

Applicant: SCI Engineering, Inc.
Contact: Kamren Metzger
Address: 650 Pierce Boulevard
O'Fallon, IL 62269

IDNR Project Number: 1811612
Date: 06/04/2018

Project: Monroe County Wind Farm
Address: Maeystown Road, Fults

Description: The project will consist of the development of an approximately 15,000-acre wind farm located between Valmeyer and Fults in Monroe County, Illinois.

Natural Resource Review Results

Consultation for Endangered Species Protection and Natural Areas Preservation (Part 1075)

The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

- Armin Krueger Speleological Area Class III Groundwater Site
- Fogelpole Cave Class III Groundwater Site
- Pautler Class III Groundwater Site
- Columbia Hill Prairie INAI Site
- Frog Karst System INAI Site
- Fults Hill Prairie - Kidd Lake Marsh INAI Site
- Horse Creek Glade INAI Site
- Madonnaville Cave INAI Site
- Monroe City Hill Prairie INAI Site
- Pautler - Annbriar Karst System INAI Site
- Potato Hill Natural Area INAI Site
- Renault Cave System INAI Site
- Renault Geological Area INAI Site
- Renault Herpetological Area INAI Site
- Renault Karst Area INAI Site
- Storment Hauss Woods INAI Site
- Angela's Prairie Land And Water Reserve
- Angela's Prairie Natural Heritage Landmark
- Brickey-Gonterman At Renault Bluffs Land And Water Reserve
- Fogelpole Cave Nature Preserve
- Fults Hill Prairie Nature Preserve
- Harry's Prairie Natural Heritage Landmark
- Horse Creek Glade Natural Heritage Landmark
- Illinois Ozarks Nature Preserve
- Luella Schaefer Memorial Hill Praries Land And Water Reserve
- Martha And Michelle Prairies Land And Water Reserve
- Paul Wightman Subterranean Nature Preserve
- Potato Hill Natural Heritage Landmark
- Salt Lick Point Land And Water Reserve
- Storment Hauss Nature Preserve
- White Rock Land And Water Reserve

White Rock Nature Preserve

Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Aquatic Cave Community (*Aquatic cave community*)
Bald Eagle (*Haliaeetus leucocephalus*)
Bald Eagle (*Haliaeetus leucocephalus*)
Bald Eagle (*Haliaeetus leucocephalus*)
Bald Eagle (*Haliaeetus leucocephalus*)
Bald Eagle (*Haliaeetus leucocephalus*)
Black-Billed Cuckoo (*Coccyzus erythrophthalmus*)
Cerulean Warbler (*Dendroica cerulea*)
Coachwhip (*Masticophis flagellum*)
Common Striped Scorpion (*Centruroides vittatus*)
Dwarf Bedstraw (*Galium virgatum*)
Eastern Narrowmouth Toad (*Gastrophryne carolinensis*)
Eastern Narrowmouth Toad (*Gastrophryne carolinensis*)
Flathead Snake (*Tantilla gracilis*)
Flathead Snake (*Tantilla gracilis*)
Gray Bat (*Myotis grisescens*)
Great Plains Rat Snake (*Elaphe emoryi*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Illinois Cave Amphipod (*Gammarus acherondytes*)
Indiana Bat (*Myotis sodalis*)
Indiana Bat (*Myotis sodalis*)
Indiana Bat (*Myotis sodalis*)
Madonna Cave Springtail (*Pygmarrhopalites madonnensis*)
Missouri Orange Coneflower (*Rudbeckia missouriensis*)
Northern Long-Eared Myotis (*Myotis septentrionalis*)
Northern Long-Eared Myotis (*Myotis septentrionalis*)
Northern Long-Eared Myotis (*Myotis septentrionalis*)
Terrestrial Cave Community (*Terrestrial cave community*)
Terrestrial Cave Community (*Terrestrial cave community*)
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Terrestrial Cave Community (*Terrestrial cave community*)
Terrestrial Cave Community (*Terrestrial cave community*)
Terrestrial Cave Community (*Terrestrial cave community*)
Timber Rattlesnake (*Crotalus horridus*)
Woolly Buckthorn (*Bumelia lanuginosa*)

An IDNR staff member will evaluate this information and contact you to request additional information or to terminate consultation if adverse effects are unlikely.

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Monroe

Township, Range, Section:

- 3S, 10W, 4
- 3S, 10W, 5
- 3S, 10W, 6
- 3S, 10W, 7
- 3S, 10W, 8
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- 3S, 10W, 35
- 3S, 10W, 36
- 3S, 11W, 1
- 3S, 11W, 2
- 3S, 11W, 3
- 3S, 11W, 10
- 3S, 11W, 11
- 3S, 11W, 12
- 3S, 11W, 13
- 3S, 11W, 14
- 3S, 11W, 24
- 3S, 9W, 31
- 4S, 10W, 1
- 4S, 10W, 2
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4S, 9W, 32
4S, 9W, 33

IL Department of Natural Resources

Contact

Keith Shank
217-785-5500
Division of Ecosystems & Environment

Government Jurisdiction

Monroe County
Mike Fausz
100 South Main Street
Waterloo, Illinois 62298

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

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EcoCAT Receipt	Project Code 1811612
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APPLICANT	DATE
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SCI Engineering, Inc.
Scott Billings
650 Pierce Boulevard
O Fallon, IL 62269

6/4/2018

DESCRIPTION	FEE	CONVENIENCE FEE	TOTAL PAID
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EcoCAT Consultation	\$ 125.00	\$ 2.94	\$ 127.94
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TOTAL PAID \$ 127.94

Illinois Department of Natural Resources
One Natural Resources Way
Springfield, IL 62702
217-785-5500
dnr.ecocat@illinois.gov



Illinois Department of Natural Resources

One Natural Resources Way Springfield, Illinois 62702-1271
www.dnr.illinois.gov

Bruce Rauner, Governor
Wayne A. Rosenthal, Director

October 4, 2018

Mr. Mike Fausz, Zoning Administrator
Monroe County Zoning Department
100 South Main Street
Waterloo, IL 62298

**RE: Monroe County Wind Farm, Monroe County
Endangered Species Consultation Program
Natural Heritage Database EcoCAT Review #1811612**

Dear Mr. Fausz:

This letter addresses consultation on this proposed action, a large wind energy generation facility, pursuant to the requirements of the *Illinois Endangered Species Protection Act* [520 ILCS 10/11], the *Illinois Natural Areas Preservation Act* [525 ILCS 30/17], and Title 17 *Illinois Administrative Code* Part 1075. Additionally, the Department may offer advice and recommendations for species covered under the *Fish & Aquatic Life Code* [515 ILCS 5, *et seq.*]; the *Illinois Wildlife Code* [520 ILCS 5, *et seq.*]; and the *Herptiles-Herps Act* [510 ILCS 69].

The proposed action is a 200-MW wind energy generation facility across approximately 15,000 acres of western Monroe County, stretching from Valmeyer to Fults. The developer is considering the deployment of wind turbines, each having a generation capacity of 4.2-MW, which will be the largest turbines deployed in the State of Illinois. An earlier proposal for this site covered less area and would have deployed smaller but more numerous turbines. The earlier proposal entailed consultation pertaining to 42 natural resources; the current expanded proposal potentially affects 79 natural resources, some of which are also accorded federal protection.¹

¹ Four animals in this vicinity are listed as endangered or threatened under the federal *Endangered Species Act*: the Gray Bat, the Indiana Bat; the Northern Long-Eared Bat, and the Illinois Cave Amphipod. Two others, the Bald Eagle and the Golden Eagle, are protected pursuant to the federal *Bald and Golden Eagle Protection Act*.

