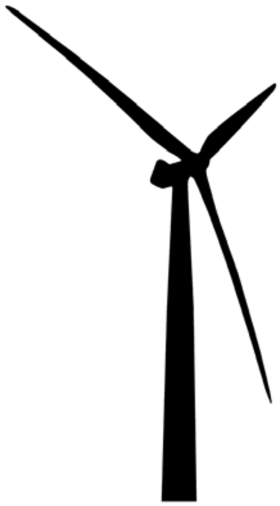
DOE/EA-1782

Final
Environmental Assessment

OF



THE UNIVERSITY OF DELAWARE LEWES CAMPUS ONSITE WIND ENERGY PROJECT

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

DECEMBER 2010

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ACRONYMS AND ABBREVIATIONS

ABPP	Avian and Bat Protection Plan
CFR	Code of Federal Regulations
BGEPA	Bald and Golden Eagle Act
dBA	A-weighted decibel
dB	decibel
DNREC	(Delaware) Department of Natural Resources and Environmental Control
DOE	U.S. Department of Energy (also called the Department)
DOI	U.S. Department of the Interior
EA	environmental assessment
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRM	flood insurance rate map
FR	Federal Register
L_{10}	10-percent sound level
L_{90}	90-percent sound level
L_{eq}	equivalent sound pressure level
NEPA	National Environmental Policy Act of 1969, as amended
SHPO	State Historic Preservation Office(r)
Stat.	United States Statutes at Large
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service

Note: Numbers in this EA generally have been rounded to two or three significant figures. Therefore, some total values might not equal the actual sums of the values.

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE)

TITLE: Final Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project (DOE/EA-1782)

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ABSTRACT: The University of Delaware has constructed a wind turbine adjacent to its College of Earth, Ocean, and Environment campus in Lewes, Delaware. DOE proposes to provide the University a $1.43 million grant for this Wind Energy Project from funding provided in the *Omnibus Appropriations Act of 2009* (Public Law 111-8) and an additional $1 million provided in the *Energy and Water Development Appropriations Act of Fiscal Year 2010*. Thus, the total amount DOE is considering providing to the University of Delaware Project is $2.43 million. This EA analyzes the potential environmental impacts of the University of Delaware's Wind Energy Project at its Lewes campus and, for purposes of comparison, an alternative that assumes the wind turbine had not been constructed.

PUBLIC PARTICIPATION: A Notice of Availability for the Draft EA was placed in *The News Journal* on June 18, 19, and 20, 2010, and in the *Cape Gazette* on June 16, 2010. A notice announcing a 30-day extension to the public comment period was placed in *The News Journal* on July 16, 17, and 18, 2010, and in the *Cape Gazette* on July 20, 2010. The Draft EA was made available for public review from June 18, 2010, through August 17, 2010, at the Lewes Public Library, 111 Adams Avenue, Lewes, Delaware, and was mailed to individuals and agencies listed in Appendix A. The Draft EA was also available from the following web site: http://www.nepa.energy.gov. This Final EA is available on the same DOE web site.

DOE invited interested parties to comment on the Draft EA during a 60-day public comment period that began on June 18, 2010, and ended August 17, 2010. The public was encouraged to submit comments to Dr. Jane Summerson via email at Jane.Summerson@ee.doe.gov or by letter or fax at the address or telephone number identified above. Comments received are summarized in the EA and, as appropriate, DOE responses are provided or modifications to EA text were made.

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SUMMARY

The U.S. Department of Energy (DOE) proposes to provide a $2.43 million grant to the University of Delaware for a 2-megawatt wind turbine and associated facilities (for example, access road, transformer) located adjacent to the University's College of Earth, Ocean, and Environment Campus in Lewes, Delaware. The DOE funding consists of $1.43 million from the *Omnibus Appropriations Act of 2009* (Public Law 111-8), which includes a congressionally directed project to establish a wind turbine project in the State of Delaware, and $1 million from the *Energy and Water Development Appropriations Act for Fiscal Year 2010* (Conference Report to Accompany H.R. 3183, Report 111-278), which includes funding for "Wind Turbine Infrastructure for Green Energy and Research on Wind Power in Delaware." The University requested funding from DOE for the Wind Energy Project at its Lewes campus in 2009 and constructed the turbine in March/April 2010. The University undertook construction of the wind turbine at its own risk, before DOE had made the decision to fund construction activities.[1] As a result, the wind turbine was constructed before the Draft EA was released to the public and is currently operating.

DOE prepared this environmental assessment (EA) to evaluate environmental impacts that occurred during construction of the wind turbine and potential impacts that might occur during turbine operation. This EA also includes analysis of an alternative that assumes the turbine had not been built (the No-Action Alternative). This alternative provides a baseline to help understand the impacts associated with the Wind Energy Project. Based on this EA, DOE will determine whether to issue a Finding of No Significant Impact or prepare a more detailed environmental impact statement. Once the environmental review process is complete, DOE will consider the information in making a decision to provide funding for this project to the University of Delaware. If DOE chooses not to provide funding to this project, it would pursue funding another wind turbine project in the state of Delaware consistent with congressional direction in the *Omnibus Appropriations Act of 2009* and the *Energy and Water Development Appropriations Act for Fiscal Year 2010*.

The wind turbine is located in an existing dredge spoils area adjacent to the campus and is interconnected with underground electrical conduit directly into University facilities. The University would use the wind turbine for research and development purposes as well as for providing electricity to the campus and to the electrical grid.

As with many wind turbines, visual and avian impacts from the University Wind Energy Project are the impacts of greatest concern. This is because the sheer size of the wind turbine has the potential to obscure the viewshed, while turning wind turbine blades can injure or kill birds and noise from wind turbines can disturb nesting and foraging birds.

Of relevance to avian impacts, much of the project site is bordered by marshlands, which, to the northwest, is part of the Great Marsh, managed by The Nature Conservancy. The wind turbine's presence and its operation could result in occasional bird and bat collisions and fatalities. This would not be expected to threaten any populations of birds or bats in the area; however, there is an important bird migration route near the coast of Delaware Bay and there is no information available on the abundance of bats at or in the immediate vicinity of the wind turbine. As a result, there is uncertainty about the number of birds or bats the operating turbine could affect. Therefore, as a condition of funding, DOE will require the University of Delaware to prepare and implement an Avian and Bat Protection Plan that addresses monitoring and evaluation protocols, and adaptive management. With regard to the *Bald and Golden*

1. DOE has not previously authorized the use of federal funds for construction of this project. If DOE had elected not to fund the Wind Energy Project, DOE would have been required to consider funding other proposals that meet the requirements of the *Omnibus Appropriations Act of 2009* and the *Energy and Water Development Appropriations Act of Fiscal Year 2010*.

Eagle Protection Act, the U.S. Fish and Wildlife Service has indicated that if the project cannot avoid disturbance to the bald eagle, a proposed permit program to authorize the take of bald or golden eagles under specific conditions will be available once the Service has issued a final rule.

With respect to visual impacts, the size of the wind turbine and the unique characteristics of shadows that could be generated at times during its operation would present the potential for visual impacts in the surrounding area. Some individuals might find the visual contrast presented by the wind turbine unpleasant and some might find exposure to shadow flicker of any duration annoying. DOE consulted with the Delaware State Historic Preservation Officer to assess the visual impact of the wind turbine on historic properties. The State Historic Preservation Officer concurred with DOE's finding that the wind turbine will not adversely affect any properties listed on or eligible for listing on the National Register of Historic Places.

The sound levels that would be generated from a single operating wind turbine would be expected to be similar in magnitude to ambient conditions at the nearest private residences. DOE recognizes, however, some individuals might be able to discern the unique sounds generated by a wind turbine from ambient sounds and, therefore be more sensitive to them.

1. INTRODUCTION

The U.S. Congress provided funding in the *Omnibus Appropriations Act of 2009* (Public Law 111-8) to the U.S. Department of Energy (DOE or the Department), Office of Energy Efficiency and Renewable Energy, for projects that provide for research, development, and demonstration of energy efficiency or renewable energy technologies or programs, including $1.43 million for the establishment of a wind turbine model and pilot project for alternative energy in the State of Delaware. Congress also provided $1 million in funding in the *Energy and Water Development Appropriations Act for Fiscal Year 2010* (Conference Report to Accompany H.R. 3183, Report 111-278) to the DOE Office of Energy Efficiency and Renewable Energy for Wind Turbine Infrastructure for Green Energy and Research on Wind Power in Delaware. DOE is proposing to provide the combined $2.43 million as a grant to the University of Delaware for its 2-megawatt, single turbine Wind Energy Project adjacent to the University's College of Earth, Ocean, and Environment Campus in Lewes, Delaware. The total cost of the project is estimated at approximately $5 million. The University undertook construction of the wind turbine at its own risk, before DOE had made the decision to fund construction activities.[2] As a result, the wind turbine was constructed before the Draft EA was released to the public and is currently operating.

DOE prepared this *Final Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project* (EA) to evaluate environmental impacts that occurred during construction of the wind turbine and potential impacts that may occur during the wind turbine's operation. This EA examines the potential environmental consequences of DOE's Proposed Action (that is, providing a financial assistance grant), the University of Delaware's project, and the No-Action Alternative (under which it is assumed, for comparison purposes, that the grant was not provided and the wind turbine was not built). The EA's purpose is to inform decisionmakers and the public of the likely environmental consequences of the project and alternatives for the installation of a wind turbine in Lewes, Delaware.

This chapter explains the *National Environmental Policy Act* and the related procedures (Section 1.1), the purpose and need (Section 1.2), public and agency involvement (Section 1.3), and the environmental considerations DOE did not carry forward to detailed analysis (Section 1.4). Chapter 2 describes the alternatives. Chapter 3 details the affected environment and potential environmental consequences of the Wind Energy Project and of the No-Action Alternative. Chapter 4 addresses cumulative impacts, and Chapter 5 provides DOE's conclusions from the analysis. Chapter 6 lists the references for this document. Appendix A contains the distribution list for this document, Appendix B includes copies of consultation letters with other agencies and other important project correspondence, Appendix C provides common and scientific names for the plants and animals identified in this document, and Appendices D, E, F, and G comprise reports of specific analyses performed for this evaluation.

1.1 National Environmental Policy Act and Related Procedures

The *National Environmental Policy Act of 1969*, as amended (NEPA, 42 U.S.C. 4321 *et seq*.), the Council on Environmental Quality NEPA regulations (40 CFR Parts 1500 to 1508), and DOE's NEPA implementing regulations (10 CFR Part 1021) require that DOE consider the potential environmental impacts of a proposed action before making a decision. This requirement applies to decisions about whether to provide different types of financial assistance to states and private entities. In compliance with these regulations, this EA examines the environmental impacts of the University of Delaware's Wind Energy Project and the No-Action Alternative.

2. DOE has not previously authorized the use of federal funds for construction of this project. If DOE had elected not to fund the Wind Energy Project, DOE would have been required to consider funding other proposals that meet the requirements of the *Omnibus Appropriations Act of 2009* and the *Energy and Water Development Appropriations Act of Fiscal Year 2010*.

DOE assesses the impacts from a No-Action Alternative, namely an alternative not to fund the Wind Energy Project. DOE typically assumes, for comparison purposes, that under a No-Action Alternative the project would not occur without DOE's financial support. One of the goals of the No-Action Alternative is to help DOE present a clear distinction between potential impacts of project implementation and impacts of not proceeding with a project. DOE recognizes that, in some instances, the assumption that the project would not occur is unlikely to be correct. The University of Delaware's Wind Energy Project is such an instance: the University of Delaware has already built the wind turbine and the project will likely proceed to its conclusion with or without DOE funding. Nonetheless, in order to provide the DOE decisionmaker a useful comparison of impacts, DOE is defining the No-Action Alternative as one where the Wind Energy Project was not built and would not operate.

DOE is not required to fund the University of Delaware Wind Energy Project. While $1.43 million of the funds must be used for a "wind turbine model and pilot project for alternative energy" and $1 million of the funds must be used for "wind turbine infrastructure for green energy and research on wind power in Delaware," the funds are not mandated to go to this particular project. Thus, if DOE decided not to fund the University of Delaware Wind Energy Project, DOE could fund a different "Wind Turbine Model and Pilot Project for Alternative Energy" and a different "Wind Turbine Infrastructure for Green Energy and Research on Wind Power" in the State of Delaware. DOE would be required to comply with NEPA to assess the potential environmental consequences of any such future proposed project or projects; however, such an alternative project has not been identified and DOE cannot conduct such an analysis at this time. As such, DOE is not considering any action alternatives in this EA.

Elements of the Wind Energy Project are located in flood zones or floodplains. Specifically, an existing access road into the wind turbine location received minor upgrades in an area where the road is within a flood zone. Pursuant to Executive Order 11988, *Floodplain Management*, each federal agency is required, when conducting activities in a floodplain, to take actions to reduce the risk of flood damage; minimize the impacts of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains. Regulations issued by DOE that implement this Executive Order are contained in 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements." This regulation requires DOE to prepare a floodplain assessment for any proposed action in the base floodplain, which is the 100-year floodplain (that is, a floodplain with a 1.0 percent chance of flooding in any given year). At 10 CFR 1022.2(b), the regulation also states that whenever possible, DOE shall accommodate requirements of the Executive Order through the applicable NEPA procedures. Accordingly, it is DOE's intent that this EA meet the requirements for a floodplain assessment as described in Section 3.1 as well as meeting requirements under NEPA.

This document is also intended to fulfill DOE's obligations under the *Coastal Zone Management Act of 1972* (16 U.S.C. 1451 *et seq*.), Section 106 of the *National Historic Preservation Act* (16 U.S.C. 470 *et seq*.), and the *Native American Graves Protection and Repatriation Act of 1990* (25 U.S.C. 470 *et seq*.). Elements of these acts are addressed in subsequent sections of this chapter.

As a consulting agency (Section 1.3.2.1) and specifically in comments on the Draft EA, the U.S. Fish and Wildlife Service (USFWS) requested that Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," be identified and implemented in this EA. This Executive Order, established on January 10, 2001, identifies the responsibility of federal agencies to protect migratory birds and their habitats, and directs executive departments and agencies to undertake actions that will further implement the *Migratory Bird Treaty Act* (16 U.S.C. 703 *et seq*.). Executive Order 13186 includes a directive for federal agencies to develop a memorandum of understanding with the USFWS to promote the conservation of migratory bird populations, including their habitats, when their actions have, or are likely to have, a measurable negative effect on migratory bird populations. Whereas the *Migratory Bird Treaty Act* only protects migratory birds, the Executive Order provides for the protection of both migratory birds and migratory bird habitat. The Order encourages federal agencies to undertake several types of conservation actions for migratory birds including "avoiding or minimizing, to the extent practicable, adverse impacts to migratory bird resources when conducting agency activities…" and to "inventory and monitor bird habitat and populations within the agency's capabilities and authorities to the extent feasible."

1.2 Purpose and Need

1.2.1 DOE'S PURPOSE AND NEED

DOE's purpose and need is to fulfill Congress' statutory aims identified in the *Omnibus Appropriations Act of 2009* (Public Law 111-8) and the *Energy and Water Development Appropriations Act for Fiscal Year 2010* (Conference Report to Accompany H.R. 3183, Report 111-278). Specifically, Congress directed DOE to provide, respectively, $1.43 million for the establishment of a Wind Turbine Model and Pilot Project for Alternative Energy in the State of Delaware and $1 million for Wind Turbine Infrastructure for Green Energy and Research on Wind Power in Delaware.

1.2.2 UNIVERSITY OF DELAWARE'S PURPOSE AND NEED

The University of Delaware's purpose and need is to facilitate its primary mission of research and education, as well as to offset electricity usage requirements at the Lewes, Delaware, campus. The University anticipates undertaking research on aspects of wind energy that are unique or prevalent in the coastal environment. In addition, the wind turbine would provide a platform for hands-on education of students, as well as outreach to the larger Delaware community.

1.3 Public and Agency Involvement

This section addresses efforts the University of Delaware and DOE made to inform the public of the Wind Energy Project and to make contact with federal, state, and local agencies that could have involvement with permitting requirements or other concerns associated with the project.

1.3.1 UNIVERSITY OF DELAWARE ACTIONS

The University of Delaware announced its plans to study the feasibility of wind power generation at it Lewes campus over two years ago. Since that time, the University posted numerous public notices, provided news releases, participated in public meetings and interviews with the media, and coordinated with local and state agencies. The public notices were posted on the University's UDaily web site (http://www.udel.edu/edaily) and on the College of Earth, Ocean, and Environment web site (www.ceoe.udel.edu). In addition, many of the public notices associated with the Wind Energy Project were sent directly to media outlets throughout the state and region, including 2 primary daily newspapers in the state (*The News Journal*, and *Delaware State News*), more than 25 non-daily newspapers, several state magazines, and 20 radio and television stations (Ohrel 2010). One of the notices sent directly to the media outlets was an announcement of the availability of the Lewes turbine web site (http://www.ceoe.udel.edu/LewesTurbine). Specific examples of community outreach actions taken by the University are summarized, by date, below:

- December 27, 2007 – Meeting with the Lewes Board of Public Works: The Dean of the College of Earth, Ocean, and Environment of the University of Delaware met with the President and General Manager of the Board of Public Works to discuss the concept for a wind turbine in Lewes (Firestone 2010a).

- March 21, 2008 – Public Notice (and press release): The University announced plans to study the potential for wind power generation at its campus in Lewes, Delaware, to include installation of a temporary tower with electronic gear to support collection of data on local wind speeds and duration (UD 2008a).

- May 28, 2008 – Public Notice: The University announced completion of the 150-foot temporary tower to collect wind data, noted that the tower would be used to collect data for about 10 months, and that the data would be used to help determine the type and size of wind turbine that could be supported (UD 2008b).

- July 8 and 28, 2009 – Public Notice and Lecture: On July 8, 2009, the University announced a free and public lecture scheduled for July 28, 2009, at the College of Earth, Ocean, and Environment Campus in Lewes, Delaware as part of the Ocean Currents Lecture series (UD 2009a). As described in the announcement, the lecture was given by College administration and covered the results of an assessment on the feasibility of placing a turbine on the campus.

- July 27, 2009 – Public Notice: The University announced a memorandum of understanding between the University and Gamesa Corporación Tecnológica that could facilitate installation of a utility-scale 2.0-megawatt Gamesa wind turbine at the Lewes campus (UD 2009b).

- September 10 and October 4, 2009 – Public Notice and Coast Day Lectures: On September 10, 2009, the University announced planned activities for October 4, Coast Day, the University's celebration of the sea. Announced free lectures included "Harnessing Wind Energy at the University of Delaware" presented by a College of Earth, Ocean, and Environment associate professor (UD 2009c).

- October 19, 2009 – Public Notice: The University announced its final agreement with Gamesa Corporación Tecnológica to install a utility-scale 2-megawatt Gamesa wind turbine at the Lewes campus in 2010. The proposed location for the turbine was identified as being on land to the north and west of the campus buildings, with final details to be determined following additional meetings with regulators and the public (UD 2009d).

- November 3, 2009 – Meeting with the Delaware Sea Grant Advisory Board: The Fall meeting of the Advisory Board in Dover, Delaware, included discussions of placing a shore-side, utility-scale wind turbine at the University's coastal campus at Lewes (Firestone 2010a).

- December 16, 2009 – Regular Meeting of the Lewes Board of Public Works: A University representative attended and supported the public meeting of the Lewes Board of Public Works, where it was motioned to endorse a Memorandum of Understanding between the University and the Lewes Board of Public Works related to the connection of the proposed wind turbine generation to the Board's electric distribution system. The motion was seconded and carried (Lewes BPW 2009).

- January 11, 2010 – Regular Meeting of the Lewes Mayor and City Council: A University representative attended and supported the public meeting of the Lewes Mayor and City Council. After a question and answer period with the University representative, a motion was made to accept the Memorandum of Agreement with the University. The motion was seconded and carried (Lewes 2010a).

- February 16, 2010 – Meeting with the Delaware Shore Chapter of the U.S. Merchant Marine Retired: A representative of the University presented information on the Wind Energy Project (Firestone 2010a).

- February 23 and 28, 2010 – Public Notice and Question and Answer Session: On February 23, 2010, the University announced a free and public question and answer session to take place on February 28, 2010, at the College of Earth, Ocean, and Environment Campus in Lewes (UD 2010a). The session was described as including an overview of the project and what its development could mean for the campus and the community.

- February 24, 2010 – Presentation to the Pilottown Village Homeowners Association: At a routine meeting of the Homeowners Association, representatives from the University provided a presentation on the design, project development, implementation, and impact of the proposed wind turbine (Sleasman 2010a, 2010b, and 2010c).

- June 11, 2010 – News Release "University of Delaware and Gamesa commission coastal wind turbine": The University provided a news release on the June 11, 2010, ceremony to commission the wind turbine at the Lewes campus. Project participants and ceremony attendees were described (UD 2010b).

- July 19 and August 12, 2010 – Public Notice and Question and Answer Session: During the public comment period on the Draft EA, the University made a July 19, 2010, announcement of a free and public question and answer session to take place on August 12, 2010, at the College of Earth, Ocean, and Environment Campus in Lewes (UD 2010b). The session was described as being specifically for the wind turbine and moderated by the Dean of the College. (The meeting was held as scheduled and is briefly described below in terms of an August 20, 2010, article in the *Cape Gazette*.)

Examples of the articles appearing in local media that similarly provided the public information on the Wind Energy Project, include the following, by date:

- October 23, 2009 – Article "Wind power comes to University of Delaware campus in Lewes" in *Cape Gazette*: This article describes the Wind Energy Project and the agreements between the University and Gamesa Corporation. It also includes quotes from University and Gamesa representatives as well as from the governor of Delaware and the mayor of Lewes (MacArthur 2009).

- December 29, 2009 – Article "Lewes, UD enter turbine agreement" in *Cape Gazette*: This article describes the memorandum of understanding between the Lewes Board of Public Works and the University of Delaware related to the University's plan to build a utility-scale wind turbine on its Lewes campus (CapeGazette 2009).

- January 21, 2010 – Article "Lewes, UD forge wind turbine agreement" in *Cape Gazette*: This article describes the Lewes mayor and City Council's approval of the memorandum of agreement with the University, which was approved at the Lewes Board of Public Works December 2009 meeting (CapeGazette 2010a).

- August 20, 2010 – Article "Lewes-area residents, UD officials talk turbine – Questions, answers on wind-power plant" in *Cape Gazette*: This article describes the University of Delaware's forum held on August 12, 2010, at the Lewes campus to address the public's questions and concerns

> about the new wind turbine. The article also describes "more than 100 people, most of them Lewes homeowners or from surrounding areas" in attendance and asking questions (Evans 2010).

As part of feasibility and siting studies, the University sought input from the Delaware Department of Natural Resources and Environmental Control (DNREC) by submitting Wind Energy Project information for review by the regulatory advisory service offered by the State. The advisory service includes representatives from each division within the DNREC and helps businesses identify permits, regulatory requirements, and other environmental issues associated with their proposed projects. In mid-2009, the advisory service considered several different wind turbine locations under consideration by the University and provided input on issues or concerns related to the siting and installation of the wind turbine. As a result of the State's review, the DNREC was formally made aware of and has been involved in the Wind Energy Project's planning process since August 2009. The University's feasibility and siting studies are addressed further in Section 2.3.3 of this EA.

As a final example of its public outreach efforts, the University undertook a mail survey of public opinion from August 2009 to October 2009 by sending out a questionnaire to randomly selected addresses within the state. The addresses were grouped as inland, along the Atlantic Ocean, and along Delaware Bay, and included an over-sampling of people living along the Atlantic Ocean or Delaware Bay. Over 600 valid responses were obtained, for a response rate of about 50 percent. One of the questions in the survey asked if the respondent supported, was in opposition, or had no opinion with respect to placing a wind turbine at the Lewes Campus. Of the approximately 160 respondents along the Delaware Bay, 75 percent supported the project and only 2 percent opposed it. In the subset of those living in Lewes, there were 60 respondents, all of whom had very similar responses (73 percent supporting and 1 percent opposing). Statewide, respondents in support of the project were slightly lower, at 65 percent, but opposition was still low, at 5 percent (Firestone 2010b). This survey not only provided the University a feeling for the level of support for its project in the general population of the area, but also provided another mechanism for notifying the public of the proposed project.

1.3.2 DEPARTMENT OF ENERGY ACTIONS

DOE's involvement in the University of Delaware's Wind Energy Project began after the *Omnibus Appropriations Act of 2009*. DOE initiated formal consultations with the responsible USFWS field office and with the Delaware State Historic Preservation Officer (SHPO). DOE initiated the consultations to comply with the provisions of the *Endangered Species Act of 1973*, as amended (16 U.S.C. 1531 *et seq*.), and the review requirements of Section 106 of the *National Historic Preservation Act*, as amended (16 U.S.C. 470 *et seq*.). DOE also sent requests to two federally recognized American Indian tribes and two State-recognized tribes for information those tribes have, and are interested in sharing, about properties of traditional religious or cultural significance within the vicinity of the project site, and any comments or concerns they have on the potential for the Wind Energy Project to affect those properties. This information was requested to aid in the preparation of this EA and to meet DOE's obligations under the *Native American Graves Protection and Repatriation Act of 1990*, as well as the *National Historic Preservation Act*. Appendix B of this EA contains a copy of the consultation letters DOE sent to the USFWS, the SHPO, and tribal governments and their subsequent responses. These letters and any responses provided are further addressed below.

DOE also conducted informal consultations with staff of the Delaware Coastal Management Program with regard to compliance with the *Coastal Zone Management Act of 1972*. The final two DOE actions described below include one taken to identify interested parties wishing to be notified of the release of the Draft EA and the second taken to release the Draft EA for public review and comment.

1.3.2.1 U.S. Fish and Wildlife Service

On April 30, 2010, DOE requested information from the USFWS Chesapeake Bay Field Office on the identification of listed or proposed species or designated or proposed critical habitat that might be present in the project area.

