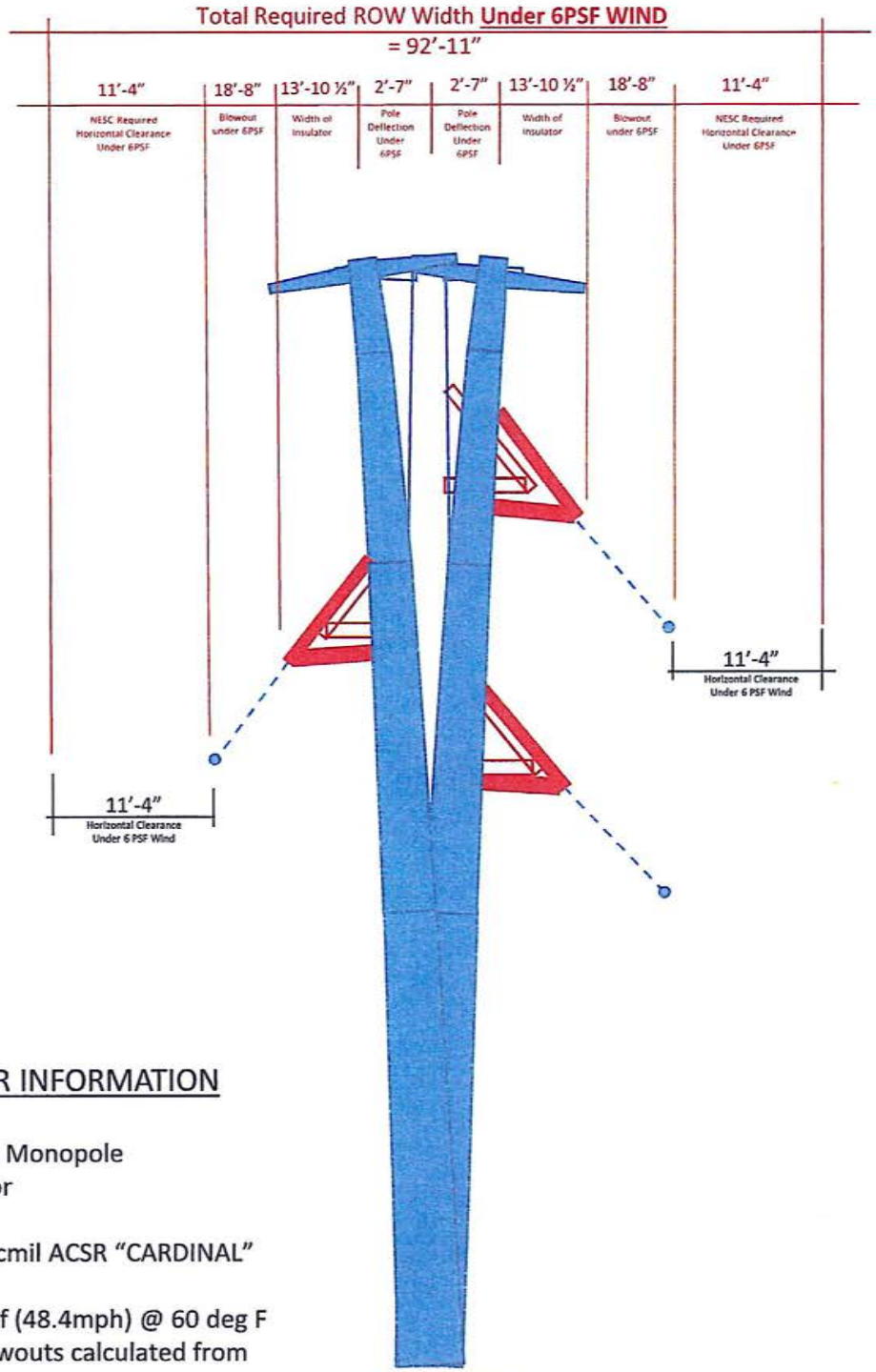
ROW WIDTH EXHIBITS
SC STEEL MONOPOLE

REVISION:
B
COR-TLO-E-ROW-005



SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 234B1b
Weather Condition Displayed = 6 psf (48.4mph) @ 60 deg F
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

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CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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ROW WIDTH EXHIBITS
SC STEEL MONOPOLE

REVISION:
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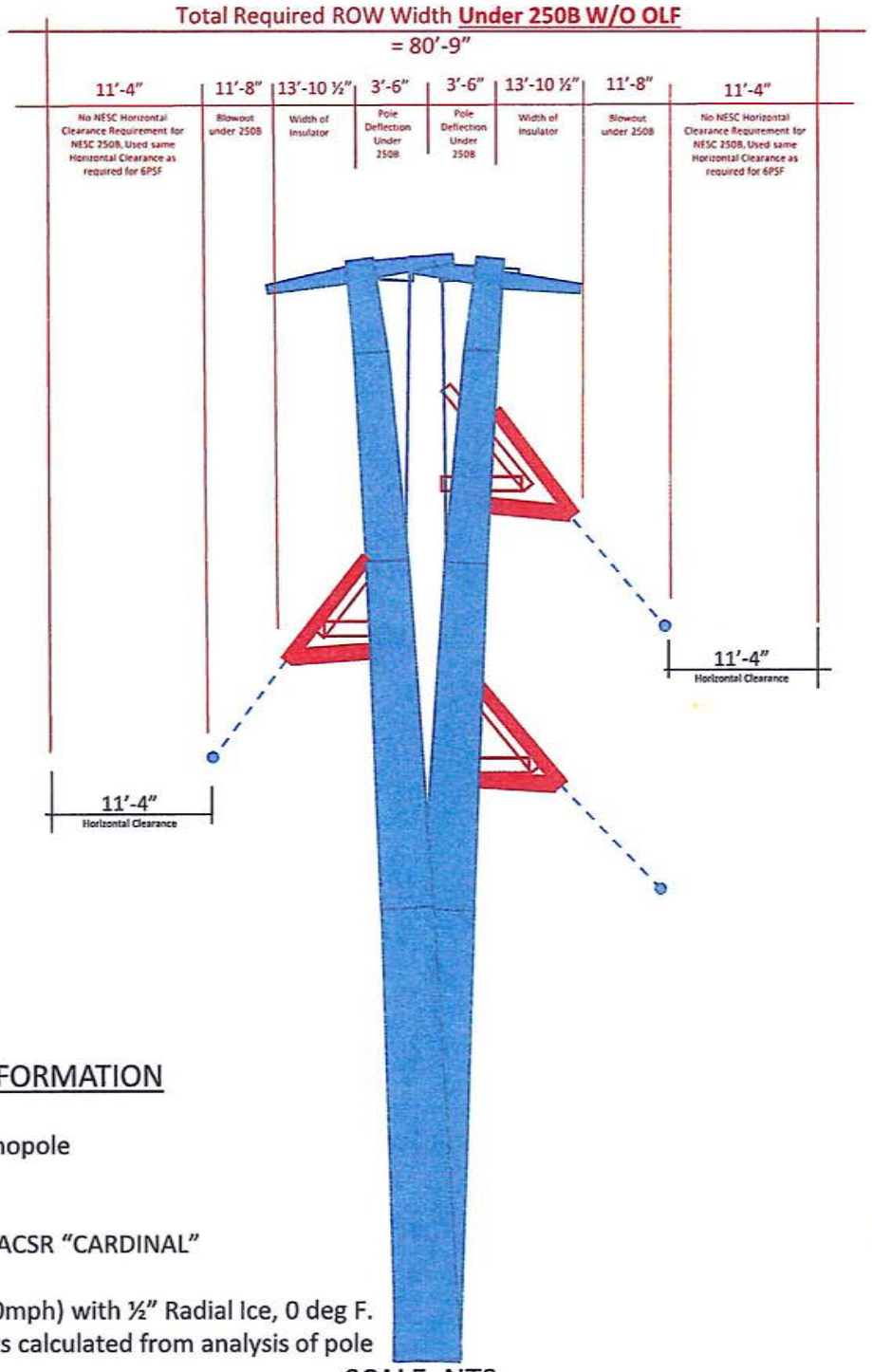
COR-TLO-E-ROW-006



STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 250B W/O OLF
Weather Condition Displayed = 4 PSF (40mph) with ½" Radial Ice, 0 deg F.
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

SCALE: NTS

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LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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ROW WIDTH EXHIBITS
SC STEEL MONOPOLE

REVISION
B
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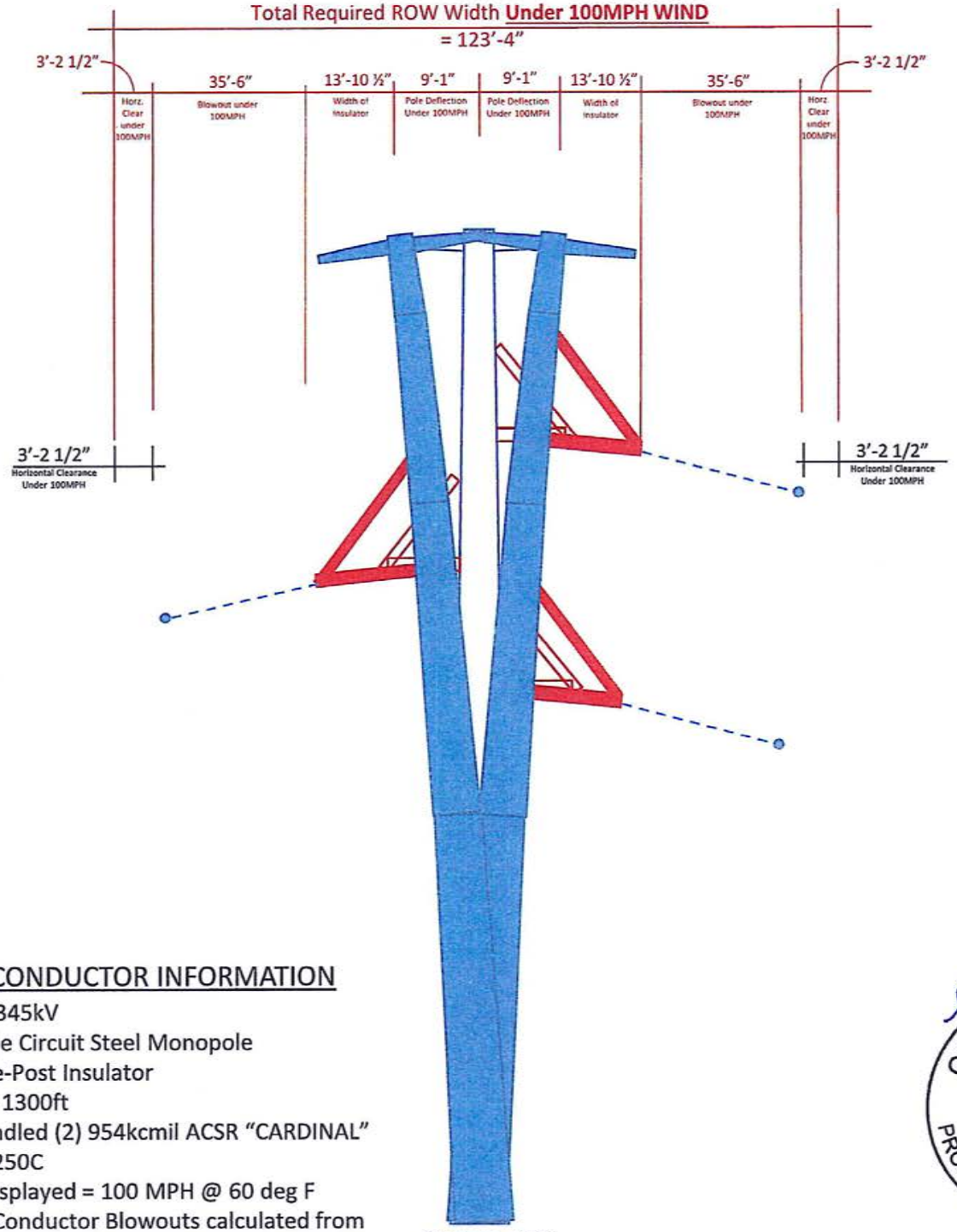

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Steel Monopole
Insulator Type = Brace-Post Insulator
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 250C
Weather Condition Displayed = 100 MPH @ 60 deg F
Pole Deflections and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

SCALE: NTS

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LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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ROW WIDTH EXHIBITS
SC STEEL MONOPOLE