The Department's role in the consultation process is to address potential *adverse* effects to Natural Areas and State-listed endangered species,² and to fish and wildlife habitat more generally. This review is not an Environmental Assessment (EA) or Environmental Impact Statement (EIS), such as those produced for compliance with the *National Environmental Policy Act* (NEPA), a federal statute which applies only to actions undertaken, authorized, or funded by the federal government. NEPA analysis is more comprehensive in scope. The Department does not consider and does not state any opinions related to other issues commonly considered in zoning proceedings.

The products of this review are advisory recommendations which the County has the discretion to adopt, modify, or reject in accordance with its powers. The only exception is when the action would be certain to take³ endangered or threatened animals. In that case, before the County may authorize the project, the applicant must demonstrate it has received an Incidental Take Authorization⁴ from the Department of Natural Resources for that species.

The statutes cited above require Monroe County to evaluate whether the action it may authorize might adversely affect or modify these natural resources. The *Illinois Natural Areas Preservation Act* requires the Department to recommend measures to avoid, minimize, or mitigate for adverse effects and adverse modifications, and requires Monroe County to attempt to avoid or mitigate for adverse effects, consistent with the proposed action.⁵ No recommendations made by the Department herein should be construed to imply the Department's approval, endorsement, or authorization of the proposed action.

The Department offers the following recommendations:

Recommendation #1: The Department recommends the County consider an alternate location for this proposed action which will avoid construction over karst geology. Many of the potential adverse effects of this proposal are related to the character of the underlying ground.

Recommendation #2: The Department recommends the County consider prohibiting the use of geophysical exploration methods likely to damage or penetrate subterranean voids. Because local cave systems are numerous and extensive, many standard geophysical exploration methods,

² This is the expressly stated intent of the statutes requiring consultation. While proposed actions may offer many benefits unrelated to natural resources, these lie outside the scope of the consultation process.

³ "Take" means, in reference to animals and animal products, to harm, hunt, shoot, pursue, lure, wound, kill, destroy, harass, gig, spear, ensnare, trap, capture, collect, or to attempt to engage in such conduct. "Take" means, in reference to plants and plant products, to collect, pick, cut, dig up, kill, destroy, bury, crush, or harm in any manner. 520 ILCS 10/2.

⁴ Pursuant to the *Illinois Endangered Species Protection Act*, the Department may authorize taking that is otherwise prohibited which occurs due to a lawful activity, provided the taking will not jeopardize the survival or recovery of the species within the State of Illinois. 520 ILCS 10/5.5. See also 520 ILCS 10/11(b).

⁵ 525 ILCS 30/17

especially test drilling, may result in adverse modification of distant Nature Preserves and the incidental taking of endangered or threatened cave-dwelling animals.

Recommendation #3: The Department recommends the County consider prohibiting the siting of any wind turbine within one mile of any Nature Preserve or Land & Water Reserve. The Department recognizes such a prohibition, given the number of such areas and their distribution around the perimeter of the requested area, will place much of the proposed project area off-limits. This recommendation is consistent with the Department's recommendations for all other wind farms in Illinois, although the Department believes this distance may be inadequate to protect these areas from the adverse effects of turbines of the size contemplated for this proposal. The Department has no experience with such large turbines, which have been deployed nowhere else in Illinois.

Recommendation #4: The Department recommends the County consider prohibiting the siting of any wind turbine within one mile of any State Park. Any lands owned by the Department of Natural Resources are State Parks by virtue of such ownership. All such lands near the proposed action contain Illinois Natural Areas Inventory (INAI) Sites eligible for dedication as Nature Preserves and warrant similar levels of protection. The Department believes this distance may be inadequate to protect these areas from the adverse effects of turbines of the size contemplated for this proposal.

Recommendation #5: The Department recommends the County consider prohibiting the siting of any wind turbine within one-half mile of any INAI Site. In making this recommendation, the Department is being consistent with its recommendations for all other wind farms in Illinois, although the Department believes this distance is inadequate to protect these areas from the adverse effects of wind turbines. The Department recognizes imposing recommendations #2, #3, #4, and #5 will severely constrain the area available for wind turbine deployment, but this reflects the abundance and distribution of important natural resources in this vicinity.

Recommendation #6: If the County does not adopt Recommendation #5, the Department recommends the County consider prohibiting the siting of any wind turbine within a Class III Ground Water currently designated by the Illinois Environmental Protection Agency.⁶ This restriction may be inadequate to protect the quality and quantity of ground water within those boundaries; some effects of wind turbine operations, with uncertain consequences, will still be experienced within those boundaries if no turbines are built within them.

Recommendation #7: The Department recommends the County consider a requirement for the applicant to document baseline seismic conditions in each cave system comprising a portion of a

⁶ All currently-designated Class III ground waters in this area lie within INAI Sites; adoption of Recommendation #5 would render Recommendation #6 unnecessary.

*Nature Preserve, INAI Site, or State Park for a period of a full year prior to commencing construction.*⁷ The objective of such monitoring would be to identify the source and magnitude of vibrations currently experienced by these systems, such as highways, farming equipment, mining, *etc.*, to enable them to be later distinguished from wind turbine vibrations.

Recommendation #8: The Department recommends the County consider a requirement for the applicant to document seismic conditions in each cave system comprising a portion of a Nature Preserve, INAI Site, or State Park for a period of a two years after commencing commercial operations. The objective of such monitoring would be to identify the bearings and magnitudes of vibrations emanating from wind turbines of the project and correlating them with wind speeds. Such monitoring should include the movements of cave structures (speleothems) and any damage apparently related to such vibrations.

*Recommendation #9: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the United States Fish & Wildlife Service an Incidental Take Permit, pursuant to Section 10 of the Endangered Species Act, for the **Illinois Cave Amphipod** prior to the commencement of construction.* It is the Department's opinion the applicant cannot avoid the taking of this species during construction and operation of the proposed action.

*Recommendation #10: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the Illinois Department of Natural Resources an Incidental Take Authorization, pursuant to Section 5.5 of the Illinois Endangered Species Protection Act, for the **Illinois Cave Amphipod** prior to the commencement of construction.* It is the Department's opinion the applicant cannot avoid the taking of this species during construction and operation of the proposed action.⁸

*Recommendation #11: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the United States Fish & Wildlife Service and from the Illinois Department of Natural Resources the required federal and state permits for the Incidental Taking of the **Gray Bat**, the **Indiana Bat**, and the **Northern Long-Eared Bat**.* Curtailment and other minimization measures cannot guarantee that listed bats, which are present year-round at this location, will not be taken.

⁷ Any form of scientific research conducted within a Nature Preserve or Land & Water Reserve requires a permit from the Illinois Nature Preserves Commission, the Department of Natural Resources, and the owner of the Preserve/Reserve in accordance with Title 17 Part 4015; similarly, scientific research activities in a State Park requires a permit from the Department of natural Resources pursuant to Title 17 Part 110

⁸ USFWS and IDNR both exercise jurisdiction over the taking of federally-listed animals which occur in Illinois, although under different laws applying different criteria; a permit from both agencies is necessary to lawfully take such an animal.