DOE sent a preliminary draft of the Draft EA to the USFWS Division of Migratory Bird Management for comments on the impact of the project on species protected under the *Bald and Golden Eagle Protection Act* (BGEPA). DOE received an email dated July 14, 2010 from the USFWS requesting a 30-day extension to the public comment period. As described in Section 1.3.2.6, DOE subsequently extended the comment period to August 17, 2010.

The USFWS Chesapeake Bay Field Office responded to DOE in a letter dated July 15, 2010. The letter identified the piping plover as the only currently identified federally listed threatened or endangered species found in the vicinity of the Wind Energy Project site, with the possible exception of occasional transient individuals of other species. The letter also discussed requirements under the BGEPA and noted that if the project could not avoid disturbance to the bald eagle, a proposed permit program to authorize the take of bald or golden eagles under specific conditions would be available once the USFWS issued a final rule. Finally, the letter identified the Service's concern for protection of wetlands and noted that all wetlands within the project area should be identified and recommended that wetlands impacts be avoided.

In its July 29, 2010, letter to DOE, the USFWS Chesapeake Bay Field Office concurred with DOE's conclusion that the proposed project is not likely to adversely affect the piping plover. On receiving this letter, DOE fulfilled its consultation requirements under Section 7 of the *Endangered Species Act*.

The USFWS provided comments on the Draft EA via letter dated August 17, 2010. The USFWS expressed its concern about not being involved until after the wind turbine was constructed. The USFWS further stated that, because of the wind turbine's location in a migratory bird travel corridor, it could not support a Finding of No Significant Impact (FONSI). The letter concluded with a recommendation that the University of Delaware should "develop a research project to monitor and measure the effects of wind turbines on avian and bat species in the Delaware Coastal Bay." The USFWS comments and DOE's responses are further addressed in Section 1.4 of this EA.

On September 13, 2010, the USFWS Chesapeake Bay Field Office met with the University of Delaware to discuss the Service's concerns over bird and bat impacts from wind turbine operations at the Lewes campus. The University of Delaware subsequently received a letter from the Chesapeake Bay Field Office, expressing its encouragement by the University's willingness to "monitor and evaluate impacts to bird and bat species as a result of this wind turbine project." The letter further indicated that, per discussions in the meeting, "if the University develops an Avian and Bat Protection Plan (ABPP) addressing monitoring and evaluation protocols and how the University will minimize impacts to bird and bats, the Service will be in a position to support a FONSI."

The USFWS Chesapeake Bay Field Office provided DOE a letter dated November 3, 2010, summarizing recent involvement with representatives of the University of Delaware. The letter stated that the University had committed in its September 30, 2010 letter to (1) develop an ABPP, addressing monitoring and evaluation protocols and adaptive management and (2) form an Advisory Group by mid-November. Because of these commitments, the USFWS agreed to support a FONSI for the Draft EA developed for the project. Consistent with the conditions for USFWS support of the FONSI, DOE made the University's development and implementation of an ABPP an enforceable condition of the proposed funding. Section 3.2.2.1.4 of this EA addresses contents of the Protection Plan and related measures.

1.3.2.2 State Historic Preservation Officer

On April 30, 2010, DOE requested information from the Delaware SHPO about the existence of known historic properties within 1 mile of the project site. In so doing, DOE initiated consultation with the SHPO under Section 106 of the *National Historic Preservation Act*.

On May 11, 2010, the Delaware SHPO responded and identified seven properties listed in the National Register of Historic Places that are within 1 mile of the turbine's location and provided a map of their locations. The letter further indicated there were (1) seven additional historic buildings and structures within 1 mile, but that were believed to not be eligible for the National Register; and (2) nine additional archaeological sites within the area that have not been evaluated for eligibility for the National Register.

The Delaware SHPO informed DOE by letter dated May 24, 2010, that archaeologists from the Delaware Division of Historical and Cultural Affairs had conducted a site visit and determined there were no adverse impacts to archaeological resources as a result of construction of the wind turbine and its access road. The letter also noted that the right-of-way for underground electrical lines between the wind turbine site and the University campus was not yet evaluated. In a subsequent letter dated July 19, 2010, the Delaware SHPO informed DOE that a site visit was performed on the area of the utility connection and it was determined that no archaeological resources had been disturbed by the turbine project. The SHPO's findings are discussed further in Section 3.3.2.1.

In a letter dated June 5, 2010, the Delaware SHPO provided DOE results from its field review to assess the visibility of the wind turbine from the historic properties closest to the turbine site. The SHPO's findings are described in Section 3.6.2.1.

The Delaware SHPO provided DOE a letter dated October 22, 2010, summarizing its involvement in the University of Delaware Wind Energy Project and provided conclusions. The letter indicated that since there was only one individual that expressed an objection to the visual effects of the turbine and because of his office's findings that no significant archaeological sites were disturbed, his office concurred with DOE's finding "that construction of the wind turbine will not adversely affect any properties listed on or eligible for listing on the National Register of Historic Places." Upon receipt of this letter, DOE completed its consultation obligations under Section 106 of the *National Historic Preservation Act*.

1.3.2.3 Tribal Governments

On May 20, 2010, DOE requested information from potentially interested American Indian tribes on properties of traditional religious and cultural significance within the vicinity of the Wind Energy Project and any comments or concerns they might have on the potential for this project to affect those properties. Letters were sent to two federally recognized tribes, The Delaware Nation and the Stockbridge-Munsee Community of Wisconsin, and two State-recognized tribes, the Nanticoke Indian Association and the Lenape Indian Tribe of Delaware. DOE subsequently sent a similar request for information to the federally recognized Delaware Tribe of Indians on July 22, 2010.

On the USFWS's recommendation, DOE and the Delaware SHPO discussed the possibility that eagle habitation in the vicinity of the University might render the landscape a potential historic property of religious and cultural importance to Indian tribes such that DOE and the SHPO would have to consider impacts to eagle habitation during consultation under Section 106. At the time of the discussions, there was no reason to believe that tribes that have a current or historic presence near the University Wind Energy Project site considered eagle habitation (which includes eagles and eagle nests) sacred. However, DOE asked the tribes referenced above with interest in the Wind Energy Project site to identify whether eagle habitation is sacred to them.

In a response of May 25, 2010 (Appendix B), the Stockbridge-Munsee Tribal Historic Preservation Officer indicated the University of Delaware wind turbine location was not an area of the Tribe's concern.

The Delaware Nation responded in a letter dated June 16, 2010, that it would be a consulting party on the project and that the Cultural Preservation Director would make a determination after review of the project.

On August 4, 2010, the Tribe Historic Preservation Office of the Delaware Tribe of Indians responded with a letter to DOE. The letter stated its review indicated no religious or culturally significant sites in the project area, so the Tribe would defer any comments in that regard to the Delaware SHPO or State Archaeologist. The letter also stated that if human remains were uncovered during the project development, the Tribe wished to receive notification, continue as a consulting party, and that project development be cease immediately. Since the University of Delaware wind turbine was already constructed and in operation at the time of this correspondence, DOE will provide the Tribe with a copy of this Final EA for their review and information.

In its response dated August 17, 2010, the Lenape Indian Tribe of Delaware stated its historic record indicates their people were likely drawn to the project area for reasons including worship and resource gathering, and that the area could contain culturally sensitive materials including those related to ancient burials. However, the letter states that since the wind turbine was already completed, it is assumed that no sensitive materials were uncovered. The letter also indicated the Lenape hold eagles and eagle habitat in high regard, further stating that some Lenape men wore a single eagle feather in their headdress to display reverence.

On October 18, 2010, DOE responded to the Lenape Indian Tribe, confirming that no sensitive materials were uncovered or disturbed during construction of the wind turbine. The letter also described the monitoring and adaptive management efforts that would be required of the University of Delaware as a condition of funding in order to reduce potential impacts to wildlife. The letter stated DOE's determination "that holding the University to this standard will result in the minimization of potential adverse effects to eagles and their nests, and will thus provide sufficient protection to the landscape associated with eagle habitation as sacred site under Section 101(d)(6)(a) of the NHPA". Thirty days has passed since DOE sent the letter to the Lenape Indian Tribe, and DOE has not received an objection from the Tribe to the Department's no adverse effect determination. DOE will provide the Tribe with a copy of this Final EA for its review and information.

1.3.2.4 Delaware Coastal Zone Management Program

The DOE's proposal to provide funding to the University of Delaware's Wind Energy Project triggered an additional regulatory requirement for the project under the *Coastal Zone Management Act of 1972* (16 U.S.C. 1451 *et seq.*). The Act's implementing regulations, "Federal Consistency with Approved Coastal Management Programs," 15 CFR Part 930, state that federal agencies may only grant federal assistance to applicant agencies for activities affecting any coastal use or resource when such activities are consistent with approved management programs (15 CFR 930.90). As an applicant agency, the University of Delaware must submit its application for federal funding as well as an evaluation of the consistency of the Project with the enforceable policies of the management program to DNREC, the state agency responsible for consistency review (15 CFR 930.94). If DNREC does not object to the Wind Energy Project, then DOE may provide funding for the Wind Energy Project in compliance with other applicable law.

In a communication dated October 15, 2010 (Appendix B), sent to DNREC, the University of Delaware explained that the Wind Energy Project is consistent with particular provisions of the Delaware Coastal Management Program that are set forth in Title 7, Section 5104 of the Delaware Administrative Code.

The DNREC responded by letter dated October 29, 2010, that it conditionally concurred with the University of Delaware's consistency determination. The conditions reflect commitments that the University of Delaware has made and that are identified in Section 3.2.2.1.4 of this EA. These include commitments to (1) develop and implement a monitoring plan to assess impacts to birds and bats resulting from the operation of the wind turbine; (2) institute adaptive management practices should impacts exceed certain thresholds for species of concern; and (3) convene an advisory committee to provide guidance and assistance with the development of the monitoring plan, assessment of impact thresholds, and implementation of adaptive management practices.

Because the University of Delaware has committed to satisfy all of the conditions on which DNREC based its concurrence, all relevant parties have satisfied their obligations under the *Coastal Zone Management Act*, and DOE may proceed to fund the Wind Energy Project in compliance with other applicable law.

1.3.2.5 Identification of Interested Parties

DOE published notices in the June 1, 2010, editions of the *Cape Gazette* of Lewes, Delaware, and *The News Journal* of Wilmington, Delaware, of its intent to release a Draft EA on the University of Delaware Wind Energy Project for public comment. The notice further asked parties interested in receiving the subsequent Notice of Availability for the Draft EA to provide DOE a name and mailing address or an email address. DOE received no responses or expressions of interest from this notice.

1.3.2.6 Release of Draft EA for Public Review and Comment

A Notice of Availability for the Draft EA was placed in *The News Journal* (Wilmington, Delaware) June 18, 19, and 20, 2010, and in the *Cape Gazette* (Lewes, Delaware) on June 16, 2010, which identified the June 18, 2010, start date of a 30-day public comment period. The Draft EA was made available for public review at the Lewes Public Library, mailed to individuals and agencies listed in Appendix A of this EA, and, as described in the Notice of Availability and the Draft EA itself, posted on the DOE NEPA web site: http://www.nepa.energy.gov. As a result of requests from several agencies and interested parties, DOE extended the public comment period, and placed a notice announcing a 30-day extension in *The News Journal* on July 16, 17, and 18, 2010, and in the *Cape Gazette* on July 20, 2010. Postcards announcing the extension were also mailed to interested parties, and a notice of the extension was included with the posting of the Draft EA on the DOE web site. The Draft EA was thus made available for public review for a total of 60 days, from June 18, 2010, through August 17, 2010.

DOE invited and encouraged interested parties to comment on the Draft EA by submitting comments to the document manager via email, letter, or fax at the addresses or telephone number identified in the announcements and the Draft EA. Comments received on the Draft EA are discussed in Section 1.4.

1.4 Draft EA Comments and Responses

DOE received 27 comments during the public comment period for the Draft EA. This included comments from 7 different local, state, or federal agencies, or Indian tribes; 4 from interest groups; and 11 from members of the public. In several instances, multiple comments were received from the same individual or agency, and several comments were requests for extension to the public comment period or general expressions of interest in the project. Comment letters received from the USFWS and from Indian tribes are considered to be part of formal consultation processes and, as a result, are also described in Sections 1.3.2.1 and 1.3.2.3, respectively.

Several of the letters and emails DOE received contained detailed comments on specific sections and discussion topics of the Draft EA. Comments of this nature included those from the USFWS, the DNREC Delaware Coastal Programs, The Nature Conservancy, and the Delmarva Ornithological Society. DOE reviewed these comments and made changes and additions to the text of the EA as appropriate.

A primary concern recurring in several comments, including from those entities specified in the preceding paragraph, was the potential for impacts to biological resources, in particular to avian and bat species. These comments noted that the wind turbine is located in an important migratory bird corridor and several commenters encouraged DOE to consider studies to monitor the turbine's effects on birds and bats and to develop designs and actions that might reduce such effects. Sections 3.2.1 and 3.2.2 in this Final EA were revised to clarify potential impacts to avian and bat species and to describe the ABPP (Section 3.2.2.1.4) the University of Delaware will develop and implement as a condition of funding.

The USFWS, the DNREC, and The Nature Conservancy described other potential wind energy actions in the region that could result in cumulative impacts and, therefore, should be addressed in the EA. As a result of these comments, the Cumulative Impacts section of the EA was expanded to discuss the University's proposed offshore wind turbine testing facility and proposed offshore wind farm programs under consideration by the U.S. Department of the Interior (DOI) and several coastal states, including Delaware.

Both the USFWS and the DNREC commented that several additional laws should be identified as applicable to the University's Wind Energy Project because they affect actions described in the EA. Sections 1.1, 1.3.2.4, and 2.2.3 were modified to identify and discuss the additional laws.

The DNREC and The Nature Conservancy comments clarified land ownership in the area and identified land in the surrounding area with specific natural resource designations. The information was added to several sections of the EA, including Section 2.2.1 for ownership of the dredge spoils area, Section 3.2.1 for The Nature Conservancy's role in the Great Marsh, and Sections 3.2.1 and 3.6.1.1 for areas with specific natural resource designations.

Other comments were more general in nature, ranging from brief expressions of support for the project to long discussions in opposition to the project. Comments in support of the project required no action from DOE, while those in opposition often included topics outside the scope of the EA. DOE believes such comments did not typically warrant specific changes to EA text, but should be discussed. The remainder of this section addresses such comments in the following format: issues, questions, or concerns raised in one or more of the comments are grouped into six categories, the comments are then summarized, and DOE's response for the summary follows.

Requests for Public Comment Period Extension

Summary of Comments – DOE received several comments, including from the Delaware Coastal Management Program, the USFWS, Mayor Ford of Lewes, and four members of the public, requesting an extension to the 30-day public comment period. The state and federal agencies requested 10- and 30-day extensions, respectively. The members of the public each requested an extension to December 31, 2010, with one indicating this would allow residents to experience the wind turbine in different weather. One of the individuals also described an extension of 60 days after receipt of materials requested under the Freedom of Information Act as an alternative to the extension to December 31, 2010.

Response – As described in Section 1.3.2.6, DOE extended the public comment period by 30 days, from an original end date of July 18, 2010, to an end date of August 17, 2010. With the extension, there was a 60-day public comment period on the Draft EA for the University of Delaware Wind Energy Project.

This length of comment period is well beyond the average for EAs of similar scope and DOE did not believe there was sufficient reason to extend it to the end of the calendar year.

Land Transactions

Summary of Comments – Two comments went into some detail on past land transactions involving the University of Delaware and the land adjacent to the University's Lewes campus, including the land where the dredge spoils and wind turbine are located. The commenters disapproved of these past actions and, as a result, are skeptical of the University's current wind turbine actions and question whether current property transactions are appropriate. One of these commenters also referenced a current bond bill, which includes a request for the University to get the adjacent property back after it had been sold to the State during the previous transactions.

Response – Past land transactions and whether area residents approved or disapproved of those transactions are beyond the scope of the EA. The recent land transactions (that is, those with some bearing on the current wind turbine project) are summarized as follows:

- In 2002, the University of Delaware transferred to DNREC a 261-acre parcel of land adjacent to its campus in Lewes. DNREC paid $3.1 million for the property through the Delaware Open Space Program, and the property is owned today by DNREC's Division of Parks and Recreation. The property includes a 40-acre dredge spoils site close to the University's campus. When title to the property was transferred from the University to DNREC, the University retained an easement to ensure use of and access to the dredge spoils site.

- In 2008, the University commenced a feasibility study to place a utility-scale wind turbine on or near its Lewes campus for the dual purposes of generating carbon-emission-free electricity and enhancing the University's research mission. In 2009, University officials met with DNREC regarding potential locations for the wind turbine, after which the University decided to site the wind turbine at DNREC's preferred location, which was within the dredge spoils site.

- On February 2, 2010, the University and DNREC executed an amendment to the 2002 dredge spoils site, clarifying and confirming the University's entitlement of using the dredge spoil site for any lawful purpose, including construction of a wind turbine.

As described in a comment, Delaware House of Representatives 145th General Assembly House Bill No. 500 (signed on July 1, 2010) authorizes the Secretary of the DNREC to negotiate a transfer of the land adjacent to the Lewes campus to the University in exchange for funds or property of at least equal value (Section 87, page 37). The comment provides more detail on this element of the Bill in the form of a query response from a DNREC representative. DOE is in no position to comment on whether these actions were taken in "good faith" by DNREC and the University as questioned by the commenter and whether the City of Lewes and its residents are aware of the action.

Impacts on Property Values

Summary of Comments – A couple of comments from members of the public expressed concern that the wind turbine's location would result in lower property values. One commenter suggested that if the University of Delaware believed this was not a problem that it should be willing to indemnify nearby property owners against any possible property value losses. This commenter also provided a copy of a signed Property Value Guarantee Agreement between the owner of a wind farm in DeKalb County, Illinois, and a typical property owner. The agreement appeared to be designed for any property owner within three-quarters of a mile of a wind turbine and, within specific terms and guidelines established in the agreement, promise reimbursement to property owners if they sold their property and it could be shown they suffered a loss as a result of the wind farm's presence.

Response – The Lawrence Berkley National Laboratory published a DOE-funded report (Hoen et al. 2009) that provided an indepth evaluation of the impacts of wind power projects on residential property values in the United States. The research included collection of data on almost 7,500 sales of single-family homes within 10 miles of 24 existing wind facilities in nine states extending from Pennsylvania and New York in the east to Washington and Oregon in the west. The conclusion of the study recognized that individual homes could be negatively impacted, but if such impacts existed in the sample of homes analyzed, they were either too small or too infrequent to result in a statistically observable effect. Overall, the study concluded that none of the evaluations performed revealed conclusive evidence of any widespread property value impacts.

The situation presented in the commenter's example is much different than that posed by the University of Delaware's Wind Energy Project. The wind farm in DeKalb County, Illinois, has well over 100 wind turbines and has so different a noise and visual impact profile from a single wind turbine that it provides little guidance on how significant the impacts of the Wind Energy Project will be on property values.

Appropriateness of City's Approval of Wind Turbine

Summary of Comments – Several comments expressed concern that the City of Lewes' approval of the wind turbine was inappropriate. These included comments that the wind turbine violated the City's height restrictions; no rezoning was done to accommodate the wind turbine even though the action had zone-change-like results; the City's action was not protective of citizens' health and safety; the agreement (of February 2010) with the University, which exempts the Wind Energy Project from height restrictions, improperly describes the property where the wind turbine is located; the size of the turbine was greater than originally applied and too large for the "quaint and historic town of Lewes"; and approval was done behind closed doors with little or no opportunity for public involvement.

Response – Although DOE acknowledges the concerns of Lewes residents, the evidence provided to DOE is that the approval was done under an open process, according to the City's typical procedures. The agreement between the City and the University specifically exempts the turbine from the height restriction requirement and describes the project location as "within the UN University or College District established by Zoning Code, Chapter 197 of the Code of the City of Lewes and the Zoning Map of the City of Lewes," which "permits various uses by right, including 'research and development laboratories'." This zoning designation is consistent with the zoning map presented in the *City of Lewes Comprehensive Plan* of October 2005 (Lewes 2005), which is available on the City's web site. Based on information provided by the University on the meetings and announcements of the proposed wind turbine project (Section 1.3.1), ample information was made available to residents, and City records document discussions in public meetings. Per discussions in this document, including those in this section, it is DOE's position that the wind turbine project should not adversely impact the health and safety of the citizens of Lewes.

With respect to the City or residents being misled about the size of the wind turbine, DOE could not determine whether this was a specific item of discussion in public presentations or meetings, but by about May 2009, when the feasibility study was complete, the University knew the area's wind profiles would support a 1- to 2-megawatt wind turbine. By the end of July 2009, an article in the University's UDaily identified plans for a 2-megawatt Gamesa wind turbine, and by October 19, 2009, the University announced via a news release that arrangements for a 2-megawatt turbine had been finalized. The *Cape Gazette* subsequently ran an article on October 23, 2009, that identified a 2-megawatt wind turbine. Again, DOE did not note that physical dimensions were identified in these articles, but information about the size of 1- to 2-megawatt wind turbines is readily available on the Internet, including on the Gamesa web site. It does not appear there was any attempt to mislead or conceal the size of the wind turbine. Further, based on comments received in favor of the project, there are citizens in Lewes that do not feel the wind turbine is too large for the city.

Noise and Health Effect Impacts

Summary of Comments – Several members of the public commented that the Draft EA did not adequately address noise impacts and the associated adverse health effects on residents in close proximity to the wind turbine. One commenter noted potential loss of sleep as a primary concern for residents near the wind turbine and cited an Acoustic Ecology Institute publication: "There is little question that noise levels more than 5 or 10dB over the still late-night ambient levels of 20-30dB can wake people. Some wind farm neighbors report many nights of getting only four or five hours of sleep. Less appreciated is that low levels of noise also trigger non-waking arousal during sleep which disrupts normal sleep stages, leaving the sleeper less well-rested upon waking in the morning" (AEI 2010). The same commenter identified support for use of a 1.25-mile setback between wind turbines and residences. Another commenter questioned the Draft EA's use of A-weighted decibels in describing noise impacts because C-weighted measurements would be crucial for evaluating impacts from low-frequency noises.

Response – The EA (Section 3.5.2.1) recognizes that some individuals could be bothered by the sounds produced by the operating wind turbine. Studies have shown that some individuals are more sensitive to the sounds than others. Studies have also shown that annoyance from wind turbine sound is higher among groups of people with negative attitudes toward wind turbines (DOE 2010a) as a result of other or more general reasons, including the turbines' visual impact, shadows and shadow flicker, a lack of control or feeling of injustice over their presence, and other conditions by which people are bothered. This is not to say that individuals are fabricating their annoyance with the sound of the turbine or do not experience adverse effects from stress or sleep loss, but rather that the causes of adverse effects can be very complicated, often involving more than just sound. Three separate evaluations on the health impacts of wind turbines were recently completed by experts from the United States, Canada, and Australia. These evaluations included reviews of current, relevant literature, and each concluded there was no demonstrated direct link between wind turbine noise and adverse health effects (Colby et al. 2009; Ontario CMOH 2010; Australia NHMRC 2010). DOE believes this EA uses accepted practices and standards to evaluate noise impacts from the University of Delaware Wind Energy Project and has found predicted noise levels to be in the normally acceptable range.

The EA (Section 3.5.2.1) addresses potential impacts to sleep, and although the decibel levels described in the EA appear different than those in the comment, they are not inconsistent. The comment states that people can be awakened by noise levels more than 5 or 10 decibels (dB) over the still, late-night ambient levels of 20 to 30 dB. The EA states that levels of 40 to 45 A-weighted decibels (dBA) awaken 10 percent of sleeping people. The EA also describes measured, outdoor ambient noise levels in residential areas near the Lewes campus as 37 to 41 dBA (with the on-campus Virden Center at about 44 dBA). With people sleeping indoors, with windows closed, these measured outdoor ambient levels would be reduced and easily comparable to the 20 to 30 dB still, late-night values described in the comment. More importantly, however, is the fact that the wind turbine noise values, as described in the EA (about 38 dBA at the nearest residence) are basically no different than the measured outdoor ambient noise levels. That is, the wind turbine is not expected to produce noise levels that are as high as 5 or 10 decibels over the still, late-night ambient levels.

There is no doubt that increasing the distance between wind turbines and residences or other dwellings decreases the potential for adverse noise or visual impacts to the individuals living at those locations. However, DOE is not aware of any legal requirement or widely recognized standard for a specific setback to apply to this situation and knows of no reason why a 1.25-mile setback would present a unique benefit. That is, a 1.5-mile setback would have lower noise levels than a 1-mile setback, but by most guidelines, noise levels would be within acceptable levels anywhere in that range, or closer. For example, the U.S. Environmental Protection Agency's (EPA's) guideline for a residential day-night average noise of 55 dBA (EPA 1974) could be achieved by the single wind turbine evaluated in this EA with a setback of about 1,100 feet (the distance to the 45-dBA contour shown in Figure 3 of Appendix E). The University of Delaware's primary purpose for the wind turbine is to facilitate its mission of research and education (Section 1.2.2). The best way to support this mission was to locate the wind turbine in close proximity to the University's Lewes campus. Both the University's and DOE's evaluations indicate that the selected location is reasonable with respect to noise and visual impacts to the nearest residential areas.

The use of the A-weighted decibel scale is standard in environmental evaluations because it better approximates the range of human hearing (Section 3.5.1). The comment is correct that the A-weight scale does not account for low-frequency sound, but the significance of low-frequency sound from wind turbines is not supported by data. Low-frequency sounds are in the range of 20 to 100 hertz and infrasonic sound (or infrasound) is low-frequency sound of less than 20 hertz. Compared to higher frequency sound, low-frequency sound persists over longer distances, is transmitted through buildings with less dampening, and can involve structural vibrations (for example, rattling windows or doors). Older designs of wind turbines, particularly those in which the blades were on the downwind side of the turbine tower, produced more low frequency sound as a result of the blades passing through more turbulent air. (In the case of the downwind turbines, turbulence was increased by the tower blocking wind flow.) Modern, upwind turbines produce a broadband sound emission that includes low-frequency sounds, but not at significant levels. A primary cause for low-frequency sounds in modern turbines is the blade passing through the change in airflow at the front of the tower, and this can be aggravated by unusually turbulent wind conditions. The University of Massachusetts at Amherst reported (Rogers 2006) on broadband noise measurements made at four different wind turbines ranging in size from 450 kilowatts to 2 megawatts. The results indicated that at distances of no more than 118 meters (387 feet) from the turbines, all infrasound levels were below human perception levels. The report further states that there is "no reliable evidence that infrasound below the hearing threshold produces physiological or psychological effects." This lack of effects at levels below the hearing threshold was supported by a scientific advisory panel composed of medical doctors, audiologists, and acoustic professionals established by the American and Canadian Wind Energy Associations to review wind turbine sound and health effects (Colby et al. 2009). It was also supported by the findings from Canadian and Australian government reviews of available scientific literature (Ontario CMOH 2010; Australia NHMRC 2010).