REVISION:
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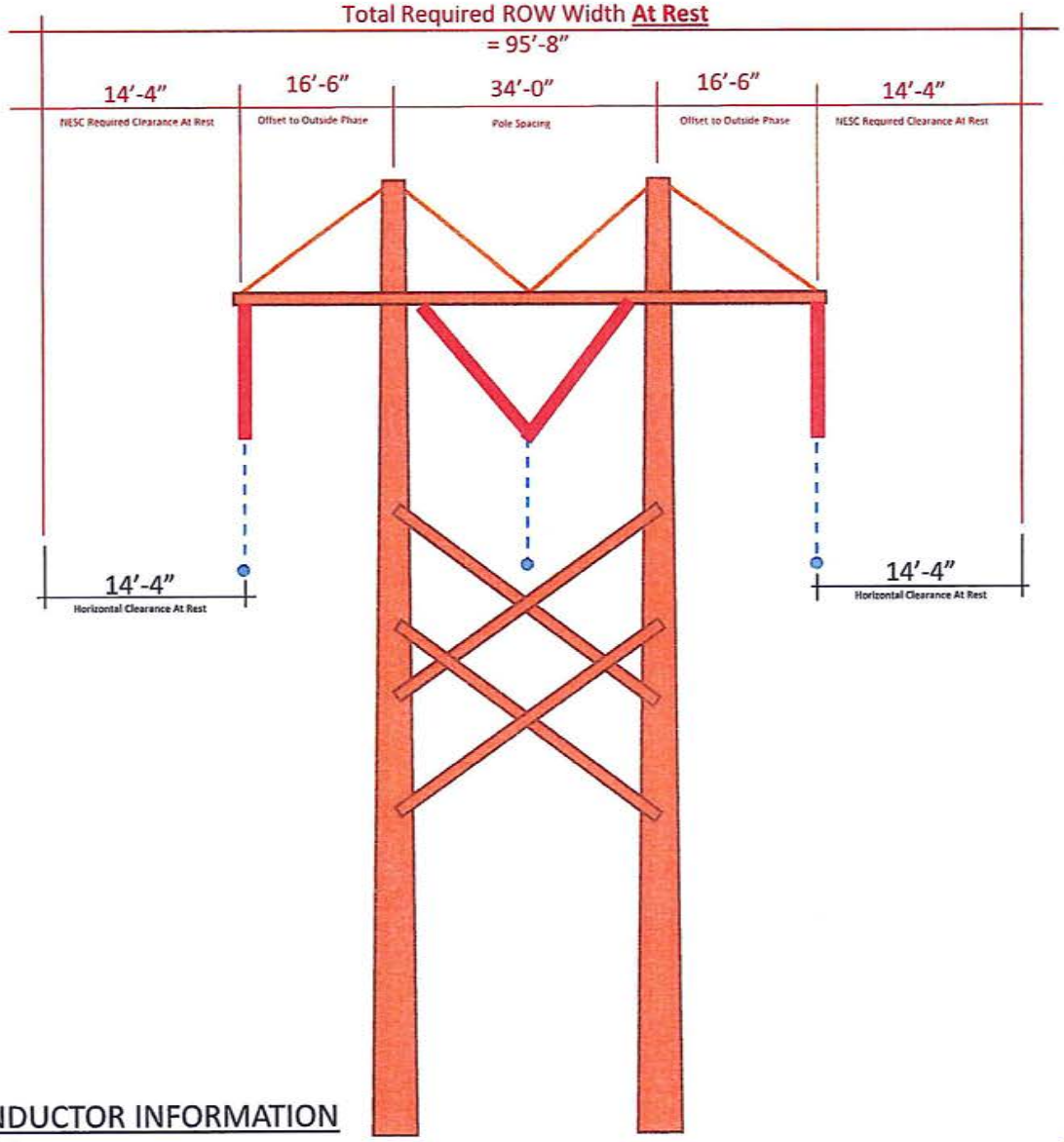

SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Wood H-Frame
Insulator Type = Suspension Insulators, I & V Type
Typical Design Span = 1300ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 234B1a
Weather Condition Displayed = 0 PSF @ 60 deg F

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LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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ROW WIDTH EXHIBITS
SC WOOD H-FRAME

REVISION:
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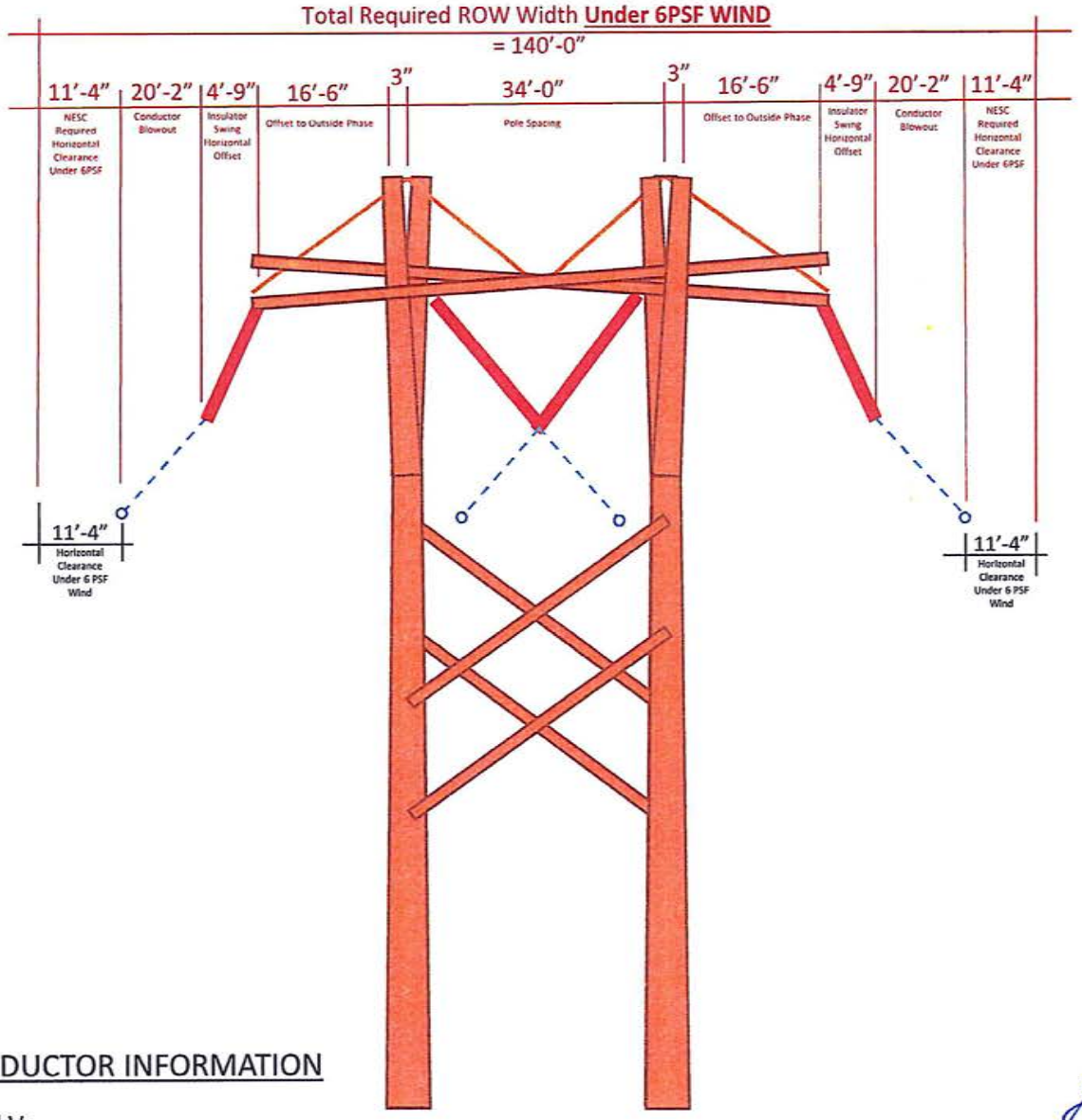
COR-TLO-E-ROW-009



SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Wood H-Frame
Insulator Type = Suspension Insulators, I & V Type
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Weather Condition Displayed = 6 psf (48.4mph) @ 60 deg F
Pole Deflections, Insulator Swings and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

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LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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SC WOOD H-FRAME

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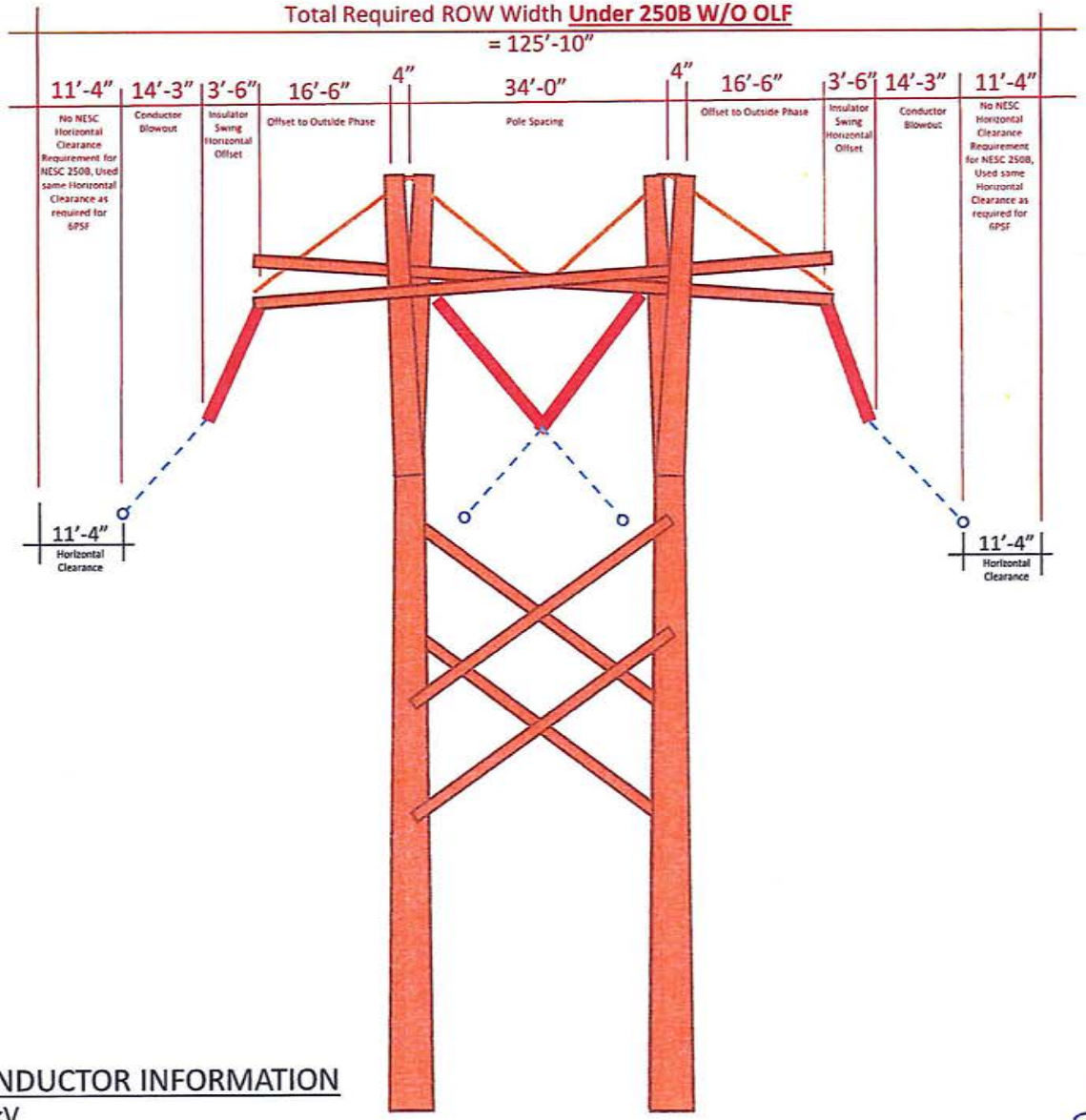

SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

Operational Voltage: 345kV
Structure Type = Single Circuit Wood H-Frame
Insulator Type = Suspension Insulators, I & V Type
Typical Design Span = 1000ft
Conductor Type = Bundled (2) 954kcmil ACSR "CARDINAL"
NESC Rule Analyzed: 250B W/O OLF
Weather Condition Displayed = 4 PSF (40mph) with ½" Radial Ice, 0 deg F
Pole Deflections, Insulator Swings and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