*Recommendation #12: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the Illinois Department of Natural Resources an Incidental Take Authorization, pursuant to Section 5.5 of the Illinois Endangered Species Protection Act, for the **Black-Billed Cuckoo**.⁹ This species has a demonstrated vulnerability to turbine blade collision and mortality and is known to breed in the near vicinity. No effective avoidance measures are known.*

*Recommendation #13: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the Illinois Department of Natural Resources an Incidental Take Authorization, pursuant to Section 5.5 of the Illinois Endangered Species Protection Act, for the **Madonna Cave Springtail**. No effective avoidance measures are known.*

*Recommendation #14: The Department recommends the County consider imposing a requirement for the applicant to seek and obtain from the Illinois Department of Natural Resources an Incidental Take Authorization, pursuant to Section 5.5 of the Illinois Endangered Species Protection Act, for the **Coachwhip, Great Plains Ratsnake, Flathead Snake, Timber Rattlesnake, Eastern Narrowmouth Toad, and the Common Striped Scorpion**. Each of these species is likely to be harassed, a form of prohibited taking, by turbine operations, and will have varying degrees of vulnerability to death or injury during construction.*

*Recommendation #15: The Department recommends the County consider requiring the applicant to document to the County its contacts with the U.S. Fish & Wildlife Service pertaining to potential adverse effects to **Bald Eagles**. The summer and winter populations of Bald Eagles within ten miles of the proposed action are significant. The protection of Bald Eagles is a federal responsibility.*

*Recommendation #16: The Department recommends the County consider imposing a requirement for the applicant to curtail turbine operations below wind speeds of 5.0 meters per second between sunset and sunrise during the entire year whenever air temperatures rise above 50 °F to conserve endangered, threatened, and non-listed bats. This measure is usually recommended during only the fall migration period, but the presence of hibernation sites within and adjacent the proposed action, and the low reach of the rotor arc support the protection of *Myotis* species whenever they are active outside the caves. Given the variability of temperatures at this latitude in the winter, a year-round requirement is appropriate. This measure will also reduce the mortality of non-listed bats by fifty percent or more and benefit nocturnal wildlife.*

Recommendation #17: The Department recommends the County consider imposing a requirement for the applicant to immobilize (feather) turbine rotors, regardless of wind speeds, for two hours after sunset and two hours prior to sunrise from April 15 to May 21 and again

⁹ The requirements of Section 5.5 are set forth in Title 17 Part 1080.

from September 1 to October 15, the peaks of spring and fall avian migrations, to reduce mortality among migratory birds. This measure will reduce mortality risk to night-flying migratory birds and benefit nocturnal wildlife.

Recommendation #18: The Department recommends the County consider imposing a requirement the applicant conduct three years of mortality monitoring to statistically quantify bird and bat mortality, by species, due to turbine operations, using methods approved by the Department.¹⁰ If the County cannot do so, or chooses not to do so, the applicant should consider implementing such a program to document the level of mortality experienced and the species affected.

Recommendation #19: The Department recommends the County consider imposing a requirement the applicant report to the County and to the Department of Natural Resources the discovery of any “mass mortality” event consisting of ten or more animal carcasses beneath a turbine within 24 hours. This measure will allow the County and/or the Department to investigate the potential causes of such an event.

The Department offers the following support for these recommendations.

Turbine Deployment Above and Adjacent Karst Geologic Formations.

The proposed wind farm will not be the first wind energy facility in North America deployed on a karst¹¹ landscape: wind energy facilities have been constructed on karst areas in Texas, New York, Oklahoma, Iowa, and Minnesota, among others.¹² The risks karst geology poses to wind turbines can be overcome by several technological means, but the same cannot be said of the risks wind turbines pose to karst geology, particularly where karst features are of unique importance. Several of the engineering methods employed to overcome karst risk to turbines make no allowance for preserving the physical or ecological integrity of karst features.

- Karst landscapes are known for their risk of sinkhole formation beneath human infrastructure, posing dangers to roads, sewers, water lines, and buildings. Wind turbines pose unusual challenges in such a landscape.

¹⁰ Persons collecting, handling, or disposing of fish & wildlife taken from the wild are required to hold scientific collector permits from the IDNR pursuant to Title 17 Ill. Admin. Code Part 520 and Part 1070.

¹¹ “Karst” is defined as “A terrain, generally underlain by limestone or dolomite, in which the topography is chiefly formed by the dissolving of rock and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves.” Monroe, W.H., 1970, A Glossary of Karst Terminology: U.S. Geological Survey, Water-Supply Paper 1899, 26 p.

¹² Bangsund, William J. and Johnson, Kenneth S.; Evaluating Karst Risk at Proposed Windpower Projects; 13th Sinkhole Conference; National Cave and Karst Research Institute; Carlsbad, New Mexico; 2013; pp.27-36.

- For proper operation, wind turbines must remain vertical, which any land subsidence might alter.
- The wind turbines envisioned for this project are the heaviest in North America; this weight will be concentrated in a relatively small area and will require deeply-excavated foundations which may encounter or enlarge existing voids.
- Wind turbines will generate and transmit vibrations to underground strata, potentially altering subterranean formations and affecting underground water flow and water quality, as well as underground flows of air, which in turn will affect subterranean animals, which in Monroe County include endangered or threatened species. Subterranean animals are likely to be directly affected by such vibrations.

Avoiding geologic hazards is essential to the success of long-term projects such as wind farms. An earlier proposal for a wind farm in another central Illinois county was withdrawn when the developer realized most of the selected area had been undermined for coal in the early Twentieth Century and that mine subsidence in the area was common. The abundance of sinkholes in the Monroe County Sinkhole Plain poses similar issues which render the area challenging for this type of energy development.

Subassemblies of the turbines proposed for installation in Monroe County weigh as much as 70 metric tons (77 tons, U.S. standard), a figure the manufacturer supplies for purposes of seeking road transportation weight limit permits. This likely reflects the weight of the turbine nacelle;¹³ other components will weigh less, but when fully-assembled the entire machine will weigh much more. This does not include the weight of the concrete foundation, which will exceed 400 cubic yards of concrete, the amount required for much smaller machines in non-karst areas. More extensive foundations are recommended in karst terrain, to bridge any possible existing or developing voids. This will increase the weight of the entire installation considerably.

The limestone bedrock in this area is overlain by an average of 10 meters of soil. About half of that soil depth will be removed and replaced by the concrete foundation. The risk to wind turbines of support failure is quite high where soils are thinner than 25 meters above karst formations,¹⁴ as is the case in this region. In some places the overlying soil may be thin enough the turbine foundation will be placed directly on or in the bedrock. Voids which can support the existing weight of rock and soils may collapse under the added weight and motion of an installed wind turbine.

¹³ With respect to wind turbines, the nacelle is the streamlined structure to which the rotor is attached, containing the gearbox, drive-train, and generator, which sits atop the supporting tower.