General Comments on the Adequacy of the EA

Summary of Comments – Several comments were critical of the EA for making no mention of ice shedding or throwing issues. One comment indicated the descriptions of the University of Delaware interactions with the public and government groups lacked substance. One comment was critical of the Acoustic Study included as Appendix E of the EA, indicating it could not have been published in January 2009 when it said field measurements were taking in November of 2009 and that the information was manipulated by picking measurement month, day, and times "when it is likely that existing sounds would be slight."

Response – Section 3.4.2.1 of the Draft EA, and now the Final EA, describes the potential for wind turbine blades to accumulate and throw ice under specific conditions. It was concluded that the distance of the wind turbine from public roads and residences or populated buildings would prevent this from being a hazard to the public should it occur.

The EA's descriptions of the University's interactions with the public and government groups (Section 1.3.1) was intended only to highlight the nature and extent of actions taken to inform the public and contact government agencies with regard to the Wind Energy Project. References are provided that can be reviewed for additional detail.

With regard to the Acoustic Study presented in the EA, the comment is correct that the completion date shown on the cover and title page is incorrect. The date should show the report's completion as January 2010 rather than 2009. It is believed this was no more than an error caused by the habit of using "2009" after the transition into the new year. The information addressed in the report was clearly collected and evaluated late in 2009, supporting the January 2010 completion. A note to this effect has been added to the cover page of the Acoustic Study in the Final EA.

In response to the comment on the validity of the sound measurement data included in the report, DOE believes the data are accurate, but recognizes that one may question whether such data, collected over a relatively short time represent those of other or longer periods of time. The field efforts were designed to gather data representative of day and night conditions in order to establish an estimate of sound characteristics over a typical day in the Lewes area, when winds are sufficient to support turbine operations. Based on information presented in reference materials (for example, EPA 1974 and Colby et al. 2009), the measured sound levels reported in the Acoustic Study appear consistent with what would be expected for a residential area in a community like Lewes.

1.5 Considerations Not Carried Forward for Further Analysis

Consistent with NEPA implementing regulations and guidelines, DOE focused its analysis on topics with the greatest potential for environmental impacts. The University of Delaware Wind Energy Project is not expected to have measureable effects on certain resources, and these resources are not analyzed in Chapter 3. However, for each of the applicable resource areas, Section 3.9 provides a basis for the reason(s) it was not carried forward for further analysis.

2. PROPOSED ACTION AND ALTERNATIVES

This chapter describes DOE's Proposed Action (Section 2.1), the University of Delaware's proposed project (Section 2.2), and alternatives to both, including the No-Action Alternative (Section 2.3).

2.1 DOE's Proposed Action

DOE Proposed Action is to support national energy needs and the development of alternative energy sources by providing the University of Delaware with $2.43 million in financial assistance in a cost-sharing arrangement to facilitate the University's placement of a wind turbine adjacent to its campus in Lewes, Delaware.

2.2 University of Delaware's Proposed Project

The University of Delaware's Wind Energy Project is described in terms of the wind turbine, associated land disturbance, and permits and approvals.

2.2.1 WIND TURBINE

The University of Delaware's Wind Energy Project involves the installation of a single, 2-megawatt wind turbine in a previously disturbed area adjacent to its College of Earth, Ocean, and Environment Campus in Lewes, Delaware. The turbine site is on land owned by the DNREC, Division of Parks and Recreation, but the University has an easement and a signed Memorandum of Agreement with the Division that allows use of the area for the turbine.

Figure 2-1 is a map of the Lewes area, which is on the central, east coast of Delaware at the lower reach of Delaware Bay. The figure also shows the location of the University of Delaware campus in Lewes. Figure 2-2 shows two aerial photographs of the Lewes area.

The top photograph is roughly the same view as Figure 2-1 but on a larger scale. The white feature in the upper right of the photograph is Cape Henlopen, which marks the southern extent of Delaware Bay. Directly across the bay to the northeast is Cape May (not shown in the figure) of New Jersey. To the right or east of Cape Henlopen is the Atlantic Ocean. The bottom photograph of Figure 2-2 shows a closer view of the University campus and the specific site where the wind turbine is located.

The City of Lewes is a relatively small community with a 2008 population estimated at just over 3,100 people (USCB 2008b). This population can, however, increase significantly during tourist season. As can be seen in the figures, the commercial and residential areas of the city are primarily to the southeast of the University campus and the project location.

Note: In July 2009, the University of Delaware's Lewes Campus became part of the College of Earth, Ocean, and Environment. The College of Marine Studies shown on this map is an outdated term.

Figure 2-1. Map of the Lewes, Delaware area, including the local University of Delaware campus.

Figure 2-2. Aerial photographs of the Lewes, Delaware, area centered on the Wind Energy Project site.

The wind turbine construction, or installation, location is an existing dredge spoils area to the west of the University campus, roughly 1,200 feet west from the nearest campus facility and further from any Lewes residences. Land disturbance at the turbine site included a 3,200 square-foot octagonal pad with a deep foundation system, a transformer, and a construction laydown area of roughly 200 by 100 feet in size. The deep foundation system is called a rammed aggregate pier system, which, as depicted in Figure 2-3, is formed by filling a drill hole with compacted layers of gravel. As each layer is compacted by ramming, the surrounding natural material is also compacted, forming a deep and stable base. The project included

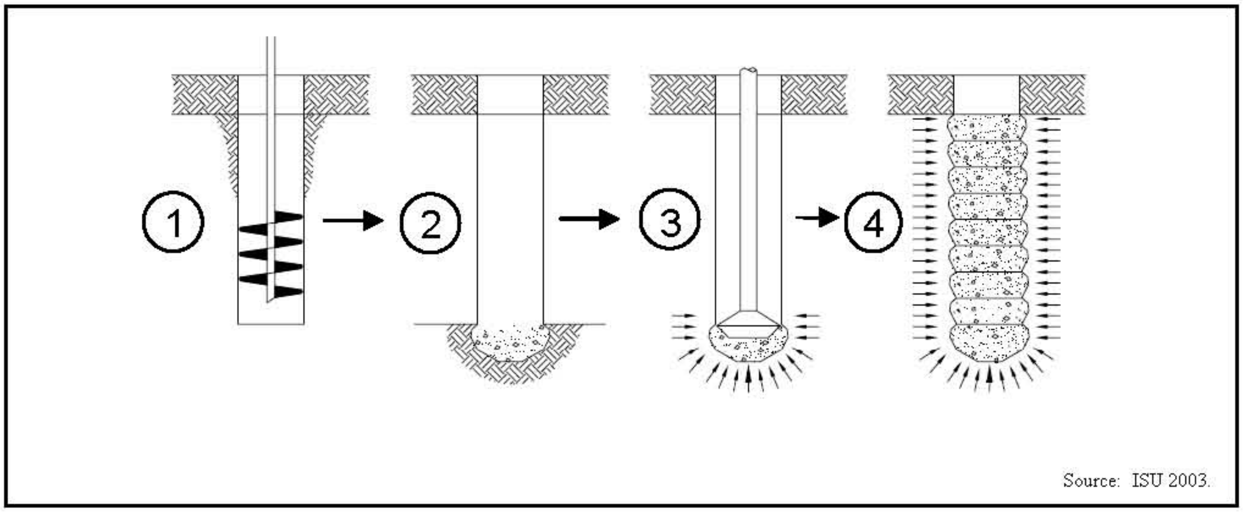


Figure 2-3. Illustration of a rammed aggregate pier construction process: (1) drill cavity, (2) place stone, (3) ram stone to form bottom bulb, and (4) place and ram lifts to form undulated-sided shaft.

a new 1,200- foot-long and 12-foot-wide access road from the northeast into the wind turbine location. The existing 850-foot gravel road from Pilottown Road to the dredge spoils area was upgraded to support movement of construction and delivery vehicles. The new road extends from the north end of the spoils area to the wind turbine location in the southwest portion of the spoils area. New, buried electrical lines follow the access road from the wind turbine, and then run eastward toward the campus area. Figure 2-4 shows the planned layout of the wind turbine pad in relation to the access road.

The specific wind turbine the University of Delaware selected for this project is the Gamesa G90-2 MW. The wind turbine weighs approximately 310 tons (620,000 pounds) and has a hub height of 80 meters (262 feet) above the ground surface. The diameter of the rotor is 90 meters (295 feet), so with a blade extended vertically upward, it reaches 125 meters (410 feet) above the ground (Figure 2-5). The wind turbine operates with a variable rotor speed ranging from 9 to 19 revolutions per minute. The manufacturer’s brochure (Gamesa 2009) identifies a cut-in wind speed of 3 meters per second (6.7 miles per hour), which is the minimum wind speed for the turbine to operate. The wind cutout speed is 25 meters per second (60 miles per hour). The wind turbine has dual braking capabilities. The primary brake is aerodynamic and is implemented by feathering the blades. A full feathering results in wind providing no rotational force to the blades. The secondary brake is a hydraulically activated mechanical disc brake on the gearbox high-speed shaft, which can be activated for emergencies.

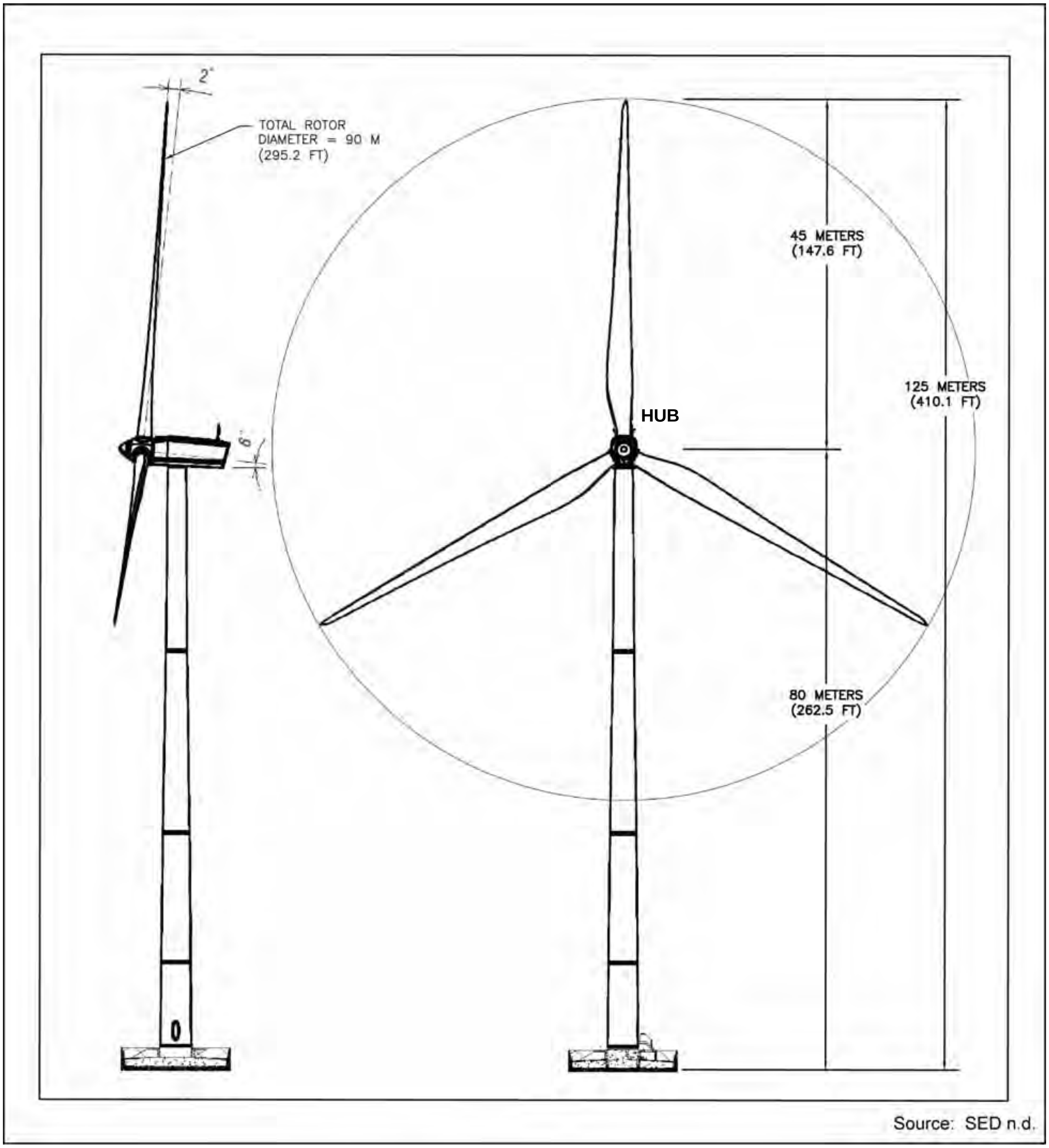


Figure 2-4. Schematic of wind turbine being considered for the Wind Energy Project.

It should be noted that there is a proposed road running along the entire right side of Figure 2-5. This road is shown as “Proposed Road (by Others)” and is not part of DOE’s Proposed Action.

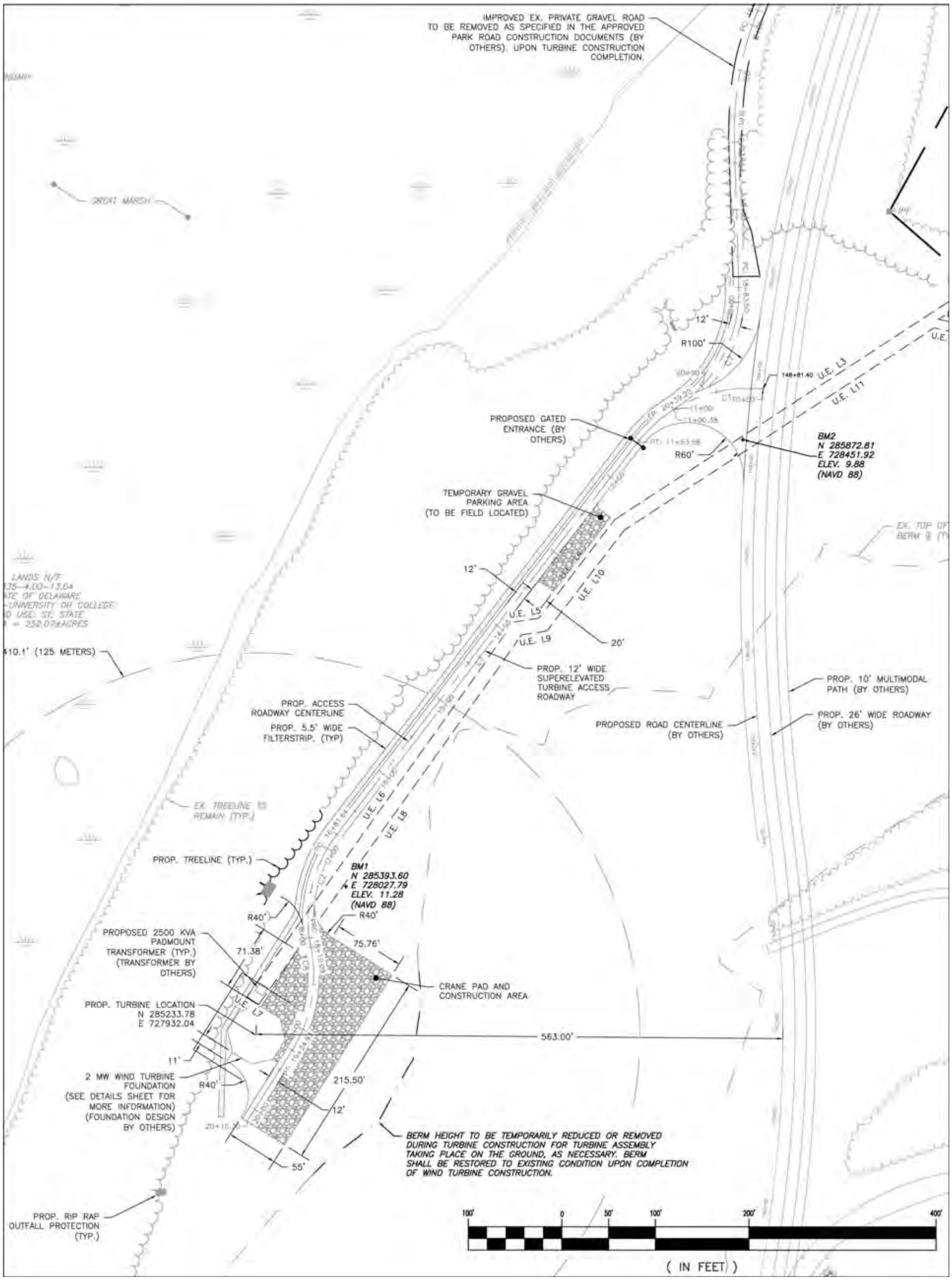


Figure 2-5. Portion of Preliminary Site Plan showing layout of wind turbine location.

This proposed road is a branch off the University of Delaware road that starts at Road 266 (Figure 2-1) and currently runs through the middle of the University campus and to Pilottown Road (also designated Road 267; Figure 2-1). The southern portion of the existing road (from Road 266 until it reaches the campus) belongs to DNREC and it has been proposed under a separate action to construct the branch road so that access can be gained to the boat launch at Roosevelt Inlet without going through the University campus.

2.2.2 ASSOCIATED LAND DISTURBANCE

The Wind Energy Project required actions to provide access into the wind turbine site and to provide temporary working areas for the construction crews. The existing gravel road that extends about 850 feet to the southwest from Pilottown Road into the spoils area was upgraded so that it could be used during construction and delivery of the wind turbine components. From the point at which the existing gravel road enters the general spoils area, a new earthen road was then constructed to extend the access road southwest along the western side of the spoils area. This earthen road is about 1,200 feet long, 12 feet wide and, as shown in Figure 2-5, extends to just beyond the wind turbine foundation. After construction of the wind turbine, upgrades made to the original existing gravel road will be removed, and the newly constructed extension road will be altered to connect to the road proposed to bypass the University campus, once in place. The location of this future connection is shown in Figure 2-5.

The 1,200-foot earthen road was constructed with onsite fill material to raise the grade in some areas while lowering the grade in others. After compaction of the fill, a geotextile and compacted base material (brought from offsite) was used to complete the 12-foot-wide road. The existing gravel road (between Pilottown Road and the spoils area) was upgraded by widening it by a maximum of 5 feet along the southeast side of the road. The intersection at Pilottown Road was upgraded with a wider turning radius to accommodate large vehicles with trailers. The upgrades consisted of placing geotextile and compacted aggregate as necessary to accommodate the anticipated construction and delivery traffic.

The construction pad, which is adjacent to the wind turbine foundation (Figure 2-5), is about 17,000 square feet, including the section of road it encompasses. This pad was constructed in the same manner and with the same materials described for the new earthen road. The pad will be left in place at the end of construction. The parking area (also shown in Figure 2-5) was temporary and consisted of little more than an area of compacted fill using a minimal amount of offsite material.

There is also an existing berm around the southeast side of the spoils area that was temporarily altered to provide a flat staging area for the lay down of turbine blades before their installation. Any alterations to the berm were built up at the completion of construction actions so that the site could continue to be used for the discharge of dredge spoils.

Underground electrical and control lines were installed from the wind turbine back into the University of Delaware campus area. These lines run parallel to the newly constructed portion of the access road for roughly 1,000 feet then veer east toward the campus. At about the western edge of the campus, the lines split, with one set running eastward toward the Henry Cannon Lab and the other to the southeast toward an existing power line on the southwest side of the Otis Smith Lab. There was about 2,000 feet of trenching required for these lines and it is estimated there was an additional 5,000 square feet of land disturbance. All of the trenches were backfilled to achieve natural contours, and outside of the spoils area, these disturbed areas will be revegetated to achieve pre-disturbance conditions.

Finally, land disturbances associated with the Wind Energy Project included actions for runoff control. A 5.5-foot-wide filter strip was installed along the northwest side of the wind turbine foundation and continues to the northeast along the length of the earthen access road within the spoils area (Figure 2-5).

This filter strip consists of a thin layer of top soil and vegetation to control erosion for the adjacent disturbed areas. A drainage outfall was installed just southwest of the wind turbine foundation to allow runoff to reach the low, marshy area to the southwest of the spoils area. Rip rap was added around the outfall to provide energy dissipation. These runoff control actions were done in accordance with the storm water management plan developed by the University of Delaware.

2.2.3 PERMITS AND APPROVALS

The University of Delaware has received the necessary permits and approvals for its Wind Energy Project from various regulatory agencies. Table 2-1 provides a summary of the results of these permitting and approval efforts. All of the necessary federal, state, and local permits and approvals were obtained prior to construction. It should be noted that Delaware does not have any specific Statewide or local regulations that guide or restrict the siting or operation of wind turbines.

Several of the DNREC letters (DNREC 2009b, 2009c, and 2009d) referenced in Table 2-1 make recommendations that the University include, as part of its project, studies on the effects of the wind turbine on birds and bats in the area. As recommendations, these were not identified as part of any permitting or regulatory requirements. However, the University is committed to conduct certain studies and take other measures related to bird and bat protection. These commitments are described in Section 2.2.5.

Table 2-1. Summary of results from consultations with regulatory agencies.

Agency	Consultation findings and identified requirements
Federal	
Federal Aviation Administration	Determination of No Hazard to Air Navigation is required. Issued 12/30/2009 (FAA 2009)[a].
State	
DNREC, Division of Water Resources, Wetlands and Subaqueous Lands Section	Determination that proposed wind turbine and the access to it are in an area outside of the State's wetlands jurisdiction and thus no wetlands permit would be required. 12/22/2009 (DNREC 2009a)[a].
DNREC, Division of Fish and Wildlife, Natural Heritage & Endangered Species Program	Prefers selected site over other proposed sites; believes there would be no significant population-level effects on wildlife, though it would likely affect individuals of local wildlife, particularly birds and bats; and requests the Division be involved in the development and implementation of research and monitoring for effects to native wildlife. 12/23/2009 (DNREC 2009b)[a].
DNREC, Division of Soil and Water Conservation, Delaware Coastal Management Program	Selected site does not appear to require federal wetlands permits, and no additional federal requirements have been identified. 12/23/2009 (DNREC 2009c)[a]. This finding was provided before DNREC was aware of the potential for the Wind Energy Project to included federal funding. With the federal funding, the project requires a Coastal Management Program Federal Consistency Certification, which was submitted to DNREC by the University. DNREC subsequently concurred with the determination on condition of the University meeting certain commitments. The certification is discussed further in this section and Section 1.3.2.4.

Table 2-1. Summary of results from consultations with regulatory agencies (continued).

Agency	Consultation findings and identified requirements
DNREC, Division of Parks and Recreation	An Amended Dredge Spoils Area Easement Agreement between the University of Delaware and the DNREC Division of Parks and Recreation was executed on February 2, 2010, to clarify and confirm the University's use of the dredge spoils area for any lawful purpose including construction of a wind turbine (DNREC 2010c).
DNREC, Division of Soil and Water Conservation, Sediment and Stormwater Management Section	Land disturbance in excess of 5,000 square feet requires submittal of a Notice of Intent and storm water plan to the State (DNREC 2009d)[a] – Notice of Intent submitted to DNREC on February 18, 2010 for Storm Water Discharges Associated with Construction Activity under a NPDES General Permit (DNREC 2010a)[a]. The storm water permit and storm water management plan were approved by DNREC.
DNREC, Division of Water Resources, Water Supply Section	Dewatering permit obtained by Gamesa to allow removal of groundwater encountered during wind turbine foundation construction. Per the permit, water was discharged to low, marshy area adjacent to foundation site.
Local	
City of Lewes	There is no wind turbine ordinance in effect in the City of Lewes, so a January 2010 Memorandum of Understanding was formalized between the City and the University of Delaware with regard to the height of the wind turbine and that no other local permitting was required.

a. The Federal Aviation Administration and Department of Natural Resources and Environmental Control letters identified in this table are included in Appendix B of this EA in addition to the Reference List (Chapter 6).

Subsequent to the University of Delaware's installation of the wind turbine at the Lewes Campus, the Lewes City Council discussed the need to develop a policy for future wind turbine installations within the city (Lewes 2010b), including the possibility of proposals for residential, commercial, and light-industrial turbines (Kunzig 2010). In this regard, it was reported (CapeGazette 2010d) that during its May 2010 meeting, the City Council agreed to a moratorium on wind turbines until a policy and ordnance dealing specifically with wind turbines could be developed. One council member indicated this was not a negative action (CapeGazette 2010d). Rather it was a general recognition that the city would likely have to address additional wind turbine proposals in the future and, as a result, the city needed to establish a policy for how it would deal with them. The policy would need to address issues associated with connecting wind turbines to the city's electrical grid and establish criteria that would make them as compatible as possible with neighboring properties and minimize negative effects.

As described in Section 1.3.2.4, DOE's Proposed Action of providing funding to the Wind Energy Project resulted in an additional regulatory requirement for the project under the *Coastal Zone Management Act of 1972* (16 U.S.C. 1451 *et seq*.) and its implementing regulations at 15 CFR Part 930. This requirement is a determination as to whether the project is consistent with Delaware's coastal zone management policies. As described in Section 1.3.2.4 of this EA, the University of Delaware submitted a consistency determination to the DNREC and the DNREC subsequently concurred with the determination on condition that the University meet certain commitments as outlined in Section 1.3.2.4.