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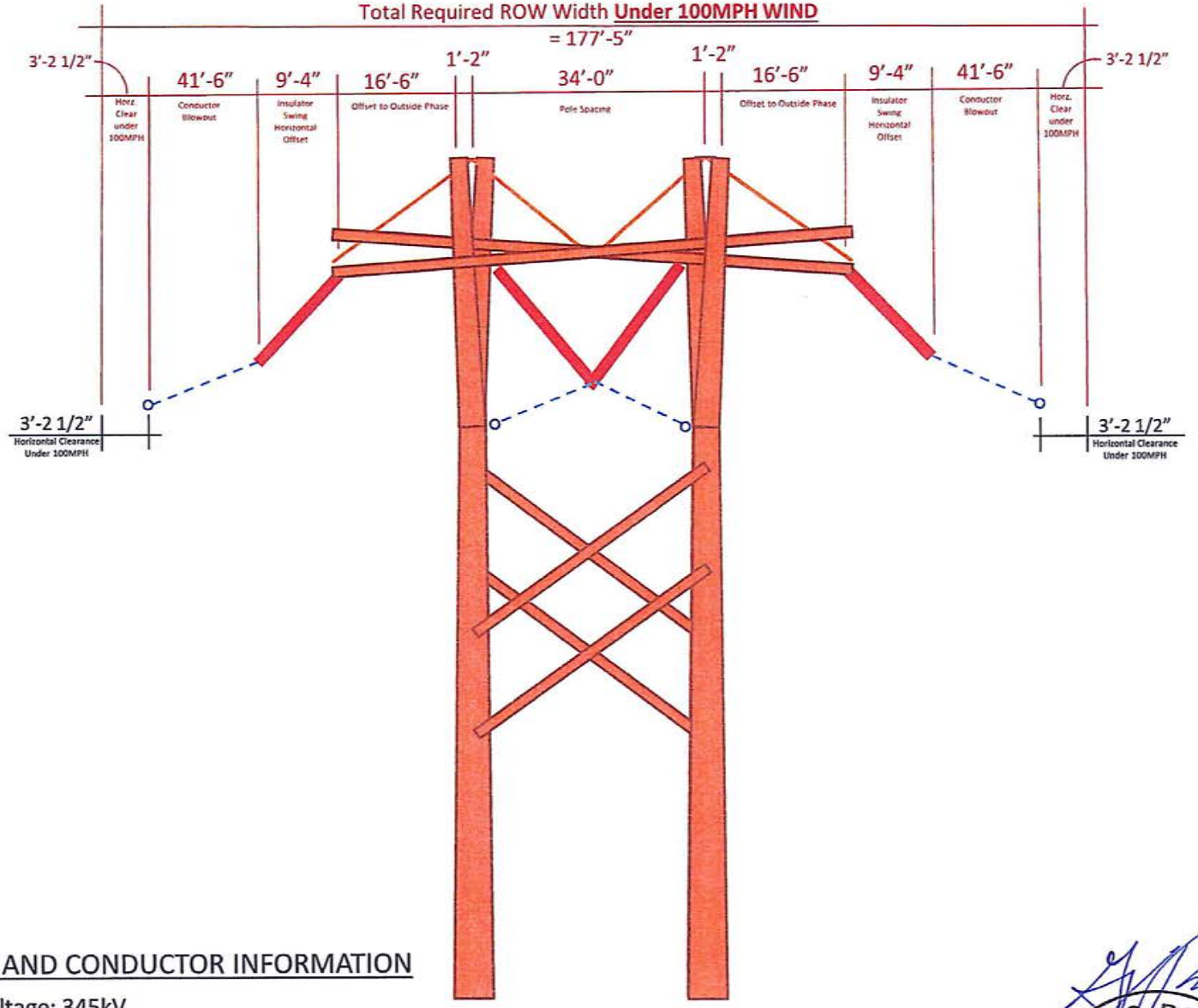

SCALE: NTS

STRUCTURE AND CONDUCTOR INFORMATION

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NESC Rule Analyzed: 250C
Weather Condition Displayed = 100 MPH @ 60 deg F
Pole Deflections, Insulator Swings and Conductor Blowouts calculated from analysis of pole models in PLS-CADD.

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CORONA WIND PROJECT

LINCOLN AND TORRANCE COUNTIES, NEW MEXICO

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ROW WIDTH EXHIBITS
SC WOOD H-FRAME

REVISION:
B

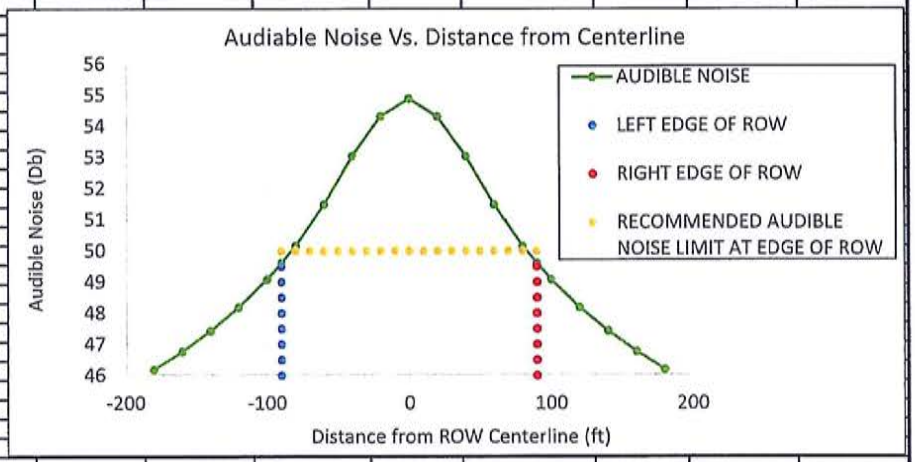
COR-TLO-E-ROW-012

Audiable Noise Calculation
Project Name: Corona Wind Project
Engineer: Greg Parent

Bundle	x-feet	y-feet	n cond	cond dia	spacing	l-n voltage	phase	Kv/cm
1	27	32	2	1.196	18	205	0	15.1994
2	0	32	2	1.196	18	205	120	16.3518
3	-27	32	2	1.196	18	205	240	15.2031
4	13.5	50.5	1	0.6		0	0	4.1242
5	-13.7	50.5	1	0.6		0	0	4.1462
6								0.0000
7								0.0000
8								0.0000
NPH=	5.00	Calculated	Altitude ft=	7100				
(Inverse	8343.59	Dummy Output)	**Note: Use "Paste Special" and "values" to copy data**					
Dist		L50 rain						

Away from Center Line (ft)	Vert	Decibles at distance away from centerline [db]	
-300	5	43.66	O.K.
-280	5	44.00	O.K.
-260	5	44.37	O.K.
-240	5	44.76	O.K.
-220	5	45.19	O.K.
-200	5	45.66	O.K.
-180	5	46.18	O.K.
-160	5	46.77	O.K.
-140	5	47.43	O.K.
-120	5	48.18	O.K.
-100	5	49.08	O.K.
-90	6	49.61	O.K.
-80	5	50.16	N.G.
-60	5	51.49	N.G.
-40	5	53.04	N.G.
-20	5	54.31	N.G.
0	5	54.88	N.G.
20	5	54.31	N.G.
40	5	53.04	N.G.
60	5	51.48	N.G.
80	5	50.15	N.G.
90	6	49.61	O.K.
100	5	49.08	O.K.
120	5	48.18	O.K.
140	5	47.42	O.K.
160	5	46.77	O.K.
180	5	46.18	O.K.
200	5	45.66	O.K.
220	5	45.19	O.K.
240	5	44.76	O.K.
260	5	44.37	O.K.
280	5	44.00	O.K.
300	5	43.66	O.K.
Max Decibles =		54.88	

Goal: output in C column < 50 DB



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The table below is a screen shot of a report from PLS CADD which shows the structure deflections for each load case. The controlling case is highlighted below:

Summary of Tip Deflections For All Load Cases:

Note: positive tip load results in positive deflection

Load Case	Joint Label	Long. Defl. (in)	Tran. Defl. (in)	Vert. Defl. (in)	Resultant Defl. (in)	Long. Rot. (deg)	Tran. Rot. (deg)	Twist (deg)
NESC 250C EXTREME WIND, NA+,I NA+	L:t	0.25	14.07	-0.12	14.07	0.01	0.21	0.00
NESC 250C EXTREME WIND, NA+,I NA+	R:t	0.24	14.05	-0.24	14.05	0.01	0.33	0.00
NESC 250C EXTREME WIND, NA-,I NA-	L:t	0.24	-14.05	-0.24	14.05	0.01	-0.33	-0.00
NESC 250C EXTREME WIND, NA-,I NA-	R:t	0.25	-14.07	-0.12	14.07	0.01	-0.21	-0.00
NESC 250D ICE W/ WIND, NA+,I NA+	L:t	0.25	3.58	-0.03	3.59	0.01	-0.01	0.00
NESC 250D ICE W/ WIND, NA+,I NA+	R:t	0.24	3.56	-0.06	3.57	0.01	0.14	0.00
NESC 250D ICE W/ WIND, NA-,I NA-	L:t	0.24	-3.56	-0.06	3.57	0.01	-0.14	-0.00
NESC 250D ICE W/ WIND, NA-,I NA-	R:t	0.25	-3.58	-0.03	3.59	0.01	0.01	-0.00
HEAVY ICE,I NA+	L:t	0.48	0.03	-0.06	0.49	0.03	-0.18	0.00
HEAVY ICE,I NA+	R:t	0.48	-0.01	-0.06	0.49	0.03	0.18	-0.00
UPLIFT,I NA+	L:t	0.34	0.02	-0.03	0.34	0.02	-0.05	0.00
UPLIFT,I NA+	R:t	0.34	0.01	-0.03	0.34	0.02	0.05	-0.00
NESC RULE 261A (wind towards 181),I Max	L:t	-56.00	0.08	-1.39	56.02	-2.33	-0.02	-0.01
NESC RULE 261A (wind towards 181),I Max	R:t	-56.00	0.06	-1.39	56.02	-2.33	0.03	0.01
DEFLECTION, NA+,I NA+	L:t	0.23	3.51	-0.02	3.52	0.01	0.02	0.00
DEFLECTION, NA+,I NA+	R:t	0.23	3.50	-0.05	3.51	0.01	0.12	0.00
DEFLECTION, NA-,I NA-	L:t	0.23	-3.50	-0.05	3.51	0.01	-0.12	-0.00
DEFLECTION, NA-,I NA-	R:t	0.23	-3.51	-0.02	3.52	0.01	-0.02	-0.00
NO WIND, DEFLECTION,I NA+	L:t	0.34	0.02	-0.03	0.34	0.02	-0.05	0.00
NO WIND, DEFLECTION,I NA+	R:t	0.34	0.01	-0.03	0.34	0.02	0.05	-0.00
HEAVY ICE (NO OLF),I NA+	L:t	0.45	0.03	-0.06	0.46	0.03	-0.16	0.00
HEAVY ICE (NO OLF),I NA+	R:t	0.45	-0.01	-0.06	0.46	0.03	0.16	-0.00
NESC 250B HEAVY W/K, NA+,I NA+	L:t	0.31	10.55	-0.10	10.56	0.02	0.06	0.00
NESC 250B HEAVY W/K, NA+,I NA+	R:t	0.30	10.51	-0.19	10.52	0.02	0.34	0.00
NESC 250B HEAVY W/K, NA-,I NA-	L:t	0.30	-10.51	-0.19	10.52	0.02	-0.34	-0.00
NESC 250B HEAVY W/K, NA-,I NA-	R:t	0.31	-10.55	-0.10	10.56	0.02	-0.06	-0.00
NESC RULE 277 INSULATORS, NA+,I NA+	L:t	0.24	3.25	-0.02	3.26	0.01	-0.01	0.00
NESC RULE 277 INSULATORS, NA+,I NA+	R:t	0.24	3.23	-0.05	3.24	0.01	0.13	0.00
NESC RULE 277 INSULATORS, NA-,I NA-	L:t	0.24	-3.23	-0.05	3.24	0.01	-0.13	-0.00
NESC RULE 277 INSULATORS, NA-,I NA-	R:t	0.24	-3.25	-0.02	3.26	0.01	0.01	-0.00
NESC RULE 277 INSULATORS, NA+,I NA+ 1	L:t	0.24	12.69	-0.10	12.69	0.01	0.19	0.00
NESC RULE 277 INSULATORS, NA+,I NA+ 1	R:t	0.23	12.67	-0.20	12.68	0.01	0.30	0.00
NESC RULE 277 INSULATORS, NA-,I NA- 1	L:t	0.23	-12.67	-0.20	12.68	0.01	-0.30	-0.00
NESC RULE 277 INSULATORS, NA-,I NA- 1	R:t	0.24	-12.69	-0.10	12.69	0.01	-0.19	-0.00
NESC RULE 277 INSULATORS, NA+,I NA+ 2	L:t	0.24	3.25	-0.02	3.26	0.01	-0.01	0.00
NESC RULE 277 INSULATORS, NA+,I NA+ 2	R:t	0.24	3.23	-0.05	3.24	0.01	0.13	0.00
NESC RULE 277 INSULATORS, NA-,I NA- 2	L:t	0.24	-3.23	-0.05	3.24	0.01	-0.13	-0.00
NESC RULE 277 INSULATORS, NA-,I NA- 2	R:t	0.24	-3.25	-0.02	3.26	0.01	0.01	-0.00
NESC 250B HEAVY NO OLF W/K, NA+,I NA+	L:t	0.26	4.16	-0.03	4.17	0.01	-0.01	0.00
NESC 250B HEAVY NO OLF W/K, NA+,I NA+	R:t	0.25	4.14	-0.07	4.15	0.01	0.17	0.00
NESC 250B HEAVY NO OLF W/K, NA-,I NA-	L:t	0.25	-4.14	-0.07	4.15	0.01	-0.17	-0.00
NESC 250B HEAVY NO OLF W/K, NA-,I NA-	R:t	0.26	-4.16	-0.03	4.17	0.01	0.01	-0.00