¹⁴ Bangsund and Johnson, *ibid.*

It will be imperative when siting these machines to place them where no voids exist directly underneath them. Doing so requires extensive geophysical exploration and test drilling to identify the presence of voids. At other wind farms built over karst, voids have been filled with grout to provide support. Neither test drilling nor void-filling are acceptable procedures in this region due to their high adverse impacts to the subterranean environment, including endangered species and Nature Preserves.

Wind turbines are subject to significant horizontal pressures from the wind, even when they are not operating. These pressures, applied from every point of the compass as winds shift, plus the motions of the rotors will transmit vibrations into the soil and bedrock, where they will interact with the vibrations emanating from 49 identical machines.

A paper recently published in Europe reports that the performance of a seismographic array intended to monitor earthquakes has been degraded by wind turbines (considerably smaller than those proposed here) sited within three miles, and its instruments pick up vibrations from turbines sited more than nine miles away. Instruments as deep as 100 meters (over 330 feet) have recorded wind turbine vibrations.¹⁵ Monroe County caves are much closer to the surface.

The authors were primarily concerned with “noise” in frequencies between 1 and 7 Hertz (Hz), the low frequencies where earthquake monitoring is done, and did not discuss vibrations from higher wind speeds. They established a direct correlation between signal strength in this frequency range and wind speeds at the turbines up to 6 meters/second.¹⁶ The turbines proposed for this project will operate at wind speeds between 3 m/s and 23 m/s.

While the authors of that research were not concerned with the effects of wind turbines on the physical integrity of the underlying bedrock, their findings give cause for concern on that score. The proposed turbine array will stretch about 15 miles from end-to-end and nearly five miles at its widest point. Points in the bedrock nine miles or more from the project boundary may receive vibrations from the array, affecting a much larger area than the wind farm itself.

The German scientists also discovered turbine noise at the 1.15 Hz frequency behaved differently than at other frequencies, not dissipating but maintaining its strength over long distances. They attributed this to waves reflecting internally from the top and bottom of the limestone formation.

¹⁵ Stammer and Ceranna; “Influence of Wind Turbines on Seismic Records of the Gräfenberg Array;” Seismological Research Letters; Volume 87, Number 5; September/October 2016; pp. 1075-1081.

¹⁶ Wind speeds higher than 6 m/s produced vibrations at frequencies of no importance to earthquake detection and so were not of interest to their research, but vibrations produced by such wind speeds may be important to the continued stability of subsurface structures.

The behavior and movement of such waves around underground voids and chambers is difficult to predict. While the movement of rock particles will be on the scale of nanometers,¹⁷ wind turbines operate 24 hours a day, 365 days a year, except when there is no wind or during maintenance. It will not be waves from just one machine – waves from 50 machines will be interacting with each other, sometimes cancelling each other (interference), sometimes reinforcing each other (amplification), and the locations where these interactions occur will vary with wind speed, which alters their frequency/wavelength. These vibrations may increase or decrease the movement of water through the limestone matrix; may stir up cave sediments, thus altering subterranean water quality; and may damage delicate speleothems which have grown for thousands of years.¹⁸ They may produce accelerated movement of soil particles, resulting in the opening of new sinkholes, possibly some distance from a wind turbine.

Such potential consequences have important implications for underground stream systems and subterranean wildlife. Every new sinkhole alters the flow of air in cave systems, with important ramifications to temperature and humidity critical to the essential habitats of cave fauna, and every new sinkhole is a potential new source of water pollution, another threat to cave-dwelling species. Available studies of wind turbine underground vibration phenomena have not been concerned with biological or ecological implications.

Subterranean Issues

The cave ecosystems of Southwestern Illinois, denoted as “aquatic cave communities” or “terrestrial cave communities,” provide essential habitat¹⁹ for more than 200 species of animals partly or exclusively adapted to subterranean conditions. All are relatively rare, if not unique to Illinois, and several are listed as endangered or threatened by the federal or State governments.²⁰

The most unique of these is the **Illinois Cave Amphipod**, *Gammarus acherondytes*, a half-inch shrimp-like creature which historically was known from six cave systems within a ten-mile radius of the City of Waterloo, and from nowhere else in the world. However, an intensive survey of 25 local cave systems in 1995 found *G. acherondytes* to be present in only three, a reduction which led directly to its federal listing in 1998 as “endangered.” Subsequent investigations have increased the number of local cave systems in which it is found to ten, although its numbers are low everywhere.

¹⁷ One nanometer equals one-billionth of a meter.

¹⁸ “Speleothem” encompasses underground structures resulting from the deposition of dissolved carbonates over time. Stalagmites and stalactites are well-known types of speleothems, which also include structures such as straws, draperies, columns, and flow walls.

¹⁹ “Essential Habitat” means the specific ecological conditions required by a species for its survival and propagation, or physical examples of these conditions. [520 ILCS 10/2].

²⁰ All federally-listed species occurring in Illinois are automatically State-listed species, as well. The State has listed other species based on its own criteria. See Title 17 Illinois Administrative Code Parts 1010 and 1050. Both USFWS and IDNR exercise jurisdiction over federally-listed species.

The Illinois Cave Amphipod is a “stygobite,” found only in the “dark zone” of cave systems; it is intolerant of light. However, it is not the only amphipod found in cave streams; it must compete with “stygophiles,” other species of amphipods which do equally well on the surface, near cave openings, and in the dark zones. Because *G. acherondytes* is adapted to a low-nutrient environment, it has a lower metabolic rate than stygophilic species. Thus, it can be outcompeted for food resources where stygophiles are abundant. Amphipods are omnivores, feeding on both organic detritus washed into the cave system and smaller invertebrate animals.

Rain water in large quantities can adversely affect populations of the Illinois Cave Amphipod. In karst areas, rain water, which is typically very low in dissolved oxygen, rapidly enters cave streams, sometimes lowering dissolved oxygen levels below those the Amphipod can tolerate, suffocating many. It may require several years for Amphipod numbers to recover after a series of heavy rains. The rainwater has the most severe effect closest to sinkholes and cave entrances. While this is an entirely natural occurrence, it is happening more frequently due to climate change. The creation of more sinkholes through human action will exacerbate the situation by creating additional pathways for rain water intrusions.

Organic debris and detritus is washed into the cave systems by the same mechanism, but high levels of food favor the dominance of competing stygophilic amphipods, greatly increasing their numbers and extending the areas they dominate farther into the cave systems. This is detrimental to the Illinois Cave Amphipod due to its lower initial numbers and its lower metabolism.

Soil erosion into sinkholes also poses threats to the Cave Amphipod. Agricultural pesticides often adhere to soil particles and are carried into cave streams, where concentrations of these toxins can far exceed levels fatal to Illinois Cave Amphipods. Nutrient loading from human septic systems and livestock operations is also an important problem. Studies have shown that all cave streams in each system known to have supported the Cave Amphipod have detectable concentrations of common pesticides, while many locations display concentrations many times those allowed in drinking water for humans. And all show levels of bacteria associated with human and animal wastes which are detrimental to oxygen levels. In addition, sediments may fill or eliminate the pools and riffles where Illinois Cave Amphipods thrive.