2.2.4 UNIVERSITY OF DELAWARE SOCIAL AND ENVIRONMENTAL RESEARCH

The University of Delaware intends to use the wind turbine for research. The University formed a committee specifically to make decisions regarding this research and has already begun to meet to discuss research priorities, having narrowed the list to about 10 to 12 potential research areas. Two possible areas of research being explored are (1) avian and bat assessment and (2) public acceptance of the wind turbine.

Before the University defines a specific avian and bat scientific protocol, it would consult with stakeholders, which include state and federal resource agencies as well as bird and wildlife advocacy groups such as the Delaware Audubon Society, to discuss relevant needs and assessment tools. This effort will build on the University's existing outreach efforts to potential partners as well as to the DNREC, the USFWS, and a scientist who has conducted scientific avian research at a wind turbine or wind turbines (for example, walking transects and calculating scavenger rates). Once this groundwork is laid, the University will be able to devise a research protocol and submit a proposal to the research committee for funding. This is an evolving process with a goal of identifying appropriate research areas for a single wind turbine.

To further understand public acceptance of the wind turbine, the University is considering conducting additional interviews and survey work, targeting residents of and visitors to Lewes. The University has conducted semi-structured interviews and survey work on a number of occasions in Delaware to understand resident and visitor knowledge, perceptions, and opinions of wind power and the processes that led to that wind power. Future work could build upon the earlier efforts.

2.2.5 UNIVERSITY COMMITTED MEASURES

In an effort to address USFWS and DNREC concerns as well as to minimize the risk of significant impact on the environment from the Wind Energy Project, particularly on birds and bats, the University has committed to taking the following measures before the stated deadlines:

1. Assemble an Advisory Group that includes representatives of the USFWS, the Delaware DNREC, and the Delaware Audubon Society to prepare an ABPP that addresses monitoring and evaluation protocols, and adaptive management;

2. By February 28, 2011, provide the members of the Advisory Group and the DOE Contracting Officer a summary of the Advisory Group's findings and recommendations on the draft ABPP;

3. By March 31, 2011, provide the members of the Advisory Group and the DOE Contracting Officer a completed ABPP in which the University of Delaware makes a good faith effort to address the Advisory Group's findings and recommendations developed for measure 2 above;

4. By March 1, 2012, and March 1, 2013, respectively, submit two annual reports to the members of the Advisory Group and the DOE Contracting Officer, describing the University of Delaware's compliance activities under the ABPP;

5. Determine, in consultation with the Advisory Group, if species-specific biological thresholds are being exceeded and, if they are being exceeded, institute adaptive management practices; and

6. Continue to execute the project in accordance with the terms of the ABPP.

If DOE elects to fund the Wind Energy Project, DOE will include these commitments as conditions in the grant agreement.

Please note that, in numerous places in this EA, DOE discusses commitments that the University is making in order to protect birds and bats. The above list provides details about those commitments and nothing in those sections of the EA should be read to modify the list above.

2.3 Alternatives

2.3.1 DOE ALTERNATIVES

Congress provided funding in the *Omnibus Appropriations Act of 2009* (Public Law 111-8) to the DOE, Office of Energy Efficiency and Renewable Energy, for projects that provide for research, development, and demonstration of energy efficiency or renewable energy technologies or programs, including the establishment of a wind turbine model and pilot project for alternative energy in the State of Delaware. Congress also provided funding in the *Energy and Water Development Appropriations Act for Fiscal Year 2010* (Conference Report to Accompany H.R. 3183, Report 111-278) to the same DOE Office for wind turbine infrastructure associated with green energy and research on wind power in Delaware. The Office of Energy Efficiency and Renewable Energy, therefore, proposes to provide a combined $2.43 million in funding from the two Appropriation Acts to the University of Delaware to site and construct a wind turbine adjacent to the University's College of Earth, Ocean, and Environment Campus in Lewes, Delaware. Because this is a Congressionally directed project, DOE's decision is limited to either accepting or rejecting the project as proposed by the funding recipient, including its proposed technology and selected site. DOE's consideration of reasonable alternatives is therefore limited to the No-Action Alternative.

2.3.2 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware for its Wind Energy Project in Lewes. For the purpose of providing the decision maker with a useful comparison, the No-Action Alternative assumes that the wind turbine had not been constructed. If DOE takes the No-Action Alternative, DOE would be required under the *Omnibus Appropriations Act of 2009* and the *Energy and Water Development Appropriations Act for Fiscal Year 2010* to consider funding other proposals to establish a "Wind Turbine Model and Pilot Project for Alternative Energy" and for wind turbine infrastructure in the State of Delaware. At present, DOE is not aware of any such proposals and, therefore, does not consider any "action" alternatives in this EA.

2.3.3 ALTERNATIVES CONSIDERED BY THE UNIVERSITY OF DELAWARE

In 2008 and 2009, the University of Delaware supported a technical feasibility study to assess the potential for a wind turbine near the College of Earth, Ocean, and Environment Campus. The effort, which included monitoring the wind for a 12-month period, provided data showing the site has positive characteristics for development of onsite wind generation, most notably a very strong wind regime. The study also used predictions of wind turbine electrical output, along with current and estimated future electricity rates, to show that the project would be economically feasible with a reasonable payback term and future savings in electrical costs for the University. The wind turbine would interconnect with underground electrical conduit directly into University facilities, and the turbine's operation would include use for research and development purposes as well as providing electricity to the campus and the electrical grid.

The feasibility study included an in-depth investigation of six potential locations for siting a multi-megawatt wind turbine at or near the University's Lewes campus (SED 2010). Figure 2-6 shows the six general locations originally considered; all were in the immediate vicinity of the Lewes campus and several were within State-owned land. Locations 1 through 3 surrounded the dredge spoils area and

Figure 2-6. Six potential wind turbine locations originally considered by the University of Delaware.

Locations 4 through 6 extended to the north of the spoils area, the farthest being to the north on Beach Plum Island (Figure 2-2) near Roosevelt Inlet. These six sites were evaluated based on several criteria, including wind resource potential, accessibility, setbacks from residences, proximity to sensitive environmental areas, and proximity to historical areas. In addition, these sites were evaluated for avoidance of areas that could trigger jurisdiction from state or federal agencies, most notably the DNREC and U.S. Army Corps of Engineers. A primary element of the evaluation came from DNREC through its regulatory advisory service process (Chapter 1, Section 1.3.1).

Findings from the initial review indicated the prospective locations surrounding the dredge spoils area were the best choices, involving the least concerns and providing the better permitting options. There were, however, issues identified for each of these spoils area sites: Locations 1 and 3 did not appear to have adequate setbacks from the new road proposed for construction by the State along the southeast side of the spoils area (Figure 2-5); in fact, Location 3 appeared to be in the proposed road's alignment. Location 2 appeared to have adequate setback from the road, but an access road from either the south or east might impact federal wetlands (DNREC 2009d). As a result of the findings, the University of Delaware proposed the current location as an optimization of the dredge spoils sites. The current location, roughly midway between Locations 1 and 2, provides a better setback from the new road than

Location 1 and is easily accessed from the northeast, thus avoiding possible impacts to federal wetlands. The current location is on land owned by the DNREC Division of Parks and Recreation.

This new site was suggested during a conversation between the University and a DNREC representative (Firestone 2010c). Once the selection was made, University representatives notified the DNREC Soil and Water Conservation, Water Resources, and Fish and Wildlife divisions (the divisions that had concerns during the earlier regulatory advisory services process). The DNREC divisions provided formal letter responses recognizing the new site as one that minimized potential impacts and permitting issues (DNREC 2009a, 2009b, and 2009c).

The University's Wind Energy Project then proceeded with this single location within the existing dredge spoils area adjacent to the campus as its selected location. The University believes this site minimizes impacts to wetlands, historical areas, and nearby residences when compared to the other locations.

The University's site selection process predated the federal action currently under consideration by DOE. That is, the process was undertaken prior to DOE's involvement in the project and, in fact, DOE has limited options with regard to the range of reasonable alternatives. As noted in Section 2.3.1, DOE's present decision is limited to either accepting or rejecting the project as proposed by the University.

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter provides descriptions of the affected environment and impacts to resources from the University of Delaware Wind Energy Project. Section 3.9 discusses those resource areas that were not carried forward for further analysis.

3.1 Water Resources – Surface Water

This section addresses only the surface water component of water resources because there would be no potential for significant impacts to groundwater (Section 3.9.2). In addition to meeting requirements for environmental evaluation under NEPA, it is the intent of this section, along with the project description elements of Chapters 1 and 2, to meet DOE's obligations for a floodplain assessment under 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements."

3.1.1 AFFECTED ENVIRONMENT

The Wind Energy Project site is within the Broadkill River watershed of the Delaware Bay and Estuary Basin. This watershed extends from Lewes in the southeast corner, as far north as about Ellendale, and as far west as about Georgetown (all south-central Delaware communities). The Broadkill River is the primary drainage feature in the watershed, but there are numerous creeks to the north and south of the Broadkill that also drain portions of the watershed toward Delaware Bay (DNREC 2005).

Shore areas along Delaware Bay consist largely of areas characterized as salt marshes, but also include palustrine or non-tidal wetlands. Roughly three-quarters of the dredge spoils area, where the wind turbine is located, is bordered by marshland; only land to the northeast and toward the adjacent University of Delaware campus to the east are shown on topographic maps as being outside of the marshland (Delaware 2010). The Great Marsh (Chapter 2, Figure 2-1), which is designated on many maps, extends from the dredge spoils area to the northeast. The nearest permanent surface water bodies to the project site are Canary Creek, about 0.2 mile to the northwest, and the Roosevelt Inlet of Delaware Bay, about 0.3 mile to the northeast (Chapter 2, Figures 2-1 and 2-2). Canary Creek is a relatively small stream that appears to begin to the south of the project site, and interconnects with other channels that also drain the low marshy areas. Roosevelt Inlet is the primary surface water feature in proximity to the project site. Canary Creek drains into the Roosevelt Inlet, which is also the location where the Broadkill River flows from the northwest and enters Delaware Bay. In addition, the Lewes and Rehoboth Canal extends from this location to the southeast and eventually south into Rehoboth Bay.

Consistent with the general low marshy topography of the Wind Energy Project area, the surface water features of primary concern with respect to the project are the wetlands and floodplains (or flood zones) that are extensive throughout this area. Figure 3-1 provides a map of wetlands within the general area of the project. This map was generated by a "Wetlands Online Mapper" tool available on the U.S. Fish and Wildlife's National Wetlands Inventory web site (http://www.fws.gov/wetlands/Data/Mapper.html).

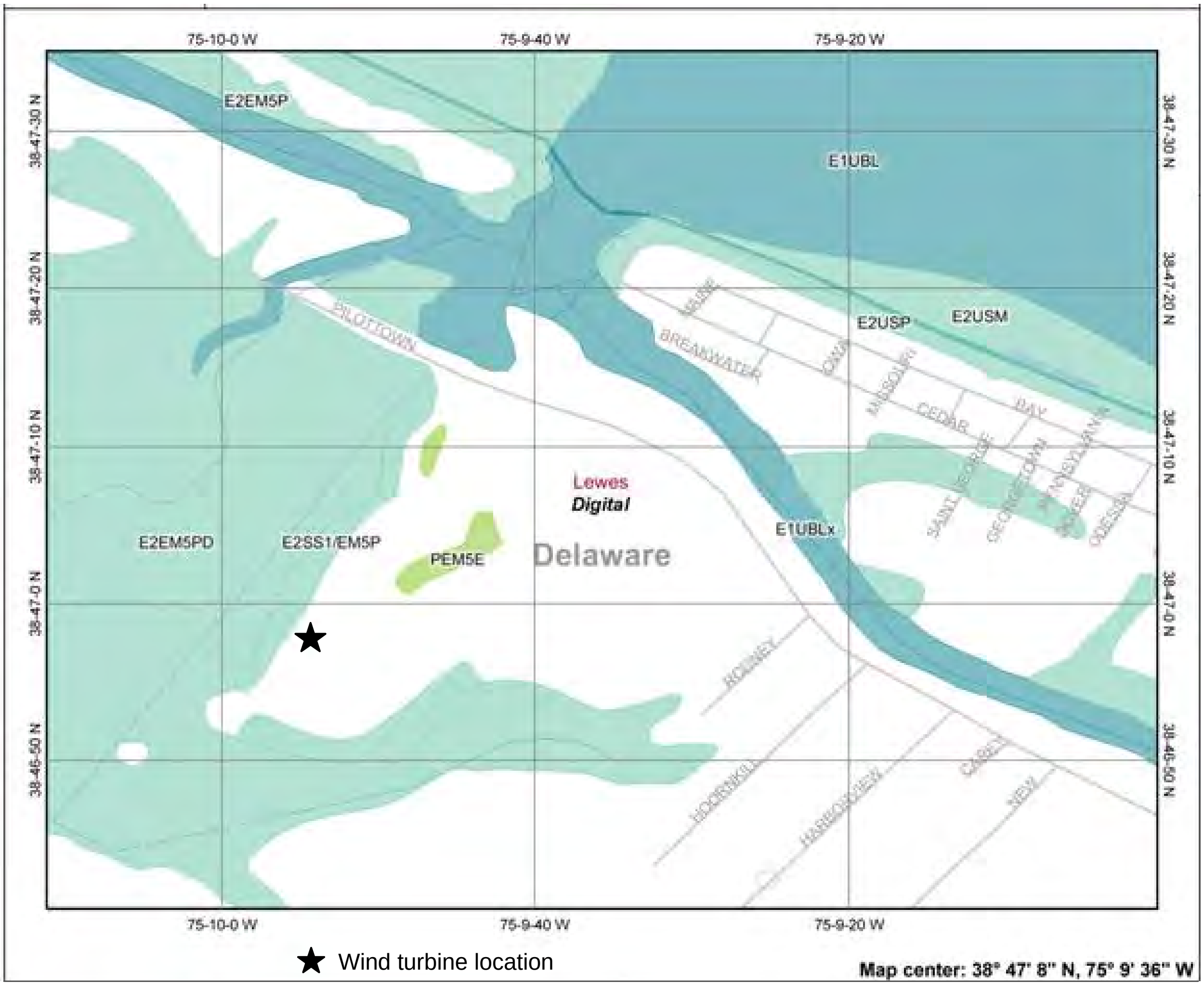


Figure 3-1. Map of wetlands within the general area of the Wind Energy Project.

Figure 3-2 is an aerial photograph of roughly the same area shown in Figure 3-1 with an overlay of the wetlands data. The codes shown in the figures (for example E2EM5PD and E1UBL) identify the types of wetlands represented by the different shadings. For purposes of this analysis, these codes can be grouped and simplified as follows:

- E1UBL and $E1UBL_X$ – Estuarine (in the transition zone between river and ocean environments), subtidal (always below water) area with unconsolidated bottoms.
- E2USM and E2USP – Estuarine, intertidal (exposed at low tide and underwater at high tide) areas with unconsolidated shores.
- E2EM5P, E2EM5PD, and E2SS1 – Estuarine, intertidal areas with vegetation present, at least most of the growing season in most years.
- PEM5E – Palustrine (marsh or swamp without flowing water) area that is seasonally flooded or saturated.

Figure 3-2. Aerial photograph with overlay of wetlands information.

Figure 3-3 shows an enlarged portion of Figure 3-2 to show the layout of the primary project features (such as the wind turbine foundation, construction laydown area, and new and existing portions of the access road) for the wind turbine site. These features are shown in more detail in Figure 2-5, but are included here to provide a clearer picture of where earth-disturbing actions were undertaken in relation to the wetlands areas.

Due to its location within Delaware's coastal zone and adjacent to large areas of marsh and wetlands, the Wind Energy Project site is also within zones of potential flooding. The Federal Emergency Management Agency (FEMA) produces Flood Insurance Rate Maps that cover most of the United States and identify areas that might be prone to flooding. Specifically, FEMA's maps generally show the extent of flood waters for a 100-year flood, which is identified as the

Figure 3-3. Enlargement of Figure 3-2 showing the layout of the Wind Energy Project's primary features.

base flood; a flood that has a 1 percent chance of being equaled or exceeded in any given year. A flood of this magnitude, or greater, would be expected to occur once (on average) within any 100-year period. Figure 3-4 provides a map of the areas that would be inundated by the 100-year flood. This map was obtained from the FEMA web site (http://www.fema.gov), which allows portions of flood insurance rate maps (FIRM) to be printed. An overlay of the primary Wind Energy Project features has been added to the figure to show their approximate locations in comparison with the flood zone designations.

The zone codes shown in Figure 3-4 (for example Zone X and Zone AE) are defined as follows:

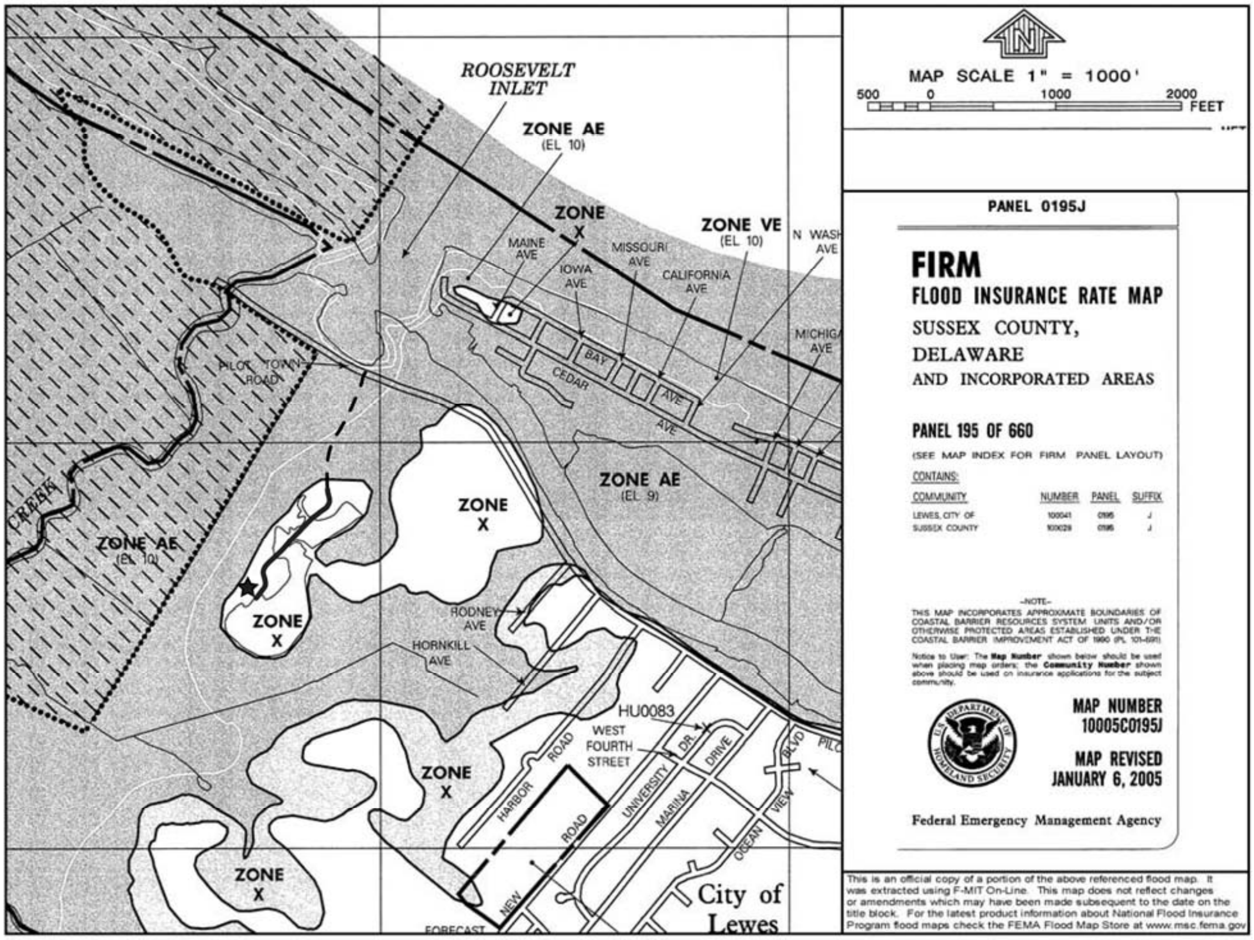
- Zone AE – Dark shading: These are areas that would be inundated by the base flood and the water elevation of the base flood has been determined and is shown in the map. Applicable floodwater elevations are shown in the map as either 9 or 10 feet above mean sea level.

- Zone VE – Dark shading: These are coastal zones that also would be inundated by the base flood and they would be subjected to wave action velocity hazard. Applicable floodwater elevations have also been determined for these areas and are shown in the map (10 feet).

- Zone X – Light shading: These areas are outside the inundation zone for the base flood (that is, for the 100-year flood), but are within the inundation zone of the larger-magnitude 500-year flood.

- Zone X – No shading: These areas are outside of the inundation levels expected for both the 100- and 500-year floods.

The somewhat kidney-bean shaped, unshaded Zone X in the center of Figure 3-4 is the dredge spoils area where the wind turbine is located. The connecting unshaded Zone X to the east is the University of Delaware campus. As shown in the figure, the dredge spoils area is almost completely surrounded by land area that could be inundated by the base flood.



Note: These types of maps are termed “FIRMettes” on the FEMA web site due to their small size in comparison to the full panel Flood Insurance Rate Maps, or FIRMs. As can be seen in this figure, this FIRMette was taken from map number 10005C0195J.

Figure 3-4. Map (a FIRMette from the FEMA web site) showing inundation areas for a 100-year flood in the area of the Wind Energy Project (the dashed line shows the improved gravel road and the solid line is the new earthen access road).

3.1.2 ENVIRONMENTAL CONSEQUENCES

3.1.2.1 Proposed Project

Neither construction, operation, nor decommissioning of the wind turbine involve discharges that could contaminate surface water, and it is anticipated there would be no reduction in surface water quality or availability as a result of the Wind Energy Project. During construction, there was an increased potential for storm water runoff to carry loosened soil away from the site, but this was minimized by the use of filter strips to restrict movement of sediment away from the site. There were four days during construction when rain events affected construction activities.

According to the University, state representatives performed inspections of storm water and erosion control measures on six different occasions during construction. The first of these inspections occurred prior to any significant rain event and resulted in modifications to storm water controls at several inspection points. The subsequent inspections resulted in satisfactory results at all inspection points.

There were no reported incidents of sediment leaving the site (Firestone 2010d). The last inspection occurred on June 15, 2010, and the final Inspection Report DNREC issued (DNREC 2010d) identified all inspection items as either Not Applicable or Satisfactory. It identified no further actions to be taken. Written comments in the report were "All disturbed areas were seeded, stabilized, and have reached acceptable vegetation stabilization. The site was in excellent condition at the time of review."

The constructed wind turbine foundation, the compacted laydown area, and the access road, represent areas of increased runoff when compared with the existing soil areas. However, the size of the affected area is relatively small and the relative flatness of the area would minimize runoff potential. Fuels and other petroleum products in construction equipment were present at the site during construction. There were no reports of any spillage or leakage from this equipment during construction. Further, there would be no significant quantities of hazardous materials present at the site during operations other than the possible lubricants and cleaning materials present during maintenance. Decommissioning would be very similar to construction, in that fuels and other petroleum productions would be present in equipment and the same precautions would be taken to ensure there were no releases of hazardous materials. Once the wind turbine materials were removed, the area would be recontoured and revegetated as appropriate to minimize any storm water runoff issues.

The location containing the wind turbine foundation, the transformer, and the construction laydown area is outside of identified wetlands (Figure 3-2). The new section of access road is also outside of the wetlands. The existing access road, however, appears to run through a small Palustrine wetlands area about mid-way between the dredge spoils area and Pilottown Road. The State of Delaware identifies this small wetlands as a non-jurisdictional wetlands that would not involve Federal permitting requirements (DNREC 2009a, 2009d). Further, the State has already identified that the new road they will be building between the University of Delaware campus and the wind turbine location will go through this same small wetlands area. Once the new, state road is constructed and operational, the applicable portion of the existing access road will be removed.

The location for the wind turbine foundation, the transformer, and the construction laydown area is within the unshaded, Zone X area in the center of the flood map (Figure 3-4) indicating these project features are not in the flood zone for either the 100- or 500-year floods. Electrical lines running to the University of Delaware campus are underground and were installed with protection from infiltrating water whether or not they ran through flood-prone areas. However, the new access road likely extends a short distance into the shaded, inundation area show in Figure 3-4 at the northern end of the dredge spoils area, and any work performed to upgrade the existing gravel road that extends to Pilottown Road was entirely within the flood zone. The more permanent access road connection to the future proposed road (by others) (Figure 2-5) appears to be just outside the flood zone. That is, the future access road connection would be in the unshaded, Zone X area and, at that point, all of the wind turbine facilities and access road would be outside of the flood zone. In summary, the Wind Energy Project involves activities in the floodplain consisting of relatively minor roadwork that is expected to be in place temporarily, until a proposed, nearby road is constructed.

The Wind Energy Project is not expected to have adverse impacts on the natural and beneficial floodplain values associated with this location. Short-term impacts consist of limited ground alterations. There would be no impacts to lives or property in the area because the project would not alter the areas that would be inundated by severe flooding or alter the depths of floodwaters. Indirect or long-term impacts are not anticipated.

3.1.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential environmental impacts to surface water resources would not occur.

3.1.2.3 Alternatives to Action in a Floodplain

Requirements for a floodplain assessment under 10 CFR Part 1022, direct DOE to consider alternatives to a proposed project that "avoid adverse impacts and incompatible development in the floodplain." The existing access road into the dredge spoils area is the only element of the project that is within a floodplain and there was a possible alternative route to reach the wind turbine location that would have avoided the flood-prone areas. Figure 3-4 shows a section of unshaded, Zone X land that extends from the wind turbine location to the east and northeast all the way to Pilottown Road. That is, a possible alternative route to the wind turbine location could have run within this unshaded area. This alternate route would have been through the University of Delaware campus and would have had to cross the center of the dredge spoils area instead of making use of the existing access road. It is very likely that such an alternative access road would have been more costly, caused more disturbance of ground and existing facilities, and even involved more adverse environmental impacts than with the existing access road. Further, based on the preceding discussion of impacts from the Wind Energy Project, activities in the floodplain were not considered particularly adverse nor were they considered incompatible with the floodplain. It can be reasoned there was no need for DOE to further pursue alternative access roads because the project did not result in impacts to floodplains.