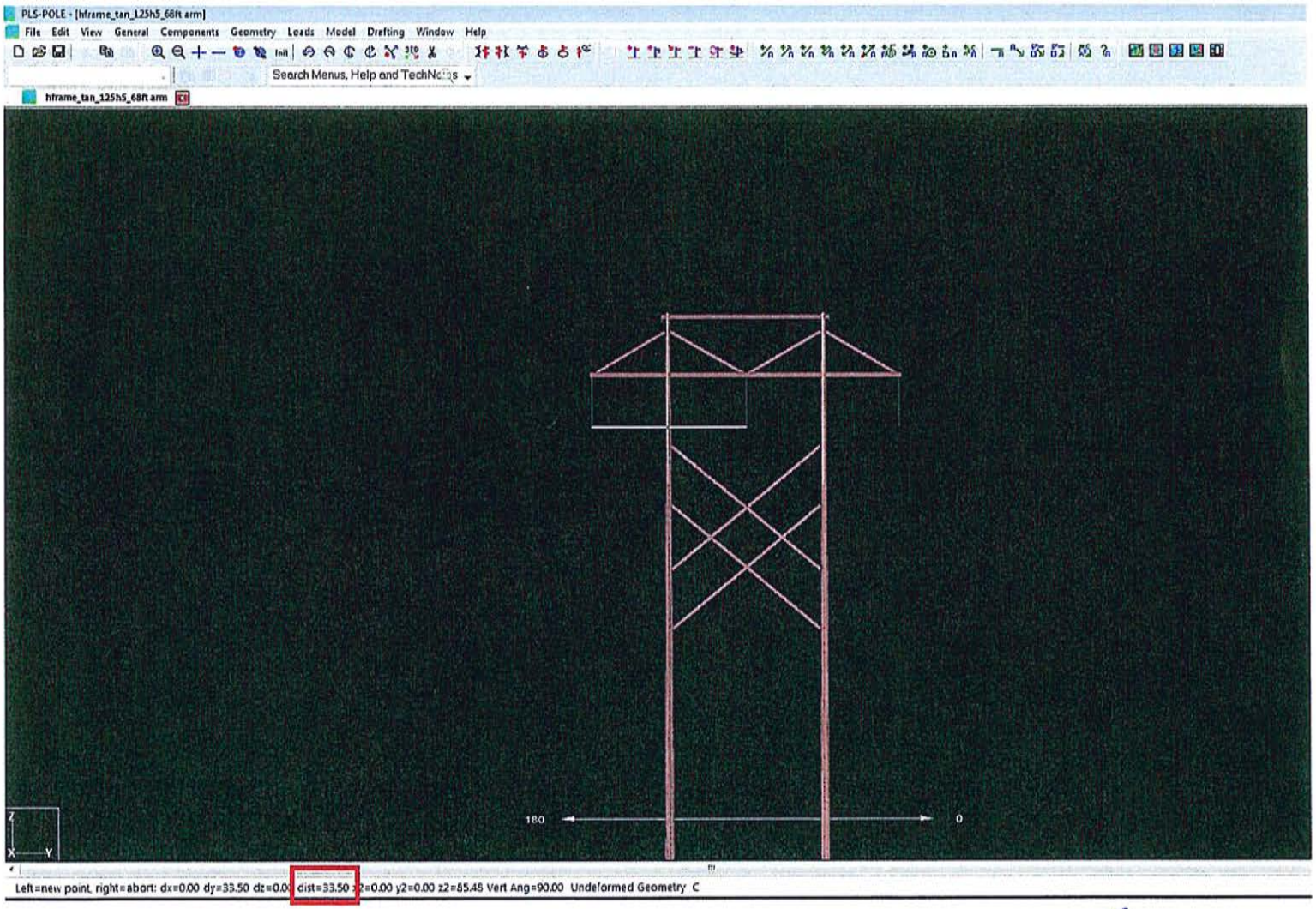


The image below is a screen shot of the cross sectional view of the structure. The insulator swing shown is at the 100 MPH Wind load case. The horizontal distance of the insulator swing (9.43 ft) is shown in the red box in the image:





The image below shows the measurement of the outer phase attachment point to the center of the structure (33.5 ft):



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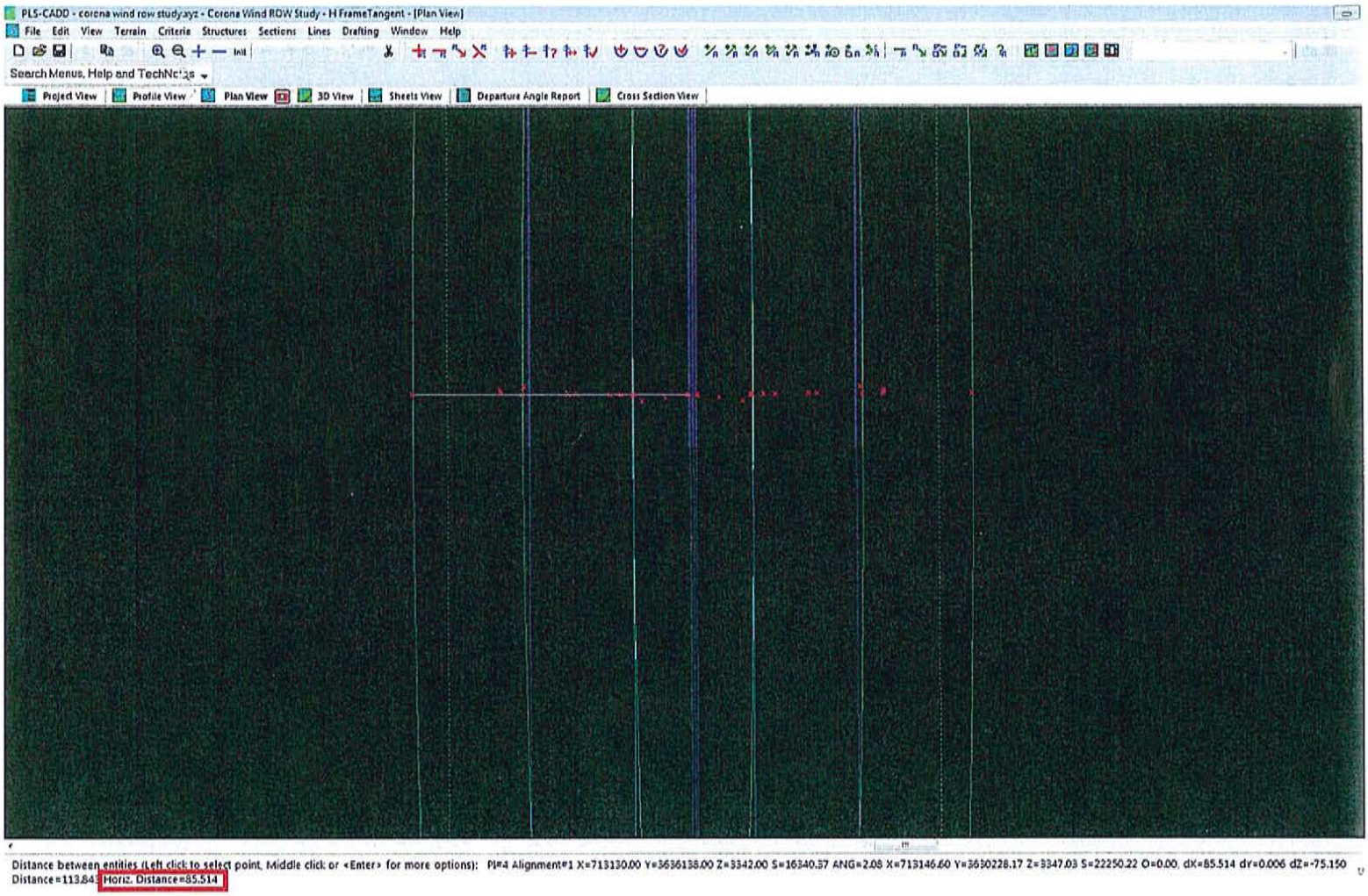
The image below shows the measurement of the total conductor blowout from the center line of the alignment. The distance shown below includes insulator swing, structure deflection and the offset of the outer phase from the center.