Yet another impact, from the operation of wind turbines rather than their construction, is the potential adverse effect of vibrations directly on the Illinois Cave Amphipod. A scientist studying the Illinois Cave Amphipod stated laboratory specimens exhibit strong reactions to accidental acoustic stimulation, such as when an aquarium is bumped by a researcher or piece of equipment.²¹ While no experimentation with acoustic stimuli has been approved, these observations suggest this species would be highly responsive to the transmission of vibrations

²¹ Shank, Keith M.; Personal communication with Dr. Frank Wilhelm, University of Idaho, November 1, 2011.

through bedrock. Sustained agitation during prolonged wind energy generation could render habitat untenable, and even result in the exhaustion and death of individual amphipods through sustained stress. Such “noise” could also interfere with the ability of Amphipods to locate invertebrate prey.

The potential exists for the construction and operation of large wind turbines – which may open new sinkholes, enlarge existing sinkholes, or alter the configuration of cave passages – to diminish populations of the Illinois Cave Amphipod to the point natural events beyond human control, such as extended heavy rainfalls, may result in its extinction.

Three species of bats listed by both the federal government and the State of Illinois make use of the cave systems in the project area, as well as non-listed species being evaluated for listing.²² The endangered **Gray Bat**, *Myotis grisescens*, is a true “cave bat,” using caves for roosting year-round, although different caves or different parts of caves may be used at different times, for bachelor and maternity colonies or for hibernation. The endangered **Indiana Bat**, *Myotis sodalis*, and the threatened **Northern Long-Eared Bat**, *Myotis septentrionalis*, primarily use caves for hibernation during the winter, although some male bats may remain in the vicinity all year and continue to use parts of the caves during the summer.

Hibernating bats may not be sensitive to turbine vibrations, but few, if any, wind turbines have been built near important hibernation sites. It is well-known that human visitation during hibernation periods is very detrimental to hibernating bats because arousal consumes precious calories needed to survive until spring. But these disturbances are due to light, disturbed or altered air flows, and higher-frequency noises; the low-frequency vibrations from turbines may not be as disruptive absent these other factors.

Each bat species has very specific temperature and humidity tolerances for hibernation; the parts of a cave which will serve their purposes depends a great deal on air flow in the cave, which affects both parameters. The Department recently spent over \$20,000 to remove 2,500 cubic feet of debris and sediment²³ which blocked 90% of the entrance to Foglepole Cave, thereby restoring airflow to maintain suitable conditions for bat hibernation.

Constructing and operating large commercial wind turbines above the cave systems risks causing physical changes to cave structure which could render large areas of the caves unsuitable as bat habitat by altering air flow and temperature, and might may even result in some areas becoming inaccessible.

²² The U.S. Fish & Wildlife Service is currently evaluating whether to list the **Little Brown Bat**, *Myotis lucifugus*, and the **Tri-Color Bat**, *Perimyotis subflavus*.

²³ This is an example of the amount of debris which can flow into a sinkhole from surrounding land which is not managed to prevent it. The former farm fields around this cave entrance have now been converted to grassland, which has greatly reduced debris flow into the sinkhole.

The **Madonna Cave Springtail**, *Pygmarrhopalites madonnensis*, listed by the State as endangered, is unique, so far as is known, to Madonnaville Cave, near Monroe City. Another “dark zone” denizen, it is a six-legged creature known as a hexapod; it is not an insect because it lacks a thorax, having only a head and abdomen. Springtails possess a posterior appendage which snaps open when the animal is disturbed, catapulting themselves many body-lengths away, an unusual mechanism for escaping predators. Like other deep cave creatures, it feeds on organic detritus washed in from the surface. Scientists have captured it baiting traps with limburger cheese, suggesting an ability to detect and follow chemicals which produce odors. As with the Illinois Cave Amphipod, the potential effects of constant stimulation from wind turbine vibrations are a matter of speculation, but they will not be beneficial and are likely to be adverse.

The Illinois Environmental Protection Agency (IEPA) has delineated and designated three Class 3 Special Resource Ground Water basins²⁴ in which many of the caves supporting these species are found: the **Pautler Class 3 Ground Water**; the **Armin Krueger Speleological Area Class 3 Ground Water**; and the **Foglepole Cave Class 3 Ground Water**. These caves are also found within Illinois Natural Areas Inventory (INAI) Sites designated by the Department: the **Pautler-Annabriar Karst System INAI Site**; the **Frog Karst System INAI Site**; the **Madonnaville Cave INAI Site**; the **Renault Karst Area INAI Site**; and the **Renault Cave System INAI Site**. The proposed wind energy facility would be constructed above significant portions of all three ground water systems. The IEPA designation creates a potential civil liability for anyone who diminishes or degrades ground water in these systems. Both the construction and operation of wind turbines pose this risk.

Several portions of these important cave systems have been voluntarily dedicated to the State by their owners as Illinois Nature Preserves, endowing them with legal protection from damage or destruction.²⁵ State law enjoins local governments to avoid planning actions which will adversely affect Nature Preserves.²⁶ Among these are the **Paul Wightman Subterranean Nature Preserve**, which protects several hundred acres of Foglepole Cave *below* the ground surface, and the adjacent **Foglepole Cave Nature Preserve**, owned by the Department of Natural Resources, which protects a major cave entrance. The privately-owned **Armin Krueger Speleological Nature Preserve** is located less than two miles from the project area, but within range of vibration effects. Due to the extent of the cave systems beyond the boundaries of these

²⁴ Designations are made pursuant to Title 35 Illinois Administrative Code Part 620.230 and create potential civil liability for persons polluting or diminishing such ground waters.

²⁵ Willful damage or destruction, including the disturbance of any animal, within a Nature Preserve is a Class A Misdemeanor. Violators are also subject to civil penalties of up to \$10,000 per day. *Illinois Natural Areas Preservation Act* [525 ILCS 30/23; 30/22].

²⁶ “All public agencies shall recognize that the protection of nature preserves, buffer areas and registered areas is the public policy of the State and shall avoid the planning of any action that would adversely affect them.” [525 ILCS 30/17].

Nature Preserves, conditions within these Preserves could be adversely modified by the construction and operation of the proposed action, even at a distance.

Nearby are the **Illinois Caverns State Natural Area** and the **Annabriar Karst State Natural Area**, both owned by the Department of Natural Resources, which although not dedicated as Nature Preserves are yet entitled to protection under the *State Parks Act* [20 ILCS 835].²⁷ While neither site lies inside the proposed project area, these cave systems can be expected to experience some effects from the operation of the wind energy facility; both support federally-listed and State-listed endangered species which require cave habitats.

Nature Preserves, Land & Water Reserves, Natural Heritage Landmarks, and INAI Sites

The Department routinely seeks a setback of one mile for wind turbines near dedicated Illinois Nature Preserves and Land & Water Reserves. Within a Nature Preserve, all aspects of the environment are protected: air, land, and water resources; all plants and animals; and all natural or manmade objects. Within a Land & Water Reserve, many activities otherwise prohibited in a Nature Preserve are allowed, and only plants and animals listed as endangered or threatened receive the strongest protection. A Natural Heritage Landmark denotes a contractual relationship between the land owner and the Illinois Nature Preserves Commission aimed at the restoration of natural communities and ecosystems within the Landmark; many Landmarks eventually become Land & Water Reserves or Nature Preserves. A landmark designation does not confer legal protection to the designated area.