3.2 Biological Resources

Note: The scientific names of all species identified in this section are provided in Appendix C.

3.2.1 AFFECTED ENVIRONMENT

Construction and operation of the wind turbine would primarily affect birds, bats, and rare species that might occur on or near the Wind Energy Project site. Thus, after describing the general environmental setting of the site, this section focuses on birds, bats, and species classified as threatened or endangered under Federal or state law that mighty occur on or around the project site.

The wind turbine was installed in an area, approximately 2,000 feet long and 800 feet wide, used to deposit dredge material, or spoils. The site where the turbine was installed, and where the construction pad is located, is an upland created by the deposition of dredge spoils and is sparsely vegetated with grasses and other low cover. The remainder of the dredge-spoils area has some open water, areas with bare mud and little or no plant growth, and other areas with grass and other low vegetation. The area is surrounded by a 25- to 300-foot-wide perimeter of dense shrubs and trees (Kerlinger and Guarnaccia 2010).

The project site is surrounded to the north and west by salt marsh, which extends to the northwest more than 3 miles. Much of this marsh is part of the Great Marsh. The State of Delaware owns the area of the Great Marsh near the turbine and the area is a designated State Natural Area. State Natural Areas are areas of unusual natural significance placed on a statewide inventory for protection as laboratories for scientific research, as reservoirs of special natural resources, or as unique habitats for plant and animal species (Delaware Code, Title 7, Chapter 73). The Nature Conservancy holds conservation easements on a portion of the remainder of the Great Marsh. To the north of the Great Marsh is the Prime Hook National Wildlife Refuge.

The coast of the Delaware Bay is about 0.6 mile northeast of the project site. The southern end of Beach Plum Island, a narrow coastal island separated from the mainland by the Broadkill River, is due north of the project site (Figure 2-2). Beach Plum Island is a Delaware State Nature Preserve. State Nature Preserves are natural areas that have been permanently protected by conservation easements and have the highest level of protection of any lands in Delaware.

To the west of the project site are cultivated fields, scattered woodlots, and developed areas, and to the south and east are developed lands, including the University of Delaware campus, residential areas of Lewes, and commercial and residential areas along the Lewes Canal and Delaware Bay.

3.2.1.1 Avian Species

The following discussion of bird species that might occur on or near the Wind Energy Project site is based primarily on the *Phase I Avian Risk Assessment* for this project (Kerlinger and Guarnaccia 2010), which is provided in Appendix D. This report summarizes the results of a Breeding Bird Atlas conducted in Delaware during 1983-1987, breeding bird surveys conducted in similar habitat within about 7 miles of the project site, and Christmas bird counts in the Cape Henlopen and Prime Hook areas. The report also summarizes applicable information from other reports or analyses of birds and their habitat in Delaware. Therefore, the following is a general description of the species that occur in the area and could be at risk from the Wind Energy Project.

The species most likely to breed on and near the project site are species that nest in salt marsh and shrub/edge habitats in the area. Common marsh nesting species include American black duck, clapper rail, willet, marsh wren, saltmarsh sparrow, seaside sparrow, and the coastal race of swamp sparrow. Shrubland/edge species known to nest in the area include willow flycatcher, eastern kingbird, brown thrasher, prairie warbler, yellow-breasted chat, eastern towhee, field sparrow, and Baltimore oriole. Raptors that nest in the salt marsh or other nearby habitat and forage in the area include Cooper’s hawks, northern harriers, osprey, red-shouldered hawks, peregrine falcons, barn owls, and barred owls. Numerous other songbirds, shorebirds, and waterfowl nest in woodlands, fields, wetlands, and shore habitats near the project site.

The closest known bald eagle nests are 3 and 5 miles from the project site at Cape Henlopen State Park and near Milton. Both territories were active in 2010. An additional eagle nesting territory exists about 4 miles from the Wind Energy Project site near Love Creek, but no nest was found in 2009 or 2010 (Gonzon 2010). Bald eagles can be observed anywhere along the Delaware coast year-round and are known to hunt in the marshes north and west of the project site. One eagle was sighted over the project site and three were observed in the adjacent saltmarsh during an avian assessment of the project area in December 2009 (Kerlinger and Guarnaccia 2010). The peak of fall migration at Cape Henlopen, where migrating raptors are counted annually, occurs from mid-September through October. Spring migration there occurs from March through May. An average of 134 bald eagles pass the Cape Henlopen site annually, with a high count of 503 observed during the fall migration of 2009 (Gonzon 2010).

Over the past 10 years, 190 species of birds have been counted at least once during Christmas bird counts in the Cape Henlopen-Prime Hook area. Snow geese comprised 73 percent of all birds counted. Other common species were common grackles, Canada goose, red-winged blackbirds, European starlings, ring-billed gulls, herring gulls, American robins, and northern pintails (Kerlinger and Guarnaccia 2010).

The Delaware Bay and Atlantic coast of Delaware are part of an important migration corridor for songbirds, raptors, and water birds (Kerlinger and Guarnaccia 2010). Songbirds, which migrate primarily at night off- and near-shore, might stop in marshes and other areas near the project site during the day.

Shorebirds, waterfowl, and raptors migrating over the Delaware Bay from Cape May, New Jersey, and along the Delaware Bay coast also rest in the marshes, wetlands, and shorelines in the area.

Raptors might migrate along or inshore of the nearby barrier beaches, and some raptors migrating south across the Delaware Bay from New Jersey might make landfall at or near the project site. Those raptors might then disperse in the local area, including the marsh adjacent to the project site, to forage before continuing south. Based on raptor counts at Cape Henlopen from 2002 to 2010, raptors are about 10 times more common in the area during fall than during spring. The most common migrating raptors in the area during the spring are sharp-shinned hawks, American kestrel, merlin, and osprey. During the fall, osprey and sharp-shinned hawks are most abundant, accounting for about 65 percent of raptors counted at Cape Henlopen during the fall migrations of 2002 to 2009. Other common fall migrating raptors include American kestrel, coopers hawks, turkey vultures, and merlin (HMANA 2010).

3.2.1.2 Bat Species

The common bat species of Delaware include the little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), tri-colored bat (*Perimyotis subflavous)*, and eastern red bat (*Lasiurus borealis*). Other species of bats that might occur occasionally near the Wind Energy Project site include the eastern small-footed bat (*Myotis leibii*), evening bat (*Nycticeius humeralis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and northern long-eared bat (*Myotis septentrionalis*) (DNREC 2010b).

A small number of bats might rest in trees and dense shrubs around the perimeter of the project site, and bats likely forage over and near the site, adjacent marsh, and nearby bodies of water, especially during spring through fall. There are no structures or natural features on or within 0.5 mile of the site where large numbers of bats would roost or hibernate.

3.2.1.3 Federally Listed Species

The USFWS has identified 12 species classified as threatened or endangered under the federal *Endangered Species Act* that may occur in Sussex County, Delaware (USFWS 2010). Three of these species are whales, which are not further discussed in this EA because the project would not affect oceanic areas. Five others are sea turtles, which also are not further discussed because this project would not affect marine foraging areas used by these species. One plant, the seabeach amaranth (*Amaranthus pumilus*) is endemic to barrier beaches along the Atlantic coast (USFWS 1996), including beaches at Cape Henlopen State Park. This project would not affect habitat for that species.

The section below discusses the remaining three species: piping plover (*Charadrius melodus*), Delmarva fox squirrel (*Sciurus niger cinereus*), and swamp pink (*Helonius bullata*).

Piping plovers, classified as threatened, breed along the Atlantic coast from Newfoundland to South Carolina, along the Great Lakes, and in the northern Great Plains. This species is present along the Atlantic Coast from about mid-March through early October. They nest above the high tide line on coastal beaches, sand flats, beach dunes, and other open sandy areas along and near beaches. According to the *Piping Plover Atlantic Coast Recovery Plan* (USFWS 1996), this species also might nest on areas where suitable dredge material has been deposited. Piping plovers forage primarily for invertebrates on intertidal portions of ocean beaches, mud- and sand-flats, and shorelines of coastal ponds and salt marshes. Foraging areas generally are contiguous with nesting territories (USFWS 1996).

In recent years, piping plovers have nested in Delaware on the beaches of Cape Henlopen State Park, about 4 miles east of the project site. From 3 to 10 breeding pairs were detected there during 2000 to 2008 (USFWS 2009a). The only other documented nesting in Delaware in the past 10 years was at the

Delaware Seashore State Park, more than 8 miles south of the project site. Non-nesting piping plovers are also regularly seen at Prime Hook National Wildlife Refuge and likely periodically use the beaches at Beach Plum Island, located 0.6 to 2.1 miles north to northwest of the project site, for foraging and resting (Bailey 2010).

The Delmarva Peninsula fox squirrel, classified as endangered, lives in stands of mature, open timber on the Delmarva Peninsula (the peninsula between the Chesapeake Bay and the Atlantic Ocean) of eastern Maryland, Delaware, and eastern Virginia (USFWS 1993, 2007a). In Delaware, the only known populations of Delmarva Peninsula fox squirrels are on and around Prime Hook National Wildlife Refuge, where they were introduced in 1986-1987, and in southwestern Delaware on the Nanticoke Wildlife Management Area (USFWS 1993, 2007a). The population on Prime Hook National Wildlife Refuge is about 4 to 10 miles northwest of the project site. Although it is feasible that squirrels from that population could move into the vicinity of the project site, there is no suitable habitat for them that would be affected by the project. The stand of trees surrounding the dredge spoils area is less than 100 feet wide in most areas, has few large trees, has a dense understory, and would not be considered a stand of mature, open timber. Because the nearest population of this endangered species is more than 4 miles away, and there is no suitable habitat on or near the project site, the Delmarva Peninsula fox squirrel is not discussed further in this EA.

The swamp pink is an endangered perennial plant in the lily family (USFWS 1991). The range of this species includes the coastal plain from New Jersey to Virginia and bog areas in the southern Appalachians. Swamp pink is found in a variety of wetlands habitats, primarily in areas with soils perennially saturated by groundwater. In 2007, there were 19 known sites with existing populations of swamp pink in Delaware (USFWS 2008). These sites were primarily along flowing streams where Atlantic white cedar grew. Because the Wind Energy Project would not disturb wetlands habitat or freshwater, flowing streams where this species might occur, the swamp pink is not discussed further in this EA.

3.2.1.4 Delaware Endangered Species

Table 3-1 lists the species classified as endangered under Title 7 Section 3900 of the Delaware Administrative Code (Natural Resources and Environmental Control–Wildlife Endangered Species) that might occur on or near the project site. This regulation prohibits the importation, transportation, possession, or sale of any species classified as endangered.

Table 3-1 lists all bird species classified as endangered in Delaware, as individuals of these species might at some time forage, migrate, or otherwise move through the area where the wind turbine would be located. The most likely protected bird species to be found near the Wind Energy Project site are those that nest in wetlands and marsh habitat, such as the black-crowned and yellow-crowned night heron, and those that forage in the area, such as bald eagles and northern harriers.

DOE identified other state-protected species that might occur within or near the project site based on a field survey of the site conducted in 2009 to evaluate potential habitat for state-protected species (Kerlinger and Dowdell 2009). This evaluation concluded that none of the Delaware-protected species, other than birds, is likely to be common on or near the project site, although it is possible that some of the more mobile species could move through the area occasionally. There is no suitable habitat for Delmarva fox squirrels (mature forests), corn snakes (pine-oak or other forests), tiger salamanders (vernal ponds), barking treefrogs (vernal ponds), or large tiger beetles (sandy beaches). The host species of the frosted elfin (wild indigo) and rare skipper (Spartina spp.) are not found or would not be disturbed by the project; however, these Lepidoptera are passively dispersed by wind and might be blown onto the project site.

Habitat for the little white tiger beetle included gravel pits and other areas with white sand; the project site does not have such habitat and is too disturbed to support this species (Kerlinger and Dowdell 2009).

Table 3-1. Species Classified as Endangered by Delaware.

Birds	
Brown Creeper[BR] (*Certhia americana*)	Bald EagleT (*Haliaeetus leucocephalus*)
Pied-billed Grebe[BR] (*Podilymbus podiceps*)	Northern Harrier[BR] (*Circus cyaneus*)
Cooper's Hawk[BR] (*Accipiter cooperii*)	Northern Parula[BR] (*Parula americana*)
Black-Crowned Night Heron (*Nycticorax nycticorax*)	Yellow-Crowned Night Heron (*Nyctanassa violacea*)
Piping Plover[T] (*Charadrius melodus*)	Short-eared Owl[BR] (*Asio flammeus*)
American Oystercatcher (*Haematopus palliatus*)	Black Rail (*Laterallus jamaicensis*)
Upland Sandpiper (*Bartramia longicauda*)	Loggerhead Shrike (*Lanius ludovicianus*)
Black Skimmer (*Rynchops niger*)	Henslow's Sparrow (*Ammodramus henslowii*)
Common Tern[BR] (*Sterna hirundo*)	Forster's Tern[BR] (*Sterna forsteri*)
Least Tern (*Sterna antillarum*)	Cerulean Warbler (*Dendroica cerulea*)
Hooded Warbler[BR] (*Wilsonia citrina*)	Swainson's Warbler (*Limnothlypis swainsonii*)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	Sedge Wren (*Cistothorus platensis*)
Reptiles	
Corn snake (*Elaphe guttata guttata*)	
Amphibians	
Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*)	Barking Treefrog (*Hyla gratiosa*)
Mammals	
Delmarva Fox Squirrel E (*Sciurus niger cinereus*)	
Insects	
Little White Tiger Beetle (*Cicindela lepida*)	White Tiger Beetle (*Cicindela dorsalis*)
Frosted Elfin (*Incisalia irus*)	Rare Skipper (*Problema bulenta*)

Sources: DNREC 2000; Kerlinger and Dowdell 2010.
BR = breeding population only.
E = federally listed endangered species.
T = federally listed threatened species.

3.2.2 ENVIRONMENTAL CONSEQUENCES

3.2.2.1 Proposed Project

3.2.2.1.1 Habitat Loss, Displacement, and Fragmentation

Approximately 0.5 acre was disturbed to create the laydown yard and pad for the wind turbine, and an additional 0.4 to 0.6 acre was disturbed to construct the access road and possibly to widen the existing road. With the exception of the small amount of area involved in widening the existing road, all of this disturbed area is over the dredge spoils. This resulted in a permanent loss of habitat for plants, amphibians, birds, small mammals, and other wildlife that use the site. This loss of habitat is expected to have a negligible impact on plant and animal populations in the area because the Wind Energy Project site, including the route for the new access road, has been disturbed recently for disposal of dredged spoils and is, therefore, marginal habitat for most native plants and animals. In addition, no endemic (native) species occur at the site, and there are no features that are uncommon in the surrounding area.

Some mobile species of wildlife likely avoided the project site and surrounding area during installation, and some wildlife could continue to avoid these areas during operation of the wind turbine. For example, it has been shown that nesting and forage birds are less abundant within 100 to 650 feet of wind turbines at some large wind farms (Kerlinger and Guarnaccia 2010). This might be due to the motion of the turbine blades, sound, changes in air pressure caused by the blades, or some other cause. Because only one wind turbine would be installed and operated for the project, and because the project site is on the edge of a large expanse of undisturbed marsh habitat, any displacement of wildlife during construction and operation of the wind turbine would result in an undetectable change in the abundance of birds and other animal populations in the marsh habitat in the area.

Habitat fragmentation did not result from construction of the wind turbine and is not anticipated from operation of this project. The project site is on the edge of a large salt marsh, and the wind turbine and access road do not bisect or otherwise block access to the area. In addition, there are no large, undisturbed areas to the east or southeast of the site (that is, toward the University of Delaware campus and Lewes) that are further isolated by the wind turbine and access road.

Decommissioning of the turbine would have no or minimal adverse impacts on biological resources, as the area surrounding the turbine that might be disturbed during removal of the turbine is marginal habitat for native plants and animals. Discontinuing operations and removal of the wind turbine could have a beneficial effect if the turbine is found to harm a higher number of birds and bats than has been documented at other wind energy projects.

As Section 3.2.1 discussed, the only species classified as threatened or endangered under federal or state regulations likely to occur on or near the project site are birds, which are discussed below.

3.2.2.1.2 Avian Mortalities

Some birds would be killed during operation of the wind turbine. Appendix D includes a review of information available prior to 2010 on bird mortalities from wind energy projects, and concludes that the number of birds killed at wind energy projects in the United States ranges from about 1 to 8 birds per turbine per year. This is a very small rate of mortality compared with other human-caused mortalities such as vehicle strikes; collisions with wires, towers, and windows; and predation by cats.

Since compilation of the information presented in Appendix D, additional data have become available from a wind energy project in New Jersey located about 2 miles inland of the Atlantic coast (New Jersey Audubon Society 2009). That project consists of five 1.5-megawatt wind turbines at the Atlantic City wastewater treatment facility, which is surrounded by saltmarsh and open water. From January through August 2010, eight dead birds were found at this facility. From August 2007 through August 2009, 38 birds of at least 25 species were found that were killed by the wind turbines. Three of the dead birds were osprey. Using estimates of the proportion of the project area that could not be searched (for example, adjacent open water), observer detection efficiency, and scavenger removal rates, it was estimated that 30 birds per turbine per year might have been killed at the New Jersey wind energy project. This information suggests that wind turbines in coastal saltmarsh habitat, such as the University of Delaware turbine, could kill more birds than turbines located in other settings.

With few exceptions (such as the large number of raptors killed at the Altamont Pass site in California), no bird species or groups of species have been found to have a substantially higher rate of collisions than other birds at wind farms in the United States (Kerlinger and Guarnaccia 2010). Thus, the most abundant species in the area surrounding the project site are the most likely to be killed by the wind turbine. This includes marsh and shrub nesting and foraging song birds, shore birds, and other species (such as American black duck, clapper rail, salt marsh sparrow, willow flycatcher, eastern kingbird, brown thrasher, and field sparrows), raptors (such as bald eagles, Cooper's hawks, and northern harriers), and common wintering waterfowl (such as snow geese and Canada geese). Individuals of other breeding, migrating, and wintering species could also be killed by the turbine. Appendix D includes a risk assessment and review of information on the abundance, habitat use, and migration behavior of birds in the region surrounding the project site.

Because the University of Delaware wind turbine is located along an important migration route near the coast of the Delaware Bay and adjacent to a large expanse of saltmarsh, it is possible that some migrating species or types of birds might be more likely to be harmed by the turbine. Large numbers of raptors migrate through the area, some of which might stop to forage in the coastal saltmarshes. Such migrating birds, as well as resident raptors such as osprey that forage in the saltmarsh adjacent to the turbine, might have a high risk of colliding with the turbine. Large numbers of shorebirds and other species also migrate through this area and could be at risk when landing in the area to rest or forage. For example, large concentrations of red knots, ruddy turnstones, and other shorebirds stage in the area during spring migration to feed on horseshoe crab eggs and other invertebrates. Although they concentrate primarily along the coast, these and other shorebirds might be killed while flying between foraging sites or when migrating through the area. DOE anticipates that the number of bird mortalities resulting from operation of the wind turbine will be similar to that experienced at other wind energy projects. However, because the University of Delaware wind turbine is located along an important migration route and adjacent to a large expanse of saltmarsh, there is substantial uncertainty about how many birds, and which species, will be harmed by the turbine. The University of Delaware has committed to preparing an ABPP that will address adaptive management that could reduce risks to wildlife from the turbine under certain scenarios. Section 3.2.2.1.4 of this EA further describes the plan and adaptive management program. The plan will, in part, aid the DOE and other agencies in implementing the measures specified in Executive Order 13186 for protection of migratory birds.

Species Protected Under the Endangered Species Act

The piping plover is the only bird species classified as threatened or endangered under the federal *Endangered Species Act* that occurs in Sussex County, Delaware. Piping plovers nest on beaches at Cape Henlopen State Park, about 4 miles from the project site, and forage on beaches, mud- and sand-flats, and other open shoreline areas, the closest of which (Beach Plum Island) is about 0.6 to 2.1 miles from the project site. The area where dredged material has been deposited at the project site is small, partially vegetated, and distant from typical nesting and foraging habitat, and thus is not suitable habitat for this species.

DOE requested information from the Delaware Division of Fish and Wildlife on the distribution and abundance of piping plovers on and near the project site, and information on observations of piping plovers using, flying over, and migrating through inland habitat such as the marsh habitat north of Lewes. In response to this request, DOE was informed that there are no data or observations of piping plovers flying over or migrating through inland habitats in Delaware. In addition, the Division of Fish and Wildlife's response stated that "It is the Delaware Division of Fish and Wildlife's opinion that, although not enough data exists to rule out the possibility that piping plovers may fly in the vicinity of the turbine, it is unlikely that piping plovers would use this site as a flight path or foraging area" (Bailey 2010).

Based on this information, DOE determined that it is unlikely that piping plovers nesting at Cape Henlopen would be at risk from the wind turbine. It is also unlikely that piping plover migrating through the area would be struck by the turbine, as there is no suitable habitat at or within 0.5 mile of the project site. Thus, DOE believes that, although there is some unquantifiable but very small possibility that a piping plover would collide with the single turbine located in an area containing no suitable habitat, the probability of that occurring is so low as to be discountable, and the project, therefore, is unlikely to adversely affect this threatened species.

In its July 29, 2010, letter to DOE, the USFWS Chesapeake Bay Field Office stated that it concurred with DOE's conclusion that the proposed project is not likely to adversely affect the piping plover. On receiving this letter, DOE fulfilled its consultation requirements under Section 7 of the *Endangered Species Act*.

Numerous bird species classified as endangered by Delaware occur in the salt marsh habitat adjacent to the project site or elsewhere in the surrounding region (Table 3-1). It is likely that one or more individuals of these species would be struck and killed during the operating life of the turbine. Because the annual rate of bird mortalities is expected to be low, the loss of one or a few individuals of these species is not anticipated to have significant population-level effects. The University of Delaware will develop an ABPP, which will include monitoring protocols, that will provide information about the impact of the wind turbine on birds (see Section 2.2.5 for the list of University commitments).

Species Protected under the *Bald and Golden Eagle Protection Act* (BGEPA)

Although the bald eagle is no longer a listed species under the *Endangered Species Act*, it remains protected under the BGEPA, which prohibits anyone, except under permit from the Secretary of the Interior, from "taking" bald eagles, their eggs, nests, or any other parts of the birds (16 U.S.C. 668a-b). The BGEPA defines "take" as "to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb" and establishes criminal and civil penalties for violations. A taking does not need to be intentional to violate the statute and trigger civil penalties. The USFWS has announced, but not yet put into effect, a permitting regime (74 CFR Part 46836) covering the taking of protected eagles. As of today, any take of a bald eagle would be a violation of the law. The USFWS works with wind turbine owners and operators to help them implement mitigation measures to minimize the risk of violating the BGEPA. Some of these measures may be part of an Adaptive Management Plan, under which the owners and operators agree to conduct monitoring studies and then implement mitigation measures, if necessary, on the basis of data from the monitoring studies (for example, data identifying a take of a bald eagle).

The nearest bald eagle nests to the project site are 3 to 5 miles (Gonzon 2010), which is a substantially greater distance than the 660-foot buffer recommended by the USFWS for new construction activities in areas with bald eagle nests (USFWS 2007b). Bald eagles forage in and travel through the marshes and other habitat surrounding the site and, thus, are among the avian species most likely to be killed by the wind turbine. Any mortality of bald eagles resulting from this project would represent a very small number of bald eagles (possibly none) over the lifetime operation of the wind turbine because relatively few birds (generally 1 to 8) are killed annually per turbine in the United States. This rate of mortality is too small to have a detectable impact on populations of bald eagles. However, the potential for an illegal, unavoidable, non-purposeful take of a bald eagle exists at the project site due to the operation of the wind turbine.

In summary, DOE concludes that there are no unique features at the project site that would cause the rate of bird mortalities from collisions with the operating turbine to be different from that measured at other wind energy projects (1 to 8 per turbine per year) and that no bird species would be exceptionally vulnerable to collisions. This low rate of collisions would not have a detectable impact on populations of birds, including species classified as threatened or endangered under federal or state regulations, and would not cause a decline or other population-level effects on any bird populations. However, because of the possibility that the operation of the wind turbine would take a bald eagle in violation of the BGEPA, DOE consulted with the USFWS to better understand the likelihood of such a take and what measures the University should adopt to prevent a violation of the BGEPA. The USFWS is requiring the monitoring and adaptive management plan described in Section 3.2.2.1.4 to reduce impacts to eagles as well as other wildlife.

3.2.2.1.3 Bat Mortalities

Bats would also be killed during operation of the wind turbine. The number of bats killed at wind energy projects in the United States has varied from less than 1 per turbine per year up to 70 per turbine per year (Arnett et al. 2005). Many of these estimates are based on searches for bat carcasses conducted for only a portion of a year, and with varying, and in some cases unquantified, efficiencies; thus, the number of bats killed at some sites probably has been under-reported. Bat fatalities at wind energy projects located on forested areas in the eastern United States (20 to 70 bats per turbine) were much higher than at projects in other areas (less than 1 to 19 bats per turbine). Migratory, foliage-roosting, and crevice-roosting species, such as hoary bats, eastern red bats, and silver-haired bats, were the most commonly killed species (Arnett et al. 2005).

Fifty-eight bats have been found dead during two years of monitoring at the five 1.5-megawatt wind turbines surrounded by saltmarsh at the Atlantic City wastewater treatment facility. Using estimates of the proportion of the project area that could not be searched (for example, adjacent open water), observer detection efficiency, and scavenger removal rates, it was estimated that 46 bats per turbine per year might have been killed at this wind energy project (New Jersey Audubon Society 2009).