The conductor blowout can be calculated by subtracting the structure deflection, horizontal insulator swing length, and attachment point offset from the total blowout value shown above.

(B_C) = Conductor Blowout (ft)
(D_S) = Structure Deflection (ft)
(D_I) = Insulator Swing Horizontal Distance (ft)
(D_O) = Outer Phase Attachment Offset From Structure Center (ft)
(B_T) = Total Blowout

$B_C = B_T - D_S - D_I - D_O$
$= 85.5 \text{ ft} - 1.17 \text{ ft} - 9.34 \text{ ft} - 33.5 \text{ ft}$
$= 41.49 \text{ ft}$

GREG C. PARENT
NEW MEXICO
24890
12-18-19
PROFESSIONAL ENGINEER

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
ANCHO WIND LLC, COWBOY MESA LLC, DURAN MESA LLC, RED CLOUD WIND LLC, TECOLOTE WIND LLC, VIENTO LOCO LLC,	)	
JOINT APPLICANTS.	)	

AFFIDAVIT OF GREG PARENT

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
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JOINT APPLICANTS.	)	

AFFIDAVIT OF GREG PARENT

STATE OF COLORADO)
) ss.
COUNTY OF Arapahoe)

I have read the foregoing Direct Testimony, and it is true and accurate based on my own knowledge and belief.

SUBSCRIBED and sworn to before me this 19 day of December 2019.

Jennifer Sievert
NOTARY PUBLIC

December 14, 2022
My Commission Expires

JENNIFER SIEVERT
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20144047228
MY COMMISSION EXPIRES 12/14/22

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE CORONA WIND COMPANIES' JOINT APPLICATION FOR THE LOCATION OF THE CORONA WIND PROJECTS AND THE CORONA GEN-TIE SYSTEM IN LINCOLN, TORRANCE AND GUADALUPE COUNTIES PURSUANT TO THE PUBLIC UTILITY ACT, NMSA 1978, §62-9-3	)	**Case No. 18-00065-UT**
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JOINT APPLICANTS.	)	

FILED IN OFFICE OF
DEC 20 2019
NM PUBLIC REGULATION COMM
RECORDS MANAGEMENT BUREAU

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that true and correct copies of the ***Motion to Reopen*** and the ***Amended Joint Application for Location Site Approval df The Expansion of The Corona Wind Projects, Reconfiguration of the Proposed Corona Gen-Tie System, Extension of The Corona Gen-Tie System and Request for Right Of Way Determination*** were sent on this 20th day of December 2019 to following:

Via Email:

Brad Borman	Brad.Borman@state.nm.us;
Milo Chavez	milo.chavez@state.nm.us;
Jack Sidler	Jack.sidler@state.nm.us;
John Reynolds	john.reynolds@state.nm.us;
John Bogatko	John.bogatko@state.nm.us;
Dhiraj Solomon	Dhiraj.solomon@state.nm.us;
Michael C. Smith	Michaelc.smith@state.nm.us;
Gideon Elliot	gelliot@nmag.gov;
Ward Marshall	ward.marshall@patternenergy.com
Adam Cernea Clark	adam.cerneaclark@patternenergy.com;
Crystal Coffman	crystal.coffman@patternenergy.com

Via Hand Delivery:

New Mexico State Engineer
407 Galisteo St. #101
Santa Fe, NM 87501

New Mexico Attorney General
Gideon Elliot, Esq.
408 Galisteo St.
Santa Fe, NM 87501

New Mexico Environment Department
Harold Runnels Building
1190 St. Frances Dr. Suite N4050
Santa Fe, NM 87505

John Bogatko
NMPRC
1120 Paseo de Peralta
Santa Fe, New Mexico 87504

Dhiraj Solomon
NMPRC
1120 Paseo de Peralta
Santa Fe, New Mexico 87504

Via US Mail

Town of Carrizozo
c/o Leann Weibrecht - Clerk-Treasurer
400 9th St.
P.O. Box 247
Carrizozo, NM 88301-0247

City of Santa Rosa
c/o Yolanda M. Garcia - City Clerk
244 S 4th St
Santa Rosa, NM 88435-2323

Town of Estancia, Public Library
c/o Angela Creamer - Head Librarian
601 South Tenth Street
PO Box 166 Estancia, NM 87016

Lincoln County
c/o Nita Taylor, County Manager
300 Central Avenue
Carrizozo, NM 88301

Guadalupe County
c/o George Dodge, Jr., County Manager
130 S. 4th Street
Santa Rosa, NM 88435

Village of Corona
c/o Terri Racher - Village Clerk-Treasurer
461 Corona Main St.
P.O. Box 37
Corona, NM 88318-0037

City of Ruidoso Downs
c/o Carol Virden -Clerk-Treasurer
123 Downs Drive
P.O. Box 348
Ruidoso Downs, NM 88346

City of Moriarty

Town of Estancia
c/o Michelle Jones – Clerk
513 Williams Ave
P.O. Box 166
Estancia, NM 87016-0166

Town of Carrizozo, Public Library
c/o Head Librarian
406 Central Avenue (Hwy 54)
Carrizozo, NM 88301

Moise Memorial Library
c/o Mary Martinez - Library Director
208 S. 5th St.
Santa Rosa, NM 88435

Torrance County
c/o Belinda Garland, County Manager
205 9th Street
Estancia, NM 87016

Village of Capitan
c/o Laura NcInnes - Clerk-Treasurer
114 Lincoln Ave.
P.O. Box 1380,
Capitan, NM 88316

Village of Ruidoso
c/o Irma Devine - Village Clerk
313 Cree Meadows Dr.
Ruidoso, NM 88345

Village of Encino
c/o Loretta Chavez - Clerk-Treasurer
427A N Main
P.O. Box 163
Encino, NM 88321-0163

Town of Mountainair

c/o Sheila Larranaga-Murphy - Clerk
201 Broadway Street
P.O. Box 130
Moriarty, NM 87035

Village of Willard
c/o Angela Halbert – Clerk/Treasurer
720 N Dunlavy St
PO Box 204
Willard, NM 87063

c/o Dennis Fulfer - Town Clerk
105 E Broadway
PO Box 115
Mountainair, New Mexico 87036

Town of Vaughn
c/o Fronia Jaramillo – Clerk
322 8th St
P.O. Box 278
Vaughn, NM 88353-0278

Sincerely,

VIRTUE & NAJJAR, PC

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Jared D. Najjar
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