Utility-scale wind turbines pose several potential adverse modifications to conditions within a dedicated, registered, or landmarked area:

- The visibility of wind turbines from a great distance compromises a visitor's ability to visualize the pre-settlement conditions of Illinois, one of the values cited by the General Assembly in creating the Illinois Nature Preserves System.
- Wind turbines create an audible intrusion among the natural sounds to be heard. Turbines are designed to have a sound impact no greater than 40 decibels at 1,000 feet from the nacelle. While this level generally complies with Illinois Pollution Control Board regulations for noise pollution, those rules were never intended to protect the auditory integrity of a natural area and do not address ultra-low frequency sounds, those generated by turbines which are most likely to travel the greatest distance. Often compared to the sound of a refrigerator or dishwasher, a sound level of 40 decibels does not represent silence.
- Depending on distance, bearing, and intervening obstacles or terrain, wind turbines cast moving shadows when illuminated by the sun or moon; such shadows are often termed

²⁷ It is a Class B Misdemeanor to break, injure, or destroy any natural object in a State Park. [20 ILCS 835/6].

“flicker” for the strobing effect created. Existing computer models can predict the theoretical location and duration of shadows cast by the sun, but they do not account for atmospheric diffraction or diffusion, nor for shadow intensity. Because “flicker” is often considered only a nuisance during daylight for people living nearby, no such models exist for lunar illumination or shadows. A lunar model would also be far more complex, since it must account for phases, which are not a factor for sunlight. As the sun rises from or sets toward the horizon, shadows may theoretically extend more than one mile, depending on the maximum blade tip height.

- It is now clear that turbines produce seismic waves transmitted through soils and waters which are measurable at distances up to nine miles. Like other waves, their strength typically diminishes with distance.

While visibility, noise, moving shadows, and seismic vibrations are unlikely to directly adversely affect plants, they have the potential to adversely affect wildlife in the protected natural communities. Plants can be indirectly affected when the balance among wildlife species is disturbed. In a case from New Mexico, when the noise from a pipeline pumping station prevented avian predators from locating prey, the resulting rodent population explosion suppressed all pine tree reproduction in the area due to seed predation pressure.²⁸

To the extent these turbine effects mimic “normal” threats, such as potential predators, they elevate levels of metabolic stress, which can depress overall fitness, and may interfere with feeding, hunting, breeding and other behaviors. Noise can interfere with finding prey or finding mates. In extreme cases, animals can be displaced from otherwise suitable habitat. No such effects are currently known to occur at distances exceeding one mile from a turbine, but few efforts have been made to study them at such distances.

Many dedicated, registered, and landmarked areas exist near the proposed project area. Within one mile west of the project area, on the bluffs and in the bluff forests, from north to south, they include the **Salt Lick Point Land and Water Reserve**, the **Illinois Ozarks Nature Preserve**; the **Martha and Michelle Prairies Land and Water Reserve**; the **Potato Hill Natural Heritage Landmark**; the **Luella Schaefer Memorial Hill Prairies Land and Water Reserve**; the **White Rock Land and Water Reserve**; the **White Rock Nature Preserve**; **Harry's Prairie Natural Heritage Landmark**; the **Fults Hill Prairie Nature Preserve**; and **Angela's Prairie Land and Water Reserve**. Located slightly beyond one mile are the **Angela's Prairie Natural Heritage Landmark**; the **Brickey-Gonterman at Renault Bluffs Land and Water Reserve**; the **Brickey-Gonterman Memorial Hill Prairie Nature Preserve**; and the **William A. DeMint Memorial Hill Prairie Nature Preserve**.

²⁸ Francis, et al.; Noise Pollution Alters Ecological Services: Enhanced Pollination and Disrupted Seed Dispersal; Proceedings of the Royal Society B: Biological Sciences; March 21, 2012.

The Nature Preserves associated with subterranean resources were noted earlier, but several other protected areas lie on the east side of the project. These include the **Horse Creek Glade Natural Heritage Landmark** and the **Storment Hauss Nature Preserve**.

Each of these dedicated, registered, or landmarked properties provides essential habitat for multiple endangered or threatened species of plants and animals. All will be affected to some degree by construction and operation of the proposed action, which in some instances could result in legal jeopardy for the project's operator.

Rotor-Blade Collisions - Birds

Wildlife deaths due to collisions with moving rotor blades stand high in the public's perception of the effects of wind turbines.

Experience in Illinois to date indicates that, although several thousand birds may be killed annually, these losses are spread over hundreds of species, so that very few species experience losses which threaten their populations. All such birds are protected from deliberate destruction by the federal *Migratory Bird Treaty Act* (MBTA), but this statute does not penalize incidental taking of migratory birds. Eagles are protected by the federal *Bald and Golden Eagle Protection Act* (BGEPA), while species which are listed as endangered or threatened are protected by the respective federal and state endangered species laws.

Generally, a single turbine in Central Illinois may kill half a dozen birds annually, but no Central Illinois wind energy facility is located near the Mississippi River, as this one would be, nor deploys turbines of the height contemplated in Monroe County. Migratory birds following the Mississippi River stop to rest in the forested bluffs along the River, and this would place them in very close proximity to the proposed wind turbines. Most birds killed at turbines are night migrants, which usually fly much higher than wind turbines reach; it is when they are seeking to roost and when they depart for the next leg that they are most at risk of collision, and the juxtaposition of these turbines with the bluff forests could produce high rates of mortality.

At one time, the Department and the Fish and Wildlife Service were considering a siting guideline which recommended not siting turbines within ten miles of the Mississippi River; no guideline was issued at the time for lack of data to support it and the issue has not been revisited, since it hasn't arisen. The entire area of this proposed action lies within ten miles of the Mississippi River.

Some conservation organizations have suggested wind turbines should not be allowed to operate during bird migration seasons but, because the migration seasons for each species occur over many months, this would mean there would be only a few weeks in the summer or winter during

which turbines could operate. Most turbine mortality to migratory birds involve passerine songbirds, and migration periods for these species are more concentrated. For Monroe County, spring migration occurs in late April and much of May, and again in September and part of October.²⁹

To date, the tally of **Bald Eagles**, *Haliaeetus leucocephalus*, killed by wind turbines in the continental United States stands at about 18, a figure much lower than road-killed Eagles in even a single state such as Michigan. None of these wind turbine losses have occurred in Illinois. However, hundreds of **Golden Eagles**, *Aquila chrysaetos*, have died at wind turbines in the Far West. Differences in their natural history account for the much higher toll among Golden Eagles. Golden Eagles are rarely seen in Illinois as far south as Monroe County, and then only in the winter. Bald Eagles, by contrast, may be present year-round.

Wind turbines within ten miles of a Bald Eagle nest or night roost are deemed to pose a risk of collision. Eight locations important to Bald Eagles are known to exist within ten miles of the proposed project area. Four of these are night roosts which host wintering Bald Eagles; and four locations represent active nests. All are located on the Mississippi River floodplain. Kidd Lake Marsh State Natural Area, along Bluff Road, supports a large winter roost of Bald Eagles about two miles from the proposed project area. The extent of Eagle use of the areas above the bluffs is unclear.

The Illinois population of Bald Eagles continues to expand at a rapid rate, and new pairs are colonizing sites, even in cities, which would have been avoided in the past. The Department believes the risk this facility poses to Bald Eagles is moderate. The protection of Bald Eagles is a federal responsibility, and the applicant should discuss its proposal with the United States Fish & Wildlife Service.