There is no information available on the abundance of bats at or in the immediate vicinity of the Wind Energy Project site. The only features at or near the project site that might attract bats are the small number of trees around the perimeter of the dredge deposition area that could be used for roosting and the adjacent saltmarsh and open bodies of water that might be used for foraging.

Although some bats would be killed by the operating wind turbine, it is not anticipated that this project would have an impact on bat populations for the following reasons. First, none of the bat species known to occur in Delaware is endangered or extremely rare in the region. Second, this project includes installation of one wind turbine in an area where there are no other existing turbines or plans for additional turbines. Finally, the number of bats likely to be killed is expected to be similar to that reported at non-forested sites elsewhere in the United States (that is, 1 to 19 bats per year), which would not result in a significant decline in the population of bat species in the project area, because none of the species is endangered or extremely rare. Because there is uncertainty about the number of bats that could be harmed by this project, DOE will require the University of Delaware to prepare and implement an ABPP that addresses monitoring and adaptive management protocols.

3.2.2.1.4 Monitoring and Adaptive Management

Because of the uncertainty about the number of birds and bats that might be killed by the operating wind turbine, DOE will require the University of Delaware to monitor the impacts of the wind turbine on birds and bats and to develop an ABPP that addresses monitoring and evaluation protocols and adaptive management. DOE is also requiring the University to take steps identified in Section 2.2.5 of this EA. Many of these steps are required by the USFWS in order to support a FONSI for the project (Section 1.3.2.1) and by the DNREC as a condition of concurring with the University of Delaware’s consistency determination under the *Coastal Zone Management Act* (Section 1.3.2.4). In particular, support of the USFWS and DNREC is conditioned on the University forming an Advisory Group that will include representation from the USFWS, DNREC, and the Delaware Audubon Society. This group must provide input to the University in development of the ABPP and will assess whether curtailment measures would need to be implemented as monitoring data become available. Appendix B of this EA contains the November 3, 2010, letter from the USFWS to DOE regarding support of a FONSI for the EA for the University of Delaware Lewes Campus Wind Energy Project. The University has committed to these actions. If DOE elects to fund the Wind Energy Project, it will incorporate these commitments as conditions in the grant agreement.

3.2.3 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential environmental impacts to biological resources would not occur.

3.3 Cultural Resources

3.3.1 AFFECTED ENVIRONMENT

This section describes the existing cultural resource conditions in the area of the Wind Energy Project site. The area of potential impacts to cultural resources includes the property within and immediately adjacent to the project area that could be affected by the construction or operation of the wind turbine. Cultural resources are historic properties as defined by the *National Historic Preservation Act*, cultural items as defined by the *Native American Graves and Repatriation Act*, archaeological resources as defined by *Archaeological Resources Protection Act*, sacred sites as defined in Executive Order 13007 to which access is afforded under *American Indian Religious Freedom Act*, and collections and associated records as defined in 36 CFR Part 79. The following material summarizes the historic background of the area, followed by the status of cultural resource inventories and Section 106 consultations, and American Indian resources.

3.3.1.1 Historic Background

Archaeologists have grouped prehistoric times in Delaware (that is, the time periods without a written history) into the following periods (DELDOT n.d.):

Paleoindian (10,000 to 6500 B.C.) – Americans Indians were adapting to great changes in climate and landscape environments during this period and were believed to be highly mobile and nomadic peoples that practiced hunting of animals and gathering of foods. The fluted point is a distinctive artifact of this period and examples have been found in central Delaware. However, these archaeological artifacts were generally surface finds and no intact sites have been found to help reconstruct behavior and activities.

Archaic (6500 to 3000 B.C.) – Life during the Archaic period shifted from highly mobile to wide-scale, seasonal foraging across various environmental zones. Oak and hemlock forests developed and browsing animals in the forests became hunted resources. Sea levels rose as glaciers melted and swampy environments were formed. The plant and animal resources that favored these areas were also relied upon for foodstuffs. Plant processing tools (for example, grinding stones and mortars and pestles) are typical of archaeological sites of this period, but finds of such sites in Delaware have been rare.

Woodland I (3000 B.C. to 1000 A.D.) – Environments changed to warm and dry during this period, which led to increases in grassland habitats and more sedentary lifestyles. Common areas for settlement included river floodplains and along swamps and marshes. Tools associated with the Woodland I period show increasing plant processing and harvesting and, for the first time, include stone and ceramic vessels. Storage pits and house foundations are more common. Evidence of societal changes includes an increased significance of burial ceremonies and more extensive trade of stone tools.

Woodland II (1000 A.D. to 1600 A.D., the latter being the time of European contact) – This period is characterized by more extensive use of plant foods and the consumption and use of shell fish along the Delaware shores. Reliance on locally available plants and marine resources resulted in increased populations in some areas. The presence of triangular points is believed to be evidence of the introduction of the bow and arrow. The styles of ceramic items and their decorations became more complex and might be evidence for social and cultural variability.

The English explorer Henry Hudson discovered the point of land now designated Cape Henlopen in 1609, but the early European settlements in Delaware were primarily Dutch and Swedish. Lewes and New Castle were the major social and commercial centers of Delaware during the late seventeenth and early eighteenth centuries. Delaware history since initial arrival of the Europeans has been grouped into several periods as follows (DELDOT n.d.):

Exploration and Frontier Settlement – 1630 to 1730
Intensified Occupation – 1730 to 1770
Early Industrialization – 1770 to 1830
Industrialization and Early Urbanization – 1830 to 1880
Urbanization and Early Suburbanization – 1880 to 1940

This latter history is long in comparison to comparable history (since European influence) in much of the United States. An often-used motto in the City of Lewes is “The First Town in the First State.” This latter history left more visible evidence than the periods that preceded it, resulting in numerous properties and sites of historic significance in the Lewes area.

3.3.1.2 Status of Cultural Resource Inventories and Section 106 Consultations

DOE performed a search of National Register of Historic Places to identify historic places near the project site. The National Park Service plotted National Properties into Google Earth layers so the properties could be located via the internet. Figure 3-5 provides the results of the data search of the National Register using Google Earth to located Historic Places in the area of Lewes. The figure shows sites within 2.3 miles of the project site, labeled with letters that correspond to the information presented in Table 3-2. Taking the search radius out to 2.3 miles captured all of the sites within the main town area of Lewes as well as the Fisher Homestead (location J in the figure), which is to the west of the project site, across the Great Marsh, and the next closest property on the National Register.

Figure 3-5 shows two circular markers at the location labeled with a “B.” There is a single label at this location because both markers are for the Maull House; the second represents a second action to expand the boundary of the initial listing. The figure also shows two “E” labels pointing to markers that are some distance apart. The markers indicate the Lewes Historical District and a second action of expanding the boundaries of the initial listing. The figure also shows the “G” and “H” labels pointing to the same circular marker; as indicated in Table 3-2, there are two properties at essentially the same location. There is an entry at the bottom of Table 3-2 (De Vries Palisade) that does not appear on Figure 3-5. This property is identified in the National Register with an “Address Restricted” entry and as a result does not appear in the Google Earth layer, but as noted in the table’s footnote, the De Vries Monument (a stone commemorative monument adjacent to Pilottown Road) is just northeast of the wind turbine location.

Figure 3-5. Locations of properties on the National Register of Historic Places (with labels corresponding to information in Table 3-2).

Table 3-2. Properties on the National Register of Historic Places (with letter designations per Figure 3-5).

Historic Place Name	Address	Description	NPS Ref. No.	Date listed	Distance from Project Site (miles)
A. Fisher's Paradise	624 Pilottown Rd. Lewes, DE	Colonial period house – private	72000298	12/1972	0.5
B. Maull, Thomas, House (original listing)	542 Pilottown Rd. Lewes, DE	Colonial period house – private	70000175	11/1970	0.6
(boundary increase)	Same	Same	78003453	04/1978	Same
C. Pagan Creek Dike	Pagan Creek near New Rd Lewes, Delaware	17th century causeway, one of oldest road structures in state	73000555	06/1973	0.8
D. Russell, William, House	410 Pilottown Rd. Lewes, Delaware	Early 1800s house – now commercial building	77000395	04/1977	0.9
E. Lewes Historic District (original listing)	Ship-carpenter, Front, Savannah, 2nd, 3rd, and 4th Sts.	Multiple buildings	77000393	09/1977	0.8 (closest)
(boundary increase)	Roughly bounded by Front St, Savannah Rd., McFee St. and the Penn Central RR tracks Lewes, Delaware	Multiple additional buildings	92000462	09/1992	1.8 (farthest)
F. Lightship WLV 534	Lewes-Rehoboth Canal between Shipcarpenter and Mulberry Sts. Lewes, Delaware	Steel Coast Guard ship built in 1938, designed to be a floating lighthouse – museum	89000006	02/1989	1.3
G. Lewes Presbyterian Church	100 Kings Highway Lewes, Delaware	1800s church – private	77000394	10/1977	1.5
H. Hall, Col. David, House	107 Kings Highway Lewes, Delaware	Colonial period house – private	76000585	04/1976	1.5
I. Coleman House	422 Kings Highway Lewes, Delaware	Early 1800s house – private	77000392	04/1977	1.6
J. Fisher Homestead	West of Lewes Lewes, Delaware	1800s farmhouse and structures – private	80000941	12/1980	2.3
De Vries Palisade	Address Restricted[a]	1631 log stockade	72000299	02/1972	
Roosevelt Inlet Shipwreck Underwater Archaeological Site	Lewes Harbor Lewes, Delaware	NA	NA	NA	0.7 to 2.0

a. The De Vries Monument is located adjacent to Pilottown Road, approximately 0.4 mile to the northeast of the wind turbine location. This monument commemorates the establishment of the first permanent European presence on the Delaware Bay

NA = not available.

On April 30, 2010, DOE sent a letter to the Delaware SHPO requesting additional information the office has developed or obtained on historic properties near the project site. Appendix B contains a copy of this letter. The Delaware SHPO responded by letter dated May 11, 2010 (Appendix B) and identified seven properties listed in the National Register of Historic Properties within about 1 mile of the Project site and provided a map of their locations. Figure 3-5 includes a 1-mile radius circle to highlight the National Register sites identified by the state and the information is integrated into Table 3-2 along with the information for sites outside the 1-mile radius. One of the registered sites identified by the state is an underwater archaeological site at Roosevelt Inlet. This site, not identified with a specific location in Figure 3-5, was added to the bottom of Table 3-2 with an assumed distance from the wind turbine site. The SHPO's letter further indicated there were seven additional historic buildings and structures within 1 mile, but which were believed to not be eligible for the National Register; and nine additional archaeological sites within the area that have not been evaluated for eligibility for the National Register.

Early in 2009, the DNREC had a Phase 1 archaeological survey performed on land to be used for the Park Road connector to Pilottown Road [that is, the "Proposed Road (by others)" described in Section 2.2.1]. The land surveyed was 180 feet by 700 feet in size, stretching southwest from Pilottown Road to the dredge spoils area. The surveyed land area incorporated the existing gravel road that is part of the wind turbine project as shown by the dashed line in Figure 3-3. According to the survey report, a total of 61 shovel test units were excavated along with a 1-meter square unit adjacent to a site of sparse scatters (JMA 2009). Although there were historical or modern artifacts recovered, they were mostly small to very small in size, suggesting secondary deposition through trash disposal, field spreading, or "road toss." The report concluded that the findings did not indicate the presence of a potentially significant archaeological site, no historical features were documented on the surface or below the ground, and no further archaeological investigations were recommended in conjunction with the road project.

3.3.1.3 American Indian Resources

On May 20, 2010, DOE sent a request to two federally recognized tribes that are not resident in Delaware, but have historic links to the State—The Delaware Nation and the Stockbridge-Munsee Community of Wisconsin—and to two State-recognized tribes that are resident in Delaware—the Nanticoke Indian Association and the Lenape Indian Tribe of Delaware. On July 22, 2010, DOE sent a similar request to a third federally recognized tribe, the Delaware Tribe of Indians. The letter requests were for information these tribes have, and are interested in sharing, on properties of traditional religious and cultural significance within the vicinity of the project site, as well as any comments or concerns the tribes might have on the potential for this project to affect their properties. Copies of the DOE's letters are included in Appendix B. In a response dated May 25, 2010, the Stockbridge-Munsee Community of Wisconsin informed DOE that the Wind Energy Project was not in an area of the tribe's concern. The Delaware Tribe of Indians provided a response on August 4, 2010 that stated its review identified no religious or culturally significant sites in the project area. The Lenape Indian Tribe of Delaware responded in a letter dated August 17, 2010, that its people were likely drawn to the area and historic records indicate the area is "rich in American Indian culturally sensitive materials including ancestral burials." The Lenape letter also notes that since the project is already completed, it is assumed that no sensitive materials were uncovered.

Section 101(d)(6)(A) of the *National Historic Preservation Act* provides that properties of traditional religious and cultural significance to an Indian tribe or Native Hawaiian organization may be eligible for listing in the National Register of Historic Places. On the recommendation of the USFWS, DOE and the Delaware SHPO discussed the possibility that eagle habitation in the vicinity of the University's Lewes Campus might render the landscape a potential historic property of religious and cultural importance to Indian tribes. If so, DOE and the SHPO would have to consider impacts to the eagle habitation during consultation under Section 106. In the recent, *Final Environmental Assessment Proposal to Permit Take* *as Provided Under the Bald and Golden Eagle Protection Act* (USFWS 2009b), the USFWS explains that some Indian tribes find eagles or eagle nests, or both, to be sacred sites. These, and the landscapes and landforms associated with them, could be eligible for listing in the National Register. Properties eligible for listing are considered historic properties and subject to Section 106 consultation. At the time the Draft EA was prepared, there was no reason to believe that tribes that have a current or historic presence near the University Wind Energy Project site consider eagle habitation (which includes eagles and eagle nests) sacred. Nonetheless, DOE asked the four tribes referenced above to identify whether eagle habitation is sacred to them. The Lenape Tribe of Indians was the only tribe to respond specifically to this question. In its August 17th letter, the Lenape stated that it does hold eagles and eagle habitat in high regard and further stated that some Lenape men wore a single eagle feather in their headdress to display reverence. DOE responded to the Lenape Indian Tribe on October 18, 2010, stating it was requiring the University to develop an ABPP (Section 3.2.2.1.4) and determined that the plan "will result in the minimization of potential adverse effects to eagles and their nests, and will thus provide sufficient protection to the landscape associated with eagle habitation as sacred site." Thirty days has passed since DOE sent the letter to the Lenape Indian Tribe and DOE has not received an objection from the Tribe to the Department's no adverse effect determination.

3.3.2 ENVIRONMENTAL CONSEQUENCES

3.3.2.1 Proposed Project

Because the Wind Energy Project site is on the border of marshlands and adjacent to the Delaware Bay, it is very likely the area was used to some extent by American Indians prior to arrival of Europeans. However, the construction site's use as a dredge spoils area has resulted in the site of the wind turbine being covered with sediments and soils that are more recent than when the American Indians might have used the land. DOE knows of no evidence of artifacts in the construction area, but if artifacts were present, they would be buried under existing spoils removed from the river and canals and would remain buried during the life of the project. The access road is outside the spoils area, but it represents ground that has already been heavily disturbed and, per a Phase 1 archaeological survey (JMA 2009) performed for DNREC, does not appear to contain any archaeological or historical features of interest. No artifacts were encountered during construction activities. Further, because of the disturbed nature of the construction site, the University of Delaware did not expect to find artifacts. However, the construction crews were sensitive to the concern, and when they discovered a few bones on the dredge spoils site, they contacted the University immediately. The University determined the bones were from a necropsy performed by the Marine Education, Research and Rehabilitation Institute in Lewes on a dead whale that washed ashore a few years ago (Firestone 2010d).

In a May 24, 2010, letter the Delaware SHPO informed DOE that it had conducted a site visit and that "a determination has been made that the construction of the wind turbine and access road are located on soils which have been previously disturbed, and that there are no adverse impacts to archaeological resources from this aspect of the construction." The SHPO has requested information about connected actions, such as constructing electricity transmission infrastructure, before determining whether those actions might have an impact on archaeological resources. After receiving the requested information and performing another site visit, the SHPO provided a letter dated July 19, 2010, stating, "…the installation of the utility connection occurred in an area that was previously disturbed by the dredging operations and the wind turbine project did not disturb any archaeological resources."

There are numerous historic structures in the Lewes vicinity, but none close enough to the location of the wind turbine that physical damage would be expected as a result of construction activities. The foundation for the wind turbine consisted of rammed aggregate piers (Figure 2-3), which involved columns of compacted gravel reaching about 35 feet below the surface. The gravel was compacted in layers using a vertical ramming device. It is assumed that the energy imparted to the ground and the resulting vibrations would be somewhat similar to that of driving deep pilings into the ground. According to a paper presented at the American Society of Civil Engineers Construction Congress 6 in 2000 (Amick and Gendreau 2000), diesel or vibratory pile drivers can typically generate vibrations with peak particle velocities as high as about 1,000 millimeters (39 inches) per second. A German standard cited in the paper identifies a peak particle velocity as low as 2 millimeters (0.08 inch) per second as being of concern for potential damage to historic or ancient buildings. However, these vibrations typically are quickly attenuated in the soil, and at a distance of about 1,000 feet, the vibrations from the pile-driving actions would be reduced by three to four orders of magnitude to the range of 0.1 to 0.2 millimeter (0.004 to 0.008 inch) per second (Amick and Gendreau 2000, citing other references). The closest historic structure to the project site is between 2,000 and 3,000 feet away (Table 3-2). Although vibration attenuation in soil can vary from the typical values described in this EA, no physical impacts to the historic places in the vicinity were expected and none were reported as a result of wind turbine construction activities.

Now that the wind turbine is in place, it represents a tall visual presence in the community. According to regulations on the protection of historic properties, specifically 36 CFR 800.5(a) (2) (v), an adverse effect can include “introduction of visual, atmospheric or audible elements that diminish the integrity of the property’s significant historic features.” Guidelines developed by the Delaware SHPO (DE SHPO 2003) describe a project as having adverse visual effects by either involving a negative aesthetic effect on historic properties or an obstructive effect on historic properties. An obstructive effect is one that diminishes the historic property’s integrity by blocking the property from view or by blocking the view from the property.

Aesthetic effects are subjective. An observer might feel that seeing a wind turbine in the distant background is incompatible with viewing an historic property. Another observer might view the wind turbine and the historic property as an interesting juxtaposition of new and old technology that heightens the viewing experience. Thus, aesthetic effects present a unique challenge to determining whether a wind turbine has an adverse effect on historic properties.

In a June 5, 2010, letter (Appendix B) the Delaware SHPO informed DOE that parts of the wind turbine are visible from certain streets in the Lewes Historic District and visible in part or in whole from three other historic properties. Given the wind turbine’s distance of half a mile or more from the historic properties, DOE believes the presence of the wind turbine would not have significant adverse impacts on the viewing aesthetics of the historic properties in the area or otherwise affect the historic integrity of the properties.

In a letter dated October 22, 2010, the Delaware SHPO summarized its involvement in the University of Delaware Wind Energy Project. Noting that field visits to the project site found that no significant archaeological sites were disturbed, the SHPO concurred with DOE’s finding “that construction of the wind turbine will not adversely affect any properties listed on or eligible for listing on the National Register of Historic Places.” This letter concluded all consultations required under Section 106 of the *National Historic Preservation Act*.

Section 3.6 of this EA discusses in greater detail the potential visual impacts associated with the wind turbine.

Sounds and the phenomenon of shadow flicker are additional operational aspects of the wind turbine that could affect historic properties. Sections 3.5 and 3.6 discuss potential impacts from wind turbine sound and shadow flicker, respectively. Impacts addressed in these sections are applicable to historic properties as well as to other properties and individuals.

3.3.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential environmental impacts to cultural resources would not occur.

3.4 Occupational and Public Health and Safety

3.4.1 AFFECTED ENVIRONMENT

Occupational health and safety is concerned with occupational and worker hazards during routine operations. The U.S. Department of Labor, Bureau of Statistics maintains statistics on workplace injuries, illnesses, and fatalities. These statistics consider the potential for total recordable cases; days away from work, days of restricted work activity or job transfer; and worker fatalities in the work environment. The incidence rates (cases per 100 full-time workers for nonfatality statistics and cases per 100,000 full-time workers for fatality statistics) the Bureau of Labor Statistics maintains are calculated separately for different industries based on the reported health and safety cases for that particular industry. A full-time worker is assumed to work 2,000 hours per year. The health and safety incident categories are defined as follows:

Total recordable cases – The total number of work-related deaths, illnesses, or injuries that result in the loss of consciousness, days away from work, restricted work activity or job transfer, or required medical treatment beyond first aid.

Days away from work, or days of restricted work activity or job transfer – Cases that involve days away from work, or days of restricted activity or job transfer, or both.

Worker fatality – Cases that involve the death of a worker.

In order to minimize the effect of industrial health and safety hazards, industries must comply with all applicable regulations that relate to industrial health and safety, including Occupational Safety and Health Administration requirements to have a health and safety plan in place before starting work.

3.4.2 ENVIRONMENTAL CONSEQUENCES

3.4.2.1 Proposed Project

For construction activities, DOE used the Bureau of Labor Statistics incident rates from the category "heavy and civil engineering construction, utility systems, power and communication line and related structures construction" for 2008. It was judged that the tower and electrical work associated with this type of construction would be a reasonable approximation for the work associated with the wind turbine construction. The total recordable cases incidence rate for the year was 4.0 injuries per 100 full-time employees (each working 2,000 hours during the year), and the days away from work, days of restricted work activity or job transfer incidence rate was 2.4 injuries per 100 full-time employees (BLS 2009a). Prior to construction, it was estimated that there would be 20 construction workers at the site at any given time during construction, which would take about 2 months (Vanderbrook 2010). Assuming nine 40-hour weeks for 20 workers, DOE estimates there would likely be no total recordable cases (calculated at 0.14 case) and no days away from work (calculated at 0.09 day) during the construction phase. This was consistent with the actual construction, as no incidents were reported. Standard best management practices for the construction industry were implemented to reduce risks to workers. This included, but was not limited to, complying with Occupational Safety and Health Agency regulation "Safety and Health Regulations for Construction" (29 CFR Part 1926).

The fatality incidence rate for construction activities in 2008 (preliminary data) was 9.6 fatalities per 100,000 full-time employees (BLS 2009b). Assuming nine 40-hour weeks for 20 workers, a fatality during construction was very unlikely because the calculated number of fatalities is about 0.0003 (or conversely, 1 chance in 3,300). No fatalities occurred during construction.

During operations, the only activities that would be different from those normally occurring at the University of Delaware campus would be those associated with periodic maintenance of the wind turbine. It is estimated that there would be two maintenance events each year and each would involve two workers for two days. That is, each event would require a total of 32 hours of labor, so there would be 64 hours of labor per year (Vanderbrook 2010). For these activities, DOE used the Bureau of Labor Statistics incidence rates from the category "other services, repair and maintenance, commercial and industrial machinery and equipment repair and maintenance" for 2008. The total recordable cases incidence rate was 4.8 injuries per 100 full-time employees, and the days away from work, days of restricted work activity or job transfer incidence rate was 2.5 injuries per 100 full-time employees (BLS 2009a). Assuming a 20-year working life for the wind turbine and 64-hours of labor per year, DOE estimates that there likely would be no total recordable cases (calculated at 0.031 case) and no days away from work (calculated at 0.016 day) during wind turbine operations. Other than the great heights involved, there would be no unusual or potentially unacceptable hazards or risks to workers, who will be trained to operate under a safety program and procedures, which would account for the working heights involved.

The fatality incidence rate for wind turbine maintenance activities is assumed to be similar to "automotive repair and maintenance" because this is the closest available category in the preliminary 2008 data. The reported fatality incident rate for this category was 5.6 fatalities per 100,000 full-time employees (BLS 2009b). Assuming a 20-year working life for the wind turbine and 64-hours of labor per year, a fatality during wind turbine operation would be very unlikely because the calculated number of fatalities is about 0.00004. There would be increased risks involved in the performance of these maintenance activities "at elevation." This increase, however, would likely increase the incident rate by a few percentage points, which would still result in very low impact values.

Decommissioning would basically be the reverse of construction. Assuming decommissioning required the same size workforce, lasted for the same duration, and that incident rates, some 20 years in the future, would be the same as at present, it can be concluded there would likely be no recordable incidents, no days away from work, and no fatalities during decommissioning.

There have been recorded incidents of wind turbines collapsing or throwing blades during operation. Video and photograph records of such events can be found on various Internet web sites. One cause of such an event would be electrical or mechanical failures that allowed the rotor to gain too much speed during high winds. As would be expected, it is not practical to design either the electronics or the structure of a wind turbine to accommodate any rotor velocity. Accordingly, wind turbines are designed for a maximum rotor speed and include controls and brakes to prevent the maximum speed from being exceeded. Utility-scale wind turbines are now better designed, certified to meet international engineering standards, and, as applicable, include ratings for withstanding hurricane force winds and other criteria. In addition to safeguards included in the design of the wind turbine, the location would minimize the potential for public safety issues. The wind turbine would be positioned farther than its full height (that is, further than 125 meters or 410 feet) from the nearest public road, which would be the proposed road running in-between the wind turbine location and the University of Delaware campus, and it would be much farther away from any residences or occupied buildings. In the highly unlikely event of a catastrophic failure and collapse of the wind turbine, no member of the public would be in significant danger. Wind turbine blades also have the potential to accumulate and throw ice under specific weather conditions. The stated isolation of the wind turbine would also prevent this phenomenon from being a hazard to the public. If there was sufficient ice build-up to slow the turbine's rotation, this would be sensed by the turbine's control system, and it would be shut down (AWEA n.d.) and this phenomenon would not be a hazard to the public.

3.4.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential impacts to occupational and public health and safety would not occur.