Only six individual birds³⁰ listed as endangered or threatened by Illinois have been documented as injured or killed by wind turbines. Four of them were threatened **Black-Billed Cuckoos**, *Coccyzus erythrophthalmus*.³¹ No members of these species were known to occur in the vicinity of these operations, illustrating the difficulty of anticipating such losses. The deaths of these birds, far from suitable habitat and not necessarily during the migration season, are puzzling.

²⁹ This conclusion is drawn from analysis of data compiled in E-Bird, a widely-acclaimed database maintained by Cornell University's Laboratory of Ornithology.

³⁰ Apart from the Cuckoos, an Osprey was injured in McLean County 2007, but recovered, and a Black Rail was killed in 2016 in Henry County. These were considered isolated random occurrences unlikely to be repeated at those facilities.

³¹ These four Cuckoo losses occurred at two wind energy facilities located on opposite sides of the State; each facility reported one mortality in successive years, and each facility has since sought and received an Incidental Take Authorization from the Department. Pursuant to the *Illinois Endangered Species Protection Act*, the Department may authorize taking that is otherwise prohibited which occurs due to a lawful activity, provided the taking will not jeopardize the survival or recovery of the species. 520 ILCS 10/5.5. These Authorizations were #139 and #140.

But deaths in consecutive seasons are sufficient to establish continuing risk. A breeding record for this species, unusual so far south, is present in the bluff forests adjacent to this project footprint, and this may indicate that a higher risk exists for this project of taking this species through collision.

The other State-listed bird with a nearby record is the threatened **Cerulean Warbler**, *Setophaga cerulea*,³² which also breeds in the bluff forests adjacent to the project. Other species of warbler are often found beneath wind turbines, but to date dead or injured birds of this species have not been found. It is unlikely this means Cerulean Warblers are not at risk. The fact breeding birds use this locality suggests they will have a longer exposure to collision than do migrants. However, Cerulean Warblers forage primarily in deep forest canopies, and this habit may reduce collision risk for this species.

The Department does not believe any effective means exists to reduce the risk of avian collision with turbine blades. Poor visibility was thought to be a factor, and many early turbine installations painted rotors with various designs and colors intended to make them more visible to birds at a distance, both by day and by night. However, this has not been effective because the speed at which avian brains can process images is slower than blade movement, so that a bird close enough to collide with a blade cannot see it, regardless of lighting or color.

The most common recommendation is to avoid siting turbines near areas where birds concentrate. There are few such areas in Illinois, but the bluff forests of Monroe County are among them.

Rotor-Blade Collisions - Bats

Wind turbines take a far greater toll on bats than on birds. Utility-scale wind turbines in the 1.5/1.6 MW class in Central Illinois, when operated normally throughout the year, kill an average of 15 bats per year. Because turbines in the 4.2 MW class begin operations at lower wind speeds (3.0 meters per second) and have larger rotor diameters, they can be expected to kill higher numbers of bats unless measures are taken to reduce bat mortality.

The vast majority of bats killed by wind turbines belong to three non-listed species of migratory “tree” bats, so-called because they do not hibernate, migrating south for the winter. While proportions vary, it is not unusual for 90% or more of bats killed at an Illinois wind facility to be comprised of **Hoary Bats**, *Lasiurus cinereus*; **Silver-Haired Bats**, *Lasionycteris noctivagans*, and **Eastern Red Bats**, *Lasiurus borealis*. Losses for these long-lived species are already so severe that experts are estimating they will all be listed as endangered by mid-century, even if no

³² This species appears in the State List as *Dendroica cerulea*, but the scientific community recently assigned the species to a different genus.

more turbines were to be built after 2014. Since wind energy facilities are expanding rapidly, conservation of these species will become increasingly important. (These bats do not suffer losses from White-Nose Syndrome, a disease to which only cave-hibernating bats are exposed.)

The federally-listed and State-listed endangered or threatened bats whose ranges include Monroe County belong to the *Myotis* genus: the endangered **Gray Bat**, *Myotis grisescens*, the **Indiana Bat**, *Myotis sodalis*, and the threatened **Northern Long-Eared Bat**, *Myotis septentrionalis*. A fourth but non-listed species, the **Little Brown Bat**, *Myotis lucifugus*, also occurs in Monroe County. These bats hibernate in mines and caves, where the White-Nose fungus poses an ever-present threat. Two other non-listed cave-hibernating species are also present: the **Tri-Color Bat**, *Perimyotis subflavus*; and the **Evening Bat**, *Nycticeius humeralis*. While these bats roost and forage generally near and above tree canopies, each species has been tallied as a wind turbine fatality in Illinois, though rarely.

The Little Brown Bat was once Illinois' most common species, followed closely by the Northern Long-Eared Bat, but these species have proven highly susceptible to White-Nose Syndrome, with annual mortality exceeding 90%. Once easily captured in surveys, they are now difficult to find. The Indiana Bat, by contrast, appears to have suffered only an approximate 20% reduction in population numbers due to this disease and has largely recovered. The US Fish & Wildlife Service is studying whether to list the Little Brown Bat and, on December 20, 2017, announced the beginning of an effort to evaluate the listing status of the Tri-Color Bat. *It is likely these species will become federally-listed (and State-listed) at some point during the useful life of this facility if it is built.*

Before the 2013 advent of White-Nose Syndrome (WNS) in Illinois, there had been no reported losses of Indiana Bats or Northern Long-Eared Bats at Illinois wind turbines, and relatively few reports of mortality for the Little Brown Bat, Tri-Color Bat, or Evening Bat.³³ The hunting and habitat preferences of bats account for the great difference in wind turbine mortality between “cave” bats and “tree” bats. Cave-hibernating species prefer to forage just below, just-above, or within the forest canopy; wind turbines are seldom built in proximity to trees. These bats do fly across and over open spaces but tend to stay below 30 meters (100 feet), and even lower, and so are less likely to collide with turbine rotors. By contrast the larger and heavier “tree” bats prefer foraging over open fields, often at higher altitudes and during higher wind speeds. This is especially true in August and September when these species migrate from northern breeding grounds to southern climes where food remains available during the winter.

There is an inverse relationship between wind speed and the number of bats in the air, and which species comprise them. Numerous research studies have shown that if turbine operations are

³³ The Monroe County Wind Farm might be the first large facility to be constructed within the Illinois range of the Gray Bat.

initiated at higher wind speeds, total bat mortality can be reduced by more than 50%, and mortality for *Myotis* species by even more. However, the industry trend is to deploy turbines which can begin operations at ever-lower wind speeds, thus making more areas with lesser wind resources viable locations for a wind energy facility and increasing the exposure of bats to collision. Whereas the turbines deployed earlier in Illinois could cut-in at wind speeds of 4.0 or 3.5 meters per second (m/s), the larger more modern turbines proposed for Monroe County do so at 3.0 m/s, increasing bat mortality risk. About 30% of bat deaths occur below cut-in speed if blades are allowed to “free-wheel” when no power is generated.