3.5 Noise

3.5.1 AFFECTED ENVIRONMENT

Noise is often referred to as unwanted sound. Sound is the rapid fluctuation of air pressure causing a repeating cycle of compressed and expanding air. The intensity is measured in decibels (dB). In terms of human response, 0 dB is the threshold of hearing and 140 dB is considered the threshold of pain. The A-weighted scale, often referred to as dBA or dB(A), is a modified scale that better approximates the range of human hearing by filtering out low-frequency sounds, which are not as damaging as higher frequencies. As a frame of reference, rustling leaves is about 10 dBA, conversational speech is about 60 dBA, and an aircraft take-off is about 120 dBA (EPA 1974). It is also important to note that decibels are a logarithmic scale, so doubling the pressure intensity of a sound does not double the decibel value. If a source is doubled (for example, two jets taking off instead of one), the measured sound would increase by about 3 dB. If the sound pressure doubled, the measured sound would increase by 6 dB (Alberts 2006). With respect to how humans perceive changes in sound levels (EPA 1974):

- A 3-dB change is considered barely noticeable;
- A 5-dB change is typically noticeable and a community response might be expected from an increase of this amount; and
- A 10-dB change is generally perceived as a doubling or halving of the sound level, and an increase of this amount would very likely result in an adverse community response.

Three additional concepts used in later discussions are the equivalent sound pressure level (L_{eq}), 10-percent sound level (L_{10}), and 90-percent sound level (L_{90}), which are described as follows:

L_{eq} – A single number that, if continuous during a specific period, would contain the same total energy as the actual time-varying sound. That is, an average sound over a given time.

L_{10} – The sound level that is exceeded 10 percent of the time. It is frequently used as a measure of the peak sound.

L_{90} – The sound level that is exceeded 90 percent of the time. It is frequently used as a measure of ambient sound levels.

The location of the wind turbine is within Lewes city limits but is largely surrounded by undeveloped marshland. The University of Delaware campus to the northeast and east is the closest area that people would frequent. The closest residential areas are farther to the northeast, east, and southeast. The closest individual residences are about 0.4 mile from the wind turbine location. Existing sound levels near the wind turbine are expected to range from those typical of a rural area to those typical of an urban setting. Since impacts of primary concern would be to people in the area, locations to the eastern side of the dredge spoils area represent the affected environment of primary concern.

The University of Delaware commissioned an acoustic study in order to establish baseline sound conditions in the area of the proposed wind turbine as well as to evaluate the impacts of the wind turbine's operation. This section includes a summary of the applicable findings; the entire acoustic study is included as Appendix E. To determine baseline conditions, the study selected sound monitoring locations close to the wind turbine site and in places where people would routinely be present. Figure 3-6 shows the monitoring locations, by number, in relation to the wind turbine site. Table 3-3 provides a summary of the sound monitoring results. The table also provides the approximate distance from each monitoring location to the site of the wind turbine. The full study in Appendix E provides further detail on the monitoring and the specifications of the equipment used. The study also describes the various sounds present and identifiable during the monitoring events. At each monitoring location, a minimum of three 10-minute sound level measurements were made during the day (defined as the time from 7 a.m. to 10 p.m.) and a minimum of three 10-minute sound level measurements were made during the night.

The results in Table 3-3 show that the average sound levels (L_{eq}) for those areas in relative close proximity to the wind turbine range from 34 to 56 dBA, which is considered typical for a suburban area. The L_{90} levels, the quietest 10 percent of the time and the value often used to represent the ambient sound level, range from 32 to 55 dBA.

Figure 3-6. Aerial photograph with sound monitoring locations identified by number.

Table 3-3. Summary of sound monitoring results by monitoring location shown in Figure 3-6.

Sound monitoring locations		Distance to wind turbine site (feet)	Sound levels (A-weighted decibels)			
			24-hour average L_{90}	24-hour average L_{eq}	Range of L_{90}	Range of L_{eq}
#1	UD College	1,400	53.4	54.7	51 – 55	52 – 56
#2	Virden Center residential units	1,200	44.2	46.1	36 – 47	38 – 49
#3	Hoornkill Avenue residences[a]	2,200	37.2	39.5	32 – 40	34 – 42
#4	Cedar Street residences	2,600	40.6	52.1	36 – 49	46 – 55

a. A public comment received on the Draft EA correctly noted that the location identified as "Hoornkill Avenue residents" in the Appendix E Acoustic Study is actually an open field area just to the southwest of where Hoornkill Avenue ends (Figure 3-6). This note also applies to subsequent uses of the "Hoornkill Avenue residents" designation in this document.

3.5.2 ENVIRONMENTAL CONSEQUENCES

3.5.2.1 Proposed Project

Noise produced during project construction was a result of heavy equipment at the site. Sound levels from typical construction equipment (for example, bulldozers, rollers, or other heavy equipment with diesel engines and limited movement) are generally in the 80 to 90 dBA range at a distance of 50 feet (EPA 1974). Assuming two of the noisiest pieces of equipment were operating at the same time and that sound intensity decreases over distance as a result of geometric spreading of the sound levels (resulting in a decrease of about 6 dB per doubling of the distance from the source), it is estimated that sound levels exceeded the guideline set by the U.S. Environmental Protection Agency for residential day-night average noise of 55 dBA (EPA 1974) for a distance of about 1,640 feet. The Virden Center residential units on the University of Delaware campus are within this distance (Table 3-3), but no private residences are this close to the construction area. Sound attenuation factors such as air absorption and ground effects from terrain and vegetation would decrease the distance at which construction noise would be 55 dBA or greater.

If it is assumed that the vertical ramming device used in installing the rammed aggregate piers produces sound similar to an impact pile driver, sound levels could have been increased by about 10 dB compared with the above analysis. However, given the relatively small size of the project (a single wind turbine), construction activities occurred during day light hours and were of short duration overall. Significant noise impacts were not expected to occur during construction of the project. The University did, however, report that it received two noise complaints during the construction activities; at least one of those was attributed to tractor-trailers parked overnight with their generators running (Firestone 2010d).

Noise produced during decommissioning of the wind turbine is expected to be very similar to, if not less than, that generated during construction. That is, with appropriate control of nighttime activities, significant noise impacts would not be expected. Accordingly, the remainder of this section describes potential noise impacts from wind turbine operations.

Operating wind turbines can generate two types of sound: mechanical sound from components such as gearboxes, generators, yaw drives, and cooling fans, and aerodynamic sound from the flow of air over and past the rotor blades. Modern wind turbine design has greatly reduced mechanical sound and it generally can be ignored in comparison to the aerodynamic sound, which is often described as a "swishing" or "whooshing" sound (BLM 2005b). The Gamesa G90 wind turbine installed under the Wind Energy Project has several characteristics that reduce aerodynamic sound levels in comparison to other, primarily older wind turbine designs. It is an upwind turbine, meaning the turbine faces into the wind and the wind encounters the rotor blades before the tower and the nacelle, making for quieter operations than a downwind turbine. It has relatively low rotational speeds and pitch control on the rotors, both of which reduce sound levels. The Gamesa wind turbine is also a variable speed design, which is quieter than a fixed speed turbine because it can operate at slower speeds in low winds resulting in a quieter operation in low winds (BLM 2005a).

Gamesa reports that its G90 wind turbine produces a sound power level of 94.8 dBA at its cut-in wind speed of 4.2 meters per second (9.4 miles per hour) at the hub height. The maximum sound power is reported at 108.4 dBA and first occurs when wind speed at the hub reaches 9.7 meters per second (21.7 miles per hour), which is the designated design speed for the G90 wind turbine. Both of these sound levels are reported as being measured values plus a 2-dB uncertainty margin (Appendix E). In the acoustic study (Appendix E), a model based on International Standard ISO 9613 (Acoustics – Attenuation of Sound During Propagation Outdoors) was used to develop sound propagation and attenuation characteristics for the wind turbine sound levels. Atmospheric absorption was calculated using recognized standard methods, and conservative, worst-case ground conditions were assumed. The model also assumed favorable sound propagation conditions as might occur on a clear night, such as downwind conditions and a ground-based temperature inversion. According to the study, conditions such as atmospheric turbulence and wind shadow effects, which were not considered by the acoustic model, could reduce sound levels by 5 to 20 dBA from those generated through the model.

The acoustic study shows decibel contours (Figures 2 and 3 of Appendix E) from the wind turbine source under the minimum (cut-in wind speed) and maximum operating conditions. At the minimum operating conditions, the 35-dBA contour extends about 700 feet from the turbine location and does not reach any of the University of Delaware campus facilities. At the maximum operating conditions, a 40-dBA contour extends about 1,800 feet from the turbine location, encompassing all of the campus facilities, but does not reach any private residences. The sound contours in the study’s figures are described for an elevation of 5 feet above the ground and representing a composite worst case in which all locations are simultaneously downwind of the wind turbine.

The acoustic study provides, in addition to the sound contours, modeled sound levels for each of the monitoring locations shown in Figure 3-6. Table 3-4 summarizes this information and includes applicable regulatory levels and results of the baseline sound level monitoring for comparison with the modeled wind turbine sound levels. Applicable regulatory levels shown in the table are from the

Table 3-4. Summary of wind turbine sound impacts at locations shown in Figure 3-6.

Sound monitoring/ receiving locations		Wind turbine operational sound levels (dBA)		Delaware Noise Control Act criteria		Baseline ambient sound levels – L_{90} (dBA)
		At cut-in wind speed	At design wind speed	Noise zone	Sound limit (dBA)[a]	
#1	UD College	29.6	43.2	Class B	75	53.4
#2	Virden Center residential units	30.8	44.4	Class A	55	44.2
#3	Hoornkill Avenue residences	24.6	38.2	Class A	55	37.2
#4	Cedar Street residences	23.3	36.9	Class A	55	40.6

a. For the Class A noise zone entries, the maximum allowable sound level shown is for nighttime (that is 10 p.m. to 7 a.m.). Sixty-five dBA is the maximum allowable sound level for daytime hours. The regulations do not distinguish night- and day-time limits for Class B and Class C noise zones.

dBA = A-weighted decibel.

Delaware Noise Control Act (Delaware Code, Title 7, Chapter 71). These regulations include two requirements that would be applicable to the wind turbine project: (1) maximum noise limits for stationary sources of sound that are based on land use zone designations; and (2) an intrusive noise designation for sound sources that exceed ambient sound levels by 10 dBA. The maximum noise levels are based on 24-hour average sound levels (Leq), and the numerical limits are set based on the noise zone classification for the location of the source and the zone classification of the receiving location. The regulations identify only three noise zones: Class A for residential areas or other such areas where people dwell and sleep; Class B for commercial areas where conversation is essential to the intended use and includes educational facilities; and Class C for industrial areas where hearing protection is necessary and the need for conversation is limited. Maximum sound levels for Class A include a value for daytime and a more restrictive limit for nighttime. The regulatory sound limits shown in Table 3-4 are based on the wind turbine being located in a Class B zone and the receiving locations shown in the table in the zones identified.

The Table 3-4 data show that sound levels generated by the wind turbine would clearly meet requirements set by the *Delaware Noise Control Act*. Even at the maximum sound production (at design wind speed), sound levels at the identified receiving locations would be well below the sound limits set for stationary sources. There are no receiving facilities closer to the wind turbine location than the Virden Center residential units on the University of Delaware campus, and sound levels at that location are well below the 55-dBA limit set for residential areas during nighttime. The second criterion of being less than 10 dBA above ambient sound levels is also met at each of the receiving locations. In most cases, sound from the wind turbine would be less than the measured ambient sound levels and in the worst case (the design wind speed at the Hoornkill Avenue location in Table 3-4), would be only 1 dBA higher.

Based on the results of the acoustic study, individuals residing in the area of the wind turbine would be unable to distinguish sound generated by the operating wind turbine from ambient sound levels. It is generally recognized that a sound level change of 3 dBA is barely noticeable to most people (Section 3.5.1) and the worst case presented by the acoustic study was a 1-dBA increase over ambient sound levels. In most cases, the wind turbine sound is expected to be lower than ambient sound levels. Results from the acoustic study are consistent with DOE studies showing that at a distance of 750 to 1,000 feet, a wind farm is no noisier than a kitchen refrigerator (DOE 2005).

Perhaps the most sensitive response to sound is during nighttime and, specifically, effects on sleep. In its report, the World Health Organization noted that noise exposure can affect sleep in several ways and, over extended periods of time, can lead to serious health issues (Alberts 2006). According to the report, sound levels of 60 dBA will wake 90 percent of sleeping people, a level of 55 dBA affects REM sleep and increases the time to fall asleep, and levels of 40 to 45 dBA wakes 10 percent of sleeping people. Individuals at locations closest to the wind turbine could experience sound levels in this lowest category. As long as ambient sounds were at the levels measured during the acoustic study, the wind turbine sound would be at similar levels. However, ambient sound levels can vary, and during still periods some individuals could be awakened by the wind turbine sounds. Further, it has been reported that some individuals become more sensitive to the "thumping and swishing" sounds of a wind turbine during nighttime, even if these sounds were not noticeable during the day.

DOE recognizes there are sound issues associated with the operation of wind turbines. Data collected for this specific wind turbine location indicate expected wind turbine sounds are comparable to ambient conditions and adverse impacts are expected to be minor. However, it is also recognized that these can only be considered general conclusions because there is always the potential for individuals to be more sensitive to sounds than the general population.

It should be noted that the ambient sound levels shown in Tables 3-3 and 3-4 are 24-hour averages and are based on sound measurements taken when there was wind movement. The acoustic study presents calculated wind speed at the height of the wind turbine hub along with each of the sound level measurements. This was done to show when the wind speed would be high enough for the turbine to operate. Considering all four of the sound monitoring locations, there were 36 sets of measurement data (each characterizing at least a 10-minute period) and 80 percent of those were during periods when wind speed (at the hub height) would have supported wind turbine operation. An important element of this information is that there were likely wind contributions to each of the reported ambient sound levels. Sound measurements taken during still periods are expected to be lower than reported in the acoustic study. However, the wind turbine would not be operating at those times, so the values reported in the acoustic study represent a fair comparison with sound levels that would be generated by the wind turbine. It is a recognized element of evaluating the effects of wind turbine sound that the wind turbine generates more sound as the blade rotation increases, but this is accompanied by increased wind sound in the area, which in turn increases ambient sound levels making the wind turbine sound potentially less noticeable.

3.5.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential impacts from sound levels would not occur.

3.6 Aesthetics and Visual Resources

3.6.1 AFFECTED ENVIRONMENT

Aesthetic and visual resources refer to the scenic or visual quality (that is, visual appeal) of the landscape. This includes all natural and manmade objects (moving and stationary) that are visible on the landscape (BLM 2005a). The visual character of the wind turbine site is that of a heavily disturbed area covered with dredge spoils and dirt access paths or roads. The area is somewhat isolated from ground view due to much of it being surrounded by trees and bushes. The visual character of the area immediately surrounding the Wind Energy Project site varies from undeveloped marshland to the north, west, and south to the University of Delaware campus and residences towards the northeast, east, and southeast. A cemetery on the western side of Pilottown Road lies just to the east of the campus. The Lewes and Rehoboth Canal lies on the eastern side of Pilottown Road.

The community of Lewes might be characterized as a blend of historic and present day properties and developments that are heavily influence by the presence of the Delaware Bay and the ocean. The Lewes Chamber of Commerce highlights the beaches and water activities, nature trails, bird sanctuaries, and the historical district as key attractions for visitors. These characteristics also provide insight into valued visual resources of the general area. The community of Lewes is also affected greatly by tourism and the economic benefits associated with tourism. Considering the hotels, bed and breakfast establishments, and seasonal residences, the number of people in the city can increase by an estimated 3,300 individuals, basically doubling the population during busy periods (Lewes 2005). In addition, the area is in close enough proximity to more populous areas to the north that visitors on day-trips can add significantly to these numbers.

The City of Lewes' Comprehensive Plan identifies several visual objectives in maintaining the core values of the community's character, including the following (Lewes 2005):

- Establish and protect the visual connection between the canal and the land,

- Preserve the unobstructed views of the canal and Lewes Beach from Pilottown and Gills Neck Roads, and
- Preserve visual access to the city from the beach and visa-versa.

These objectives provide further insight into visual resources that are important to the community. These are objectives identified to maintain the community's character, which is also undoubtedly part of the reason the area is popular for tourists and other visitors.

3.6.2 ENVIRONMENTAL CONSEQUENCES

3.6.2.1 Proposed Project

Aesthetic and visual consequences of the project are grouped into the areas of direct visual effects and shadow flicker.

3.6.2.1.1 Direct Visual Affects

Construction of the wind turbine involved the presence of heavy equipment, construction workers and their vehicles, trucks delivering large pieces of equipment, dust and vehicle exhaust emissions, and, for a period, a crane to lift the wind turbine components. All of these items were in contrast to the normal visual landscape of the site. However, these actions were relatively short term and occurred primarily in an area that is somewhat shielded from ground view in much of the surrounding area. The crane was the exception, in that it was visible for some distance when in the upright position, as were the wind turbine components as they were erected. Because there was only one wind turbine involved, the duration of construction was relatively short (about 2 months), and the overall size of the construction effort was relatively modest. Eventual decommissioning would require essentially the same types of activities as construction and, similarly, is expected to have relatively modest visual effects (other than the change of eliminating the visual impact of the wind turbine).

With construction complete, the project resulted in a tall, narrow structure on the outer boundary of Lewes. Its height makes a portion of the wind turbine visible from much of the city. However, its location does not restrict, or otherwise significantly affect, views deemed most significant to the character of the community. The wind turbine's location is not between any primary viewing locations and the ocean/bay, the canal, or beaches. That is, looking at Figures 2-1, 2-2, and others, locations that have the wind turbine in their view toward the bay are marsh areas and, farther away, agricultural areas. However, the wind turbine could be present in views from the beaches back toward the community.

The height of the wind turbine also makes it visible from areas outside of the city, possibly as far away as across Delaware Bay in New Jersey. Beach Plum Island Nature Preserve is on the barrier island running north from Roosevelt Inlet (Figures 2-1 and 2-2) and the Prime Hook National Wildlife Refuge runs adjacent to the coast of Delaware Bay just north of the Great Marsh area. These areas are valued for their wildlife habitat and natural settings and from which the wind turbine is likely visible. However, with the possible exception of the Beach Plum Island area near Roosevelt Inlet, these areas and others outside Lewes would be far enough away that the visual impact of the single wind turbine to visitors and residents near those areas would be greatly diminished.

The University of Delaware arranged for a visual simulation of how the wind turbine would appear from typical locations within Lewes. This was done by tethering a balloon at the wind turbine location at an elevation corresponding to the hub of the wind turbine. Pictures were then taken at locations in the city and the balloon was used as a reference point to paste a clip of a wind turbine into the photograph at the appropriate scale. From the wind turbine site, the two locations selected for the photographs were at a distance of about 3,500 feet to the south and about 8,200 feet to the southeast. The evaluation and resulting simulations are provided in Appendix F of this EA. As can be seen in the photographs, the top portion of the tower and most of the blades would be visible from both of these distances. It can be concluded from this that unless there was something close in the view that blocked the wind turbine, it would be visible from most areas in the city. However, based on these simulations, DOE considers the appearance of a single wind turbine at the Project site to represent a fairly minor component of the landscape, and it would be difficult to characterize its appearance as overwhelming in any regard. Further, because the terrain is relatively flat, the wind turbine is not on a hill or elevated point that would add to its visual impact and there is no elevated ground in the surrounding area that would have a better view of the wind turbine. Within the developed, community areas, it would not be unusual for views toward the wind turbine to be blocked by local structures or trees.

In early June 2010, the Delaware SHPO undertook a field review to assess the visibility of the University's wind turbine from the historic properties closest to the turbine site. The historic properties considered include the first five places or districts identified in Table 3-2 plus the DeVries Pallisade Site, which is identified at the bottom of the table without a specific location. These observations, with the wind turbine in place, supplement the visual simulation performed by the University as described in the preceding paragraph. The results from the state's effort, reported in a letter (Appendix B) to DOE, are summarized as follows:

- Locations within the Lewes Historic District
  - Along Pilottown Road, including from the William Russell House – not visible
  - Along streets running northwest from Savannah Road – not visible
  - Along streets running southeast from Savannah Road to Kings Highway – only the top visible at a distance of 1.5 miles
  - At the bridge over the Lewes and Rehoboth Canal – only the top half visible at a distance of 1.5 miles
- Thomas Maull House – not visible, view blocked by houses and trees
- Fisher's Paradise – visible through trees, visibility may be greater in winter
- DeVries Pallisade Site – fully visible from St. Peters cemetery and commemorative monument
- Pagan Creek Dike – slightly visible through trees, visibility may be greater in winter

Visual impacts can be characterized as the contrast perceived by observers between the existing landscape and the project and activities (BLM 2005a). The wind turbine stands out from the existing landscape, and observers likely consider it to be in contrast with the surroundings. The general presence of overhead power lines and communication towers and the familiarity observers have with these elements of the community might diminish such contrast. Recognizing the existence of a visual impact still leaves the magnitude of the impact in question and whether it would be an adverse impact. These are very subjective in nature and can vary greatly based on the observer. Some observers would undoubtedly feel the wind turbine represents an environmentally favorable means of generating energy and will not separate their observation from that feeling. At the other end of the spectrum, some observers might simply see it as a large, unwelcome addition to the landscape. The potential for some adverse visual impact might be overcome by the beneficial aspects of energy capture, the research and development that would be performed by the University, and determining the overall feasibility of this means of electrical energy generation in this region.

3.6.2.1.2 Shadow Flicker

Shadow flicker is the phenomenon of a wind turbine's moving blades casting shadows on a residence or some other location where it would be observed as flickering of the natural light. This strobe-like effect has been likened to what one observes when driving down a tree-lined road with the sun shining intermittently through the trees. Shadow flicker is most pronounced when the sun is at a low angle and, as a result, it has probably received more attention in Europe than in the continental United States because of the sun's lower angle in northern latitudes.

Because of the strobe-like effect of shadow flicker, there have been investigations into whether it might have the potential to produce epileptic seizures in individuals with photosensitivity. It has been determined that modern utility-scale wind turbines do not have the potential to cause these types of problems because of their relatively slow blade rotation. In one study (Harding et al. 2008), it was reported that flickers with a frequency greater than 3 hertz could pose a potential for inducing photosensitive seizures; that is, a light flashing at a rate of more than 3 times per second. The American Epilepsy Foundation reports that lights flashing in the range of 5 to 30 hertz are most likely to trigger seizures and recommends that flash rates of visual alarms be kept under 2 hertz (Epilepsy Foundation n.d.). A wind turbine with three blades would have to make a full revolution every second (or 60 revolutions per minute) to reach a frequency of 3 hertz. The Gamesa G90 wind turbine proposed for this project operates within the range of 9 to 19 revolutions per minute (Gamesa 2009). This would put the flicker frequency created by this wind turbine at 0.45 to 0.95 hertz; well below rates identified with photosensitivity issues.

Some data suggest that shadow flicker has the potential to cause a disorienting effect on a small segment of the population. The data also suggest that rotor rotation below 2.5 hertz can avoid such effects (BLM 2005c). As stated above, the rotor speeds involved with the project would be well below this level.

Health or safety concerns aside, shadow flicker is often considered annoying by those exposed. The locations where shadow flicker would occur are dependent on the relative positions of the sun and the wind turbine. Further, impacts depend on the position of observers relative to the line of sight to the sun through the turning rotor. Once a wind turbine location is set, the changing position of the sun by time of day and time of year can be used along with geometric relationships to determine the locations and duration of shadow flicker under ideal conditions for flicker generation. These ideal conditions (or worst-case conditions in terms of impacts) include no cloud cover or fog (that is, the sun is shining), the turbine rotor is turning, and the wind direction relative to the wind turbine is directly into or away from the sun. If the wind is blowing at a 90-degree angle to the sun's relative position, the sun will shine on the narrow side or silhouette of the rotor, and no moving shadow would be generated. Software programs have been developed to generate predictions of shadow flicker and can be used to support analyses of various levels of detail.

The University of Delaware initiated a shadow flicker analysis to help gauge potential impacts of the Wind Energy Project. Rather than generate exposure contours for the entire area of the wind turbine, the analysis selected several representative locations in the vicinity, established hypothetical window orientations and sizes, and determined shadow flickers occurrences at those locations. The analysis selected locations based on several criteria:

- Distance to wind turbine location – within 10 rotor diameters of the site;
- Areas most likely to be see shadow effects related to the sun's position in the sky;
- Current use of the facility (residence, classroom, overnight lodging);
- Areas of cultural and historical significance; and
- Line of site to the wind turbine from windows at the site.

The 10-rotor-diameter criterion is generally accepted as a reasonable distance limit beyond which shadow flicker is of little concern. The farther the observer is from the wind turbine, the smaller the portion of the sun being blocked and the distance allows the shadow to diffuse (weaken). The 10-rotor criterion in this case represents a distance of 900 meters (2,950 feet) from the wind turbine location. For each of the selected locations, the analysis assumed a building with a large, 3-meter wide by 2-meter high (9.8-feet wide by 6.6-feet high) window facing directly toward the wind turbine. Results of the analysis are in the form of plots showing the time of year and the time of day when shadows from the wind turbine would travel across the hypothetical window at a specific location under the ideal (or worst-case) conditions. The plots show the time of day in terms of when the exposure would start and when it would stop, resulting in an estimated duration. Figure 3-7 shows the locations of the sites selected for analysis and Table 3-5 summarizes the results. The report of the shadow flicker analysis initiated by the University of Delaware is provided in its entirety in Appendix G.

As can be seen in Table 3-5, the locations selected for analysis (or more appropriately the assumed windows at those locations) would experience shadow flicker for 35 to 51 days per year and the period of time the phenomenon would occur on each of those days would average from 0.36 to 0.46 hour (22 to 28 minutes). This is the time from when the flickering shadows would first reach the assumed window to when they would entirely pass the window. All of the selected locations lie to the east or southeast of the wind turbine location (consistent with the locations of residences in the area), so the periods of shadow flicker would always be in the afternoon hours when the sun is positioned in the western sky. The selected locations are listed in the table from north to south and the applicable months of shadow flicker

Figure 3-7. Aerial photograph with shadow flicker (SF) analysis locations identified by number.

Table 3-5. Characteristics of shadow flicker occurrences at locations shown in Figure 3-7 under ideal/worst-case conditions.