To date, one Indiana Bat and four Northern Long-Eared Bats have been reported killed at Illinois wind turbines.³⁴ Each turbine was being operated “normally,” that is, in accordance with manufacturers’ recommended wind speeds, and all but one of these bats died during the fall migration period, which may begin as early as mid-July and runs through October in most parts of Illinois.³⁵ Currently, based on experience in this State, the Department is recommending that turbine operations not located near hibernation sites be curtailed below wind speeds of 5.0 m/s between July 15 and October 15 to avoid killing listed bats; this is also the wind speed which reduces total bat mortality of all species by approximately 50% or more. However, unless directed by the local government with jurisdiction, or pursuant to a State or federal Incidental Take Permit,³⁶ operation of a wind facility in this manner remains voluntary with the facility owner.

The “average” foraging radius from a roost tree for the Indiana Bat is often given as 2.5 miles, but five miles or farther is not unusual, depending on the configuration of local streams and woodlands. In Monroe County, due to the presence of multiple hibernation sites in the numerous local caves and sinkholes, it is known that members of these three species are present in the vicinity all year, not just during breeding or migration periods. Moreover, the distribution of woodlands, caves, and water bodies on the landscape assures that *Myotis* bats will be passing through or among the turbines of this project on a nightly basis throughout the year, except when temperatures fall below 50°F.³⁷

Turbines in the 4.2 MW class currently available to the U.S. market come in two configurations: those with 136-meter diameter rotors, and those with 150-meter diameters. Standard tower heights for those platforms are 82 meters and 87 meters, although some ability to “customize”

³⁴ Approximately 2,700 commercial utility-scale wind turbines are operating in Illinois.

³⁵ The presence of hibernation sites lengthens the period bats are active in the area.

³⁶ At present, only one wind energy facility in Illinois possesses both a federal and state Incidental Take permit, the Pioneer Trail facility in Ford and Iroquois Counties (Illinois ITA #134). After two years of operating only above 5.0 m/s during the period from August 1 to October 15, no *Myotis* species of bats were killed, and the average mortality per turbine was held to about 7.5 bats per turbine. That facility deploys 1.6-MW GE turbines on 80-meter towers with 82.5-meter rotors, with a lower rotor arc above 38 meters.

³⁷ 50°F (10°C) is the temperature below which cave bats are in a state of hibernation and thus not active outside the cave.

tower heights may exist. A 136-meter rotor on an 82-meter tower brings the lower rotor sweep to 14 meters above ground level, well within the 30-meter flight zone of *Myotis* species. Even if 100-meter towers can be crafted for this platform, the lower blade sweep will approach or penetrate the 30-meter altitude. Therefore, this proposal, situated as it is among bat hibernation sites, would pose a much higher risk of taking *Myotis* bat species throughout the year than other Illinois wind energy facilities.

Terrestrial Species

Six State-listed endangered or threatened species which live on or near the ground surface and could be affected by wind turbine construction or operation occur in the area. These include four snakes (the endangered **Coachwhip**, *Masticophis flagellum*; the endangered **Great Plains Ratsnake**, *Pantherophis emoryi*; the threatened **Flathead Snake**, *Tantilla gracilis*; and the threatened **Timber Rattlesnake**, *Crotalus horridus*); the **Eastern Narrowmouth Toad**, *Gastrophryne carolinensis*; and the **Common Striped Scorpion**, *Centruroides vittatus*.

These species have the potential to be adversely affected directly (by persecution; crushing by vehicles; stress through shadows or vibration; damage to hibernation sites) or indirectly (blocking migration routes, dispersing prey).

Except for the Flathead Snake, which tends to spend the winter alone, the other three snakes may migrate considerable distances from shared winter dens, moving from the bluffs to either upland prairies or bottomland fields, or may use roughly circular routes of several miles which in the course of a year return them to the vicinity of dens, which are used year-after-year. These movements bring these animals into contact with people and with hazardous obstacles, such as roads.

Being cold-blooded, basking sites are important in the spring and fall. Additional private roads for servicing turbines may offer tempting basking sites where snakes may be crushed by vehicles or persecuted by humans. Shadow-flicker, which simulates the movement of aerial predators, may limit the use of basking sites and raise metabolic stress. Vibrations transmitted through the ground may interfere with the detection of prey or reduce its availability and may interfere with surviving the winter if they stimulate higher calorie consumption. Vibrations may also damage the hibernation den itself.

The Great Plains Rat Snake and the Coachwhip are extremely rare in Illinois and even small losses to their populations may result in extirpation from this State. The relocation of Valmeyer from the floodplain to its new upland location has resulted in the destruction of dens important to Rattlesnakes as well as the loss of numerous individuals through persecution. Most Flathead Snake records are located along Bluff Road, but that likely reflects greater human search effort rather than the snake's preference; this species has also been found in a limestone glade located five miles east of the bluffs.

The Eastern Narrowmouth Toad is broadly distributed in this part of Monroe County, occupying areas extending from the floodplain, through the bluffs, and in and around the numerous sinkholes in the karst areas. The Toad may be stressed by shadows and vibrations, which may reduce its ability to detect and avoid predators.

The Common Striped Scorpion is known from thirteen locations along and above Bluff Road in Monroe County, but this is where human search effort has been concentrated and does not necessarily reflect its actual distribution. In Missouri, and areas farther west, this species makes extensive use of woodland habitats. It is nocturnal, emerging after dark to forage. The potential adverse effects of vibration and intermittent lighting from aircraft warning lights mounted on the turbines are unknown.

State-listed Plants

This consultation identified three State-listed plant species in the vicinity, none of which is known to occur within the outlined proposed action area. Each is located within a Nature Preserve or Land & Water Reserve and, if affected at all, may be affected only indirectly. However, the proposed action area has not been systematically surveyed for endangered or threatened plants, so there may be species and locations of which the Department is unaware.

Listed plants are the property of the landowner. It is unlawful to “take” (that is, harm in any manner) a listed plant without the express written permission of the landowner. The Department does not have the authority to override the will of the landowner. Thus, the project developer may find it prudent to survey for listed plants on leased properties, or to at least seek the written permission of private landowners to take any listed plants which may occur on their property.

Many Nature Preserves and Land & Water Reserves are privately-owned, but in those areas a landowner does not have sole discretion. Within their boundaries, the permission of the Department of Natural Resources and the Illinois Nature Preserves Commission must also be sought. However, given the nature and character of those properties, it is likely such permission could not be granted.

Conclusion

Consultation on the part of the Department is closed unless Monroe County desires additional information or advice related to this proposal. In accordance with 17 Ill. Adm. Code 1075.40(h), the County should notify the Department of its decisions on these recommendations in writing: whether it will proceed with the action as proposed; whether it will require modification of the proposed action consistent with the Department’s recommendation or otherwise; or whether it will forego the proposed action.

This consultation is valid for two years unless new information becomes available which was not previously considered; the proposed action is modified; or additional species, essential habitat, or Natural Areas are identified in the vicinity. If the action has not been implemented within two

years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary.

The natural resource review reflects the information existing in the Illinois Natural Heritage Database at the time of project submission and should not be regarded as a final statement on the project being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, the applicant must comply with the applicable statutes and regulations. The closure of consultation does not imply IDNR's authorization or endorsement of the proposed action.

Please do not hesitate to contact the Department should any questions arise regarding the Department's review of this proposed action.

Sincerely,

A handwritten signature in black ink that reads "Keith M. Shank". The signature is written in a cursive style with a large initial "K".

Keith M. Shank, Natural Resource Manager
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