Analyzed locations (north to south)	Time of year		Total days occurring per year[a]	Hours per day when occurring		Total hours per year
	Spring	Fall		Maximum	Mean	
SF4	March	September into October	35	0.46	0.36	12.5
SF5	March	September into October	36	0.47	0.36	13.1
SF3	March into April	August into September	44	0.56	0.44	19.5
SF6	March into April	August into September	42	0.52	0.41	17.1
SF1	April	August into September	51	0.59	0.46	23.3
SF2	April into May	August	50	0.57	0.44	22.2

a. The total number of days in the year during which shadow flicker would occur at a location are basically split between days in the spring and days in the fall.

SF = shadow flicker.

occurrence are identified to help describe the nature of the phenomenon. In the spring, the sun's position adjusts northward over time and the occurrence of shadow flickers within the analyzed locations moves to the south in response. That is, the table shows the springtime shadow flicker occurring earliest in the north and then moving to the south. In the fall, as the sun's position gradually moves southward over time; the occurrence of shadow flickers moves to the north in response.

There are no firm criteria on what is acceptable or unacceptable in terms of exposure to shadow flicker. The level of annoyance is very subjective and depends on how the exposed portion of the facility is being used, and on the individual observer. Furthermore, mitigation measures can be as simple as hanging drapes or blinds or planting screening vegetation. There are, however, some guidelines or reference points on what some might term acceptable levels of exposure to shadow flicker occurrences. The Danish Wind Industry Association identifies a court case in Germany in which a judge set 30 hours of actual shadow flicker per year as a tolerable level (DWIA 2003). In a review of wind energy ordinances, the DOE's National Renewable Energy Laboratory identified a county ordinance in Wisconsin that required facilities to be designed such that shadow flicker or blade glint would not exceed 10 hours per year (NREL 2008). The National Wind Coordinating Committee, a collaboration of U.S. industry and government groups, identifies shadow flicker of 20 to 30 hours per year as the threshold for concern (NWCC 2006). Based on this information, all of the locations would be at exposure levels deemed tolerable by the German court and the two locations in Table 3-5 with the most exposure (that is, the two locations with greater than 20 hours per year) would be just reaching levels of possible concern based on National Wind Coordinating Committee criteria. Considering the conservative nature of the assumptions made in generating these values, it is unlikely total exposure durations would ever be as high as shown in Table 3-5. Conditions that would occur with some regularity (some more frequently than others) include cloud cover, no wind, or wind blowing in some other direction than the worst case. If any one of these conditions occurred at the time of a calculated shadow flicker, it would reduce the shadow flicker exposures shown in Table 3-5. A single wind turbine operating near the University of Delaware campus would not be expected to generate significant shadow flicker impacts. It is recognized, however, that some individuals might find any exposure to shadow flicker unacceptable, but there is no evidence to date that such individuals would be harmed by the low duration exposures expected in this case.

3.6.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential impacts to visual resources would not occur.

3.7 Utilities, Energy, and Materials

Discussions in this section are limited to the electrical energy associated with the Wind Energy Project. The Wind Energy Project would not have impacts on other utilities or utility services of the community. Water was required during construction for activities such as soil compaction and dust suppression, but these were not expected to have any impact on water supplies or the water distribution system. The project would not involve routine production of sanitary sewage or other wastewater, and other than possibly some waste debris generated during construction (which went to the local landfill), there would be no routine production of solid waste. Fabrication of the wind turbine components involved the unavoidable commitment of various materials, but these materials represent a small fraction of those available in the world marketplace.

3.7.1 AFFECTED ENVIRONMENT

Electricity at the Wind Energy Project site is provided by the City of Lewes, and the city is part of the Delaware Electric Cooperative, which covers Kent and Sussex counties in Delaware. Members of this cooperative, in addition to the City of Lewes, are the Delaware Electric Co-op, Delmarva Power, and the municipalities of Dover, Milford, Seaford, and Smyrna (DEC n.d.). The Delaware Electric Cooperative and several other cooperatives in surrounding states are, in turn, member-owners of the Old Dominion Electric Cooperative, which owns approximately 1,350 megawatts of peaking electrical generation capacity and has agreements with other electrical power generating plants for additional power (DEC 2009).

The Delaware Electric Cooperative, serving only Kent and Sussex counties, reported selling 1.15 million megawatt-hours of electricity in 2008 (DEC 2008). Assuming this electricity was used evenly throughout the 8,760 hours in a year, this represents an average electrical load of about 130 megawatts. Peak loads would be much higher than the 130-megawatt average.

At the state level, Delaware’s capacity for generating electricity is one of the lowest in the nation, with a summer production capacity of only 3,350 megawatts (about 0.3 percent of the national production capacity) (DOE 2010b). Actual electricity production in December of 2009 was 0.576 million megawatt-hours (DOE 2010b). Assuming this was produced evenly over a 24-hour day, this equates to production capacity of about 770 megawatts. Peak production during the month was likely much higher than the 770-megawatt average.

3.7.2 ENVIRONMENTAL CONSEQUENCES

3.7.2.1 Proposed Project

The Wind Energy Project would involve a peak electrical power production capability of 2 megawatts. Portions of this power not used by the University of Delaware would be sent to the electrical grid. The wind turbine itself has minor electrical demands, such as the motors to control the pitch of the blades and to keep the face of the turbine into the wind. Over time, these electrical demands would be very small in comparison with the power production, and the power production would be a very small component of the loads at the regional and state levels. The project would have a very minor positive impact on the electricity generating capacity currently tied to the electrical grid of the region.

3.7.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential impacts to utilities, energy, and materials would not occur.

3.8 Transportation

3.8.1 AFFECTED ENVIRONMENT

Primary access into the Lewes area is via State Highway 1 (also known as the Coastal Highway) and U.S. Highway 9 (Figure 3-8). Both routes are classified as principal arterials by the Delaware Department of Transportation (DELDOT 2006). Roads of this classification are considered high traffic volume corridors

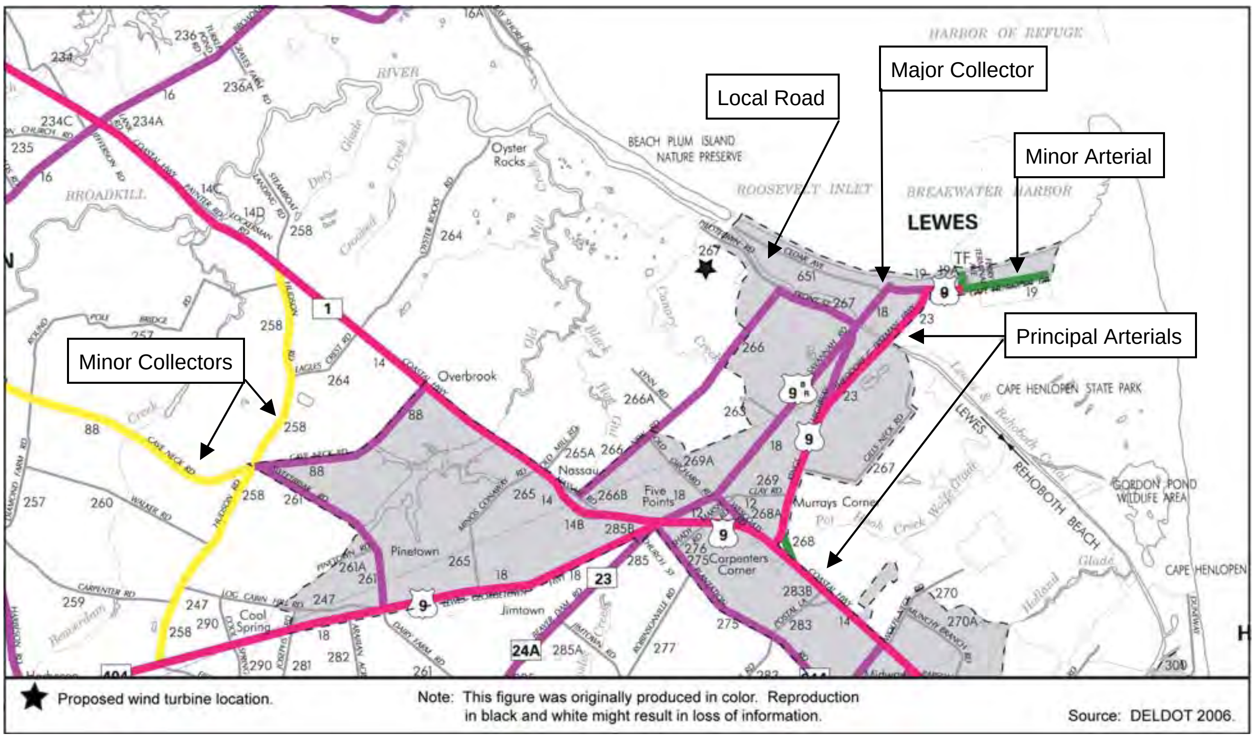


Figure 3-8. Road map of Lewes area showing Delaware Department of Transportation functional classifications.

that generally serve major centers of activity and urban areas. Other roads of note within Lewes include Savannah Road and New Road (also designated Road 266). Both roads run southwest-to-northeast; Savannah Road through the downtown or middle portion of the city, and New Road through the northwest portion of the city, closer to the University of Delaware campus. Both roads are classified as major collectors, which provide service to important community locations not served by higher-classification roads and that collect traffic from lower-classification roads for channeling to higher-classification roads (DELDOT 2006). The portion of Pilottown Road running between New Road and Savannah Road also is classified as a major collector. Pilottown Road to the northwest, where it runs adjacent to the University campus, is classified as a local road, which is the lowest classification and is for roads with the lowest volume of traffic that provide direct access to land and to higher-classification routes.

As noted in Section 3.6, the population of Lewes can more than double during periods of high tourist and visitor influx. Traffic volume on surface roads within the city during these periods can correspondingly be much higher.

Lewes does not have a public airport; however, the Sussex County Airport, located just outside Georgetown, is about 12 miles southwest of the Wind Energy Project location. This airport is classified as a business class, general aviation facility. It has two runways and experiences approximately 45,600 aircraft operations per year, with 1,200 of those military aircraft (DELDOT 2008). The Sussex County Airport is instrument-flight-rule-capable, and the applicable airspace reservation area extends to the southwest and northeast from the airport. The northeast portion of the airspace extends directly over Lewes and a portion of Delaware Bay (DELDOT 2008).

There are a couple of private air transportation facilities in the Lewes area. A private airfield, designated the Eagle Crest-Hudson Field, has a turf runway and is located about 4 miles east of Milton and about 3.5 miles to the west of the wind turbine location. There is also a private helicopter pad (also turf) 1 mile east of Lewes on Cape Henlopen Drive (DELDOT 2008). This helicopter pad is about 3.2 miles east of the wind turbine location.

3.8.2 ENVIRONMENTAL CONSEQUENCES

3.8.2.1 Proposed Project

Construction of the wind turbine involved increased vehicular traffic, including heavy equipment, in the area of the University of Delaware campus and specifically on Pilottown Road. However, with only a single wind turbine involved, construction was of a relatively short duration (about 2 months) and the workforce small (about 20 workers at any given time). Possibly of more concern was the traffic associated with delivery of the wind turbine components, not because of the volume of traffic but because of the size of the loads. The wind turbine was transported to the site in several large pieces for onsite assembly. This was accomplished in several oversized loads, performed by experienced haulers with appropriate state and local hauling permits. Because only a single wind turbine was involved, transportation of these large items to the site was not expected to pose significant issues. Transportation during construction, particularly with respect to the transport of the wind turbine components to Lewes and the construction site, required careful planning and appropriate authorizations, and significant impacts were not experienced.

Once the wind turbine was constructed, it presents a possible concern to air traffic due to its total height of 125 meters (410 feet) to the tip of a vertical blade (Figure 2-5). The University of Delaware has addressed this issue by beginning discussions with the Federal Aviation Administration (FAA). The FAA has conducted an aeronautical study with regard to the Wind Energy Project, and in a formal letter (FAA 2009, Appendix B) to the University states the "study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation." This determination was contingent upon the following conditions: (1) the structure must be marked and/or lighted in accordance with specific FAA guidelines; and (2) the FAA must be notified if the project is abandoned or with 5 days of the construction reaching is greatest height. The letter also noted that although the structure would "not constitute a hazard to air navigation, it would be located within or near a military training area and/or route." The letter further stated the determination expires on December 30, 2011, two years after the date it was issued. Following the determination of the FAA, DOE believes the Wind Energy Project would have no adverse impacts on air traffic of the area.

Decommissioning of the wind turbine would require equipment similar to that present during construction and would be expected to result in similar transportation issues to those dealt with during construction. Depending on the condition of the removed wind turbine components, there could, however, be actions taken at the site to cut up items to make them easier to remove from the area, which would decrease potential transportation concerns.

3.8.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and the Wind Energy Project would not be implemented. The potential impacts to transportation would not occur.

3.9 Resource Areas Not Carried Forward for Further Analysis

As stated in Section 1.4, DOE did not perform detailed environmental impact analyses for resource areas for which there would be no, or minimal impacts involved. This section identifies the resource areas that were not carried forward for further analysis and provides a basis for why there would be no, or minimal effects from the University of Delaware Wind Energy Project.

3.9.1 LAND USE

The wind turbine is located in a previously disturbed area used for placement of dredge spoils. The University of Delaware has an easement from the State for the dredge spoils area and, under a separate easement agreement (DNREC 2010c), the University can use the property for any lawful purpose, including the construction of the wind turbine, with prior notification to the State. The much larger 260-acre tract containing the dredge spoils area belongs to the State of Delaware, specifically the DNREC Division of Parks and Recreation, and is zoned "University or College" by the City of Lewes (Lewes 2005). This tract of land, which extends to the northwest as far as Canary Creek, coupled with the University of Delaware property to the east, completely surrounds the Wind Energy Project site. The wetlands that surround the dredge spoils area, except on the side of the University's campus, are also part of the Great Marsh Preserve, which extends to the northwest. Agricultural areas border the 260-acre tract to the southwest and there are residential areas to the south, southeast, and east. Potential impacts to these outlying areas are addressed in applicable resource area discussions, but no significant change in land use is expected as a result of the Wind Energy Project.

3.9.2 WATER RESOURCES – GROUNDWATER

Water, provided by the City of Lewes, was used as necessary during construction for soil compaction and dust suppression, but these water demands were short term. The City of Lewes obtains its water from groundwater (Lewes BPW 2008), specifically from the Columbia aquifer, which is a shallow subsurface hydrologic unit that underlies most of the Coastal Plain in Delaware (Andres 1987). At the Wind Energy Project location, the base of the Columbia aquifer is about 100 feet below sea level (Andres 1987). The project required the installation of a deep foundation system, using Rammed Aggregate Piers. These piers were constructed to a depth of about 35 feet, which extended them into the geologic unit that is the aquifer. The resulting foundation consists of pillars of compacted gravel surrounded by zones of natural material, also compacted, when the gravel was pushed outward against the natural materials by vertical ramming. Groundwater flow close to the piers was likely altered by the compacted materials, but this is in a very isolated, small area and is not expected to promote vertical mixing beyond what already occurs.

There would be no water needs during operation of the wind turbine and there would be no storage of hazardous substances that could release and migrate to the aquifer. Any oil or lubricants brought in during maintenance would be small inventories and would be handled, collected, transferred, and reused or recycled in accordance with applicable federal, state, or local regulations.

3.9.3 AIR QUALITY

Lewes, Delaware, is in an area of moderate non-attainment for ozone (EPA 2010). In this case, conformity requirements of 40 CFR Part 93, Subpart B, are that federal actions not cause air emissions of volatile organic compounds and nitrogen oxides, which are ozone precursors, in excess of 50 and 100 tons per year, respectively. Emissions during construction and installation of the wind turbine consisted of vehicle and equipment exhaust emissions. Fugitive dust was also generated during construction from earth movement and vehicle traffic over dirt surfaces. However, standard construction practices for dust suppression were implemented as necessary in order to minimize the potential for adverse impacts to air quality from particulate matter. These construction activities involved volatile organic compounds and nitrogen oxides emissions, but the limited duration and scale of the activities kept total quantities to fractions of the conformity threshold values.

Operation of the wind turbine would not affect air quality of the local area or region. It could, however, provide a beneficial effect at a nearby location by offsetting greenhouse gases that, otherwise, would be generated through traditional technologies involving fuel combustion. PJM Interconnection, the regional transmission organization coordinating the movement of electricity in multiple states in the Delaware region, estimates the average system production of carbon dioxide (a greenhouse gas) in 2009 equated to about 1,140 pounds per megawatt-hour of electrical energy produced (PJM 2010). The feasibility study for the University of Delaware wind turbine estimated the wind characteristics of the site would support generation of about 4,000 megawatt-hours per year from a 1.5-megawatt turbine (SED 2009). If it is assumed that the 2.0-megawatt turbine would generate a third again of this amount, it would generate about 5,300 megawatt-hours per year. At the average system production for carbon dioxide, the 5,300 megawatt-hours would offset (eliminate) about 6 million pounds, or 3,000 tons, of carbon dioxide production per year.

Air emissions during eventual decommissioning of the wind turbine would be very similar to those generated during construction and installation actions. That is, they would be limited to vehicle and equipment emissions and fugitive dust. Standard practices for dust suppression would be implemented and, like construction actions, decommissioning would be of limited duration and scale with total air emission quantities being fractions of the conformity threshold values.

3.9.4 GEOLOGY AND SOILS

Construction occurred on previously disturbed areas with surface materials consisting of fill that had been dredged from construction and deepening of nearby channels. The underlying materials are marsh deposits consisting primarily of silts and clays (Ramsey 2003). Preliminary project plans identified the need for a deep (possibly 35 feet) foundation system (Vanderbrook 2010a) to provide an appropriate base for the wind turbine to avoid possible issues of soil instability. Actions were taken during construction to minimize soil erosion, but because the area is relatively flat, there was little potential for significant problems. With construction complete, the potential for soil erosion should be no different than under existing, pre-project conditions.

Delaware is not in a seismically active region (Woodruff 2007), and it is unlikely that earthquake activity would occur and result in adverse impacts to the Wind Energy Project. The project would neither affect nor be adversely affected by site geology.

3.9.5 SOCIOECONOMICS

The wind turbine components were constructed outside of the Lewes, Delaware, area and assembled/constructed by experienced teams from outside the area. Development of the site, including construction of the wind turbine foundation and the access road, was supported by local construction expertise, but the potential for significant new employment or influx of monies as a result of construction actions was low.

Operation of the wind turbine would provide minor beneficial impacts in the form of employment and possibly new programs at the University of Delaware campus. It would also involve a relatively minor decrease in funds going from the University to the local electrical utility. The single wind turbine would not be expected to decrease residential property values in the area (Hoen et al. 2009).

3.9.6 WASTE AND HAZARDOUS MATERIALS

Construction-related debris waste, including equipment packaging materials, was generated during the Wind Energy Project's construction phase, but no waste would be routinely generated during operation of the wind turbine. Construction debris and any excavated soil removed from the area were managed in accordance with local regulations.

Fuels and other petroleum products in construction equipment were present at the site during construction. No significant spills or leaks from this equipment occurred. There would be no significant quantities of hazardous materials present at the site during operations other than the possible lubricants and cleaning materials used for maintenance. All wastes generated over the life of the Wind Energy Project would be managed in accordance with applicable federal, state, and local regulations.

3.9.7 ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," directs federal agencies to address environmental and human health conditions in minority and low-income communities. The evaluation of impacts to environmental justice is dependent on demonstrating that significant, adverse impacts from a proposed Wind Energy Project are not disproportionately borne by any low-income or minority groups in the affected community. The analyses in this EA do not indicate a potential for high and adverse impacts to the human population.

The low-income and minority populations in Lewes are at lower percentages of the total population than the national average and lower than at the Sussex County or Delaware State level (USCB 2000, 2008a). The area's public and community services, for instance schools, health care, social services, and fire protection, would not be adversely affected or relocated as a result of the Wind Energy Project, and no other uses, such as religious or cultural, of a natural resource would be restricted as a result of the project. Therefore, the project would not result in disproportionately high and adverse impacts on minority and low-income populations.

3.9.8 INTENTIONAL DESTRUCTIVE ACTS

DOE considers intentional destructive acts (that is, acts of sabotage or terrorism) in its EAs and environmental impact statements (DOE 2006). Construction and operation of the Wind Energy Project would not involve the transportation, storage, or use of radioactive, explosive, or toxic materials. The project would not offer any particular attractive targets of opportunity for terrorists or saboteurs to inflict adverse impacts on human life, health, or safety. In the unlikely event an attack were to occur, its consequences would be similar to those of an accident, such as those discussed in Chapter 3, Section 3.4.2.1 of this EA.

3.10 The Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Council on Environmental Quality regulations that implement the procedural requirements of NEPA require consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). Construction and operation of the wind turbine would require short-term uses of land and other resources. Short-term use of the environment, as used here, is that used during the life of the Wind Energy Project, whereas long-term productivity refers to the period of time after the project has been decommissioned, the equipment removed, and the land reclaimed and stabilized. The short-term use of the project site for the wind turbine would not affect the long-term productivity of the area. If it is decided at some time in the future that the project has reached its useful life, the wind turbine, its foundation, and the electrical equipment could be decommissioned and removed, and the site reclaimed and revegetated to resemble a similar habitat to the pre-disturbance conditions.

3.11 Irreversible and Irretrievable Commitments of Resources

There would be an irretrievable commitment of land required for construction and operation of the new wind turbine because other uses would be precluded during the time the land is being used for the project. There would also be an irreversible commitment of energy and materials used to fabricate the wind turbine components, as well as to construct and operate the device. The materials used for the project would include those necessary for the fabrication of the wind turbine components, for construction of the foundation and access road, and for the transformer and electrical lines. DOE would also have expended the finances associated with the funding for the project.

3.12 Unavoidable Adverse Impacts

Construction and operation of the wind turbine would involve the following potentially adverse impacts:

Biological Resources – There would be the potential for bird and bat fatalities as a result of collisions with the wind turbine, but it is expected the rates of collisions would be low. With respect to birds, the project would not have a detectable impact on populations, including species classified as threatened or endangered under federal or state programs. Further, the University has committed to instituting adaptive management practices, in consultation with the USFWS, if the Wind Energy Project exceeds certain species-specific thresholds. DOE does not anticipate a significant impact on bat populations, and none of the bat species known to occur in Delaware is endangered or extremely rare in the area.

Cultural Resources – The wind turbine would represent a tall visual presence in the community that some observers might feel is incompatible with the area's historic properties.

Noise – Sound levels generated by the operating wind turbine would be minor and within applicable regulatory standards. However, some individuals might find the sound levels annoying.

Aesthetics and Visual Resources – The wind turbine would be visible throughout the community unless blocked by something in the local view. This contrast from the existing landscape might be unwelcome to some observers. Some observers in close proximity (within about 0.5 mile) of the wind turbine might experience shadow flicker at certain times of the day and certain times of the year. Based on total exposure times estimated, these exposures should not be an issue; however, DOE recognizes some individuals might find any exposure unacceptable.

Utilities, Energy, and Materials – The use of manufacturing and construction materials would be unavoidable, but would represent a small fraction of those materials available in the marketplace.

4. CUMULATIVE IMPACTS

Council on Environmental Quality regulations stipulate that the cumulative effects analysis within an EA consider the potential environmental impacts resulting from the "incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such actions" (40 CFR 1508.7). This chapter addresses potential cumulative impacts.

4.1 New Road Proposed by State of Delaware

Chapter 2 describes a proposed road that is not part of DOE's Proposed Action but which would have some effect on the project. This new road is an action proposed by the State of Delaware and its construction could begin during the summer of 2010. The proposed road would branch off the University of Delaware road that starts at New Road (or Road 266, Figure 2-1) and currently runs through the middle of the University campus to Pilottown Road (also designated Road 267). The branch would extend to Pilottown Road by going between the dredge spoils area and the University campus. This would provide a more direct route to the boat launch at Roosevelt Inlet, primarily because it would avoid the University campus. The project would affect the Wind Energy Project only because the access road to the wind turbine would be tied into the new road, once the new road is available. This proposed road action would be cumulative with the wind turbine action to the extent that it would involve additional land disturbance in the same general area. Both actions would involve ground disturbance and work in 100-year flood zone. However, in both cases, the nature of the disturbance would not be expected to affect flood levels in other areas so there would be no anticipated effects to other properties. Further, there is no significant beneficial use identified for the areas of floodplains that would be lost by the road construction. Land use of the area would not be significantly affected by the cumulative disturbance associated with both projects.

Were construction actions for the two projects to occur at the same, or overlapping, times there could be cumulative impacts in the form of air emissions, sound levels, and transportation. The road project would be expected to involve much more earth movement and earth moving equipment than the Wind Energy Project. Although the two projects could be cumulative, air emissions, sound levels, and transportation impacts from the project would be expected to be small in comparison with those from the road project.

With the exception of the actions described in Sections 4.2 and 4.3, which are in early planning stages, the University of Delaware knows of no other past, present, or future projects in the Lewes area that could potentially involve impacts that would be cumulative with those of the wind turbine (Vanderbrook 2010b). The primary impacts associated with the wind turbine are related to its size and its unique visual and sound characteristics. Visual and sound impacts are expected to be minor, but are recognized as being very subjective and dependent on the individuals exposed to the sights and sounds of a wind turbine. It is very unlikely that other actions, unless they involved additional wind turbines, would present impacts that would be cumulative in these areas.

4.2 University of Delaware Wind Turbine Testing Facility

The University of Delaware is proposing to establish an offshore testing facility for wind turbines. The objective is to provide manufacturers with a testing facility where wind turbines designed for offshore use could be installed and operated from one to several years at a location with ease of access, but with real, offshore conditions. This would include exposure to salt water and salt mists, gusts and weather events such as "Nor'easters," as well as realistic power provisions. Testing would be used to prove new designs and configurations, to facilitate certification of turbines for offshore operation, and possibly to test installation vessels and procedures.

Planning for the offshore testing facility is in its early stages and the University was originally considering possible locations both within Delaware Bay and along the Atlantic Coast. However, the DNREC has recently informed the University of its position that development of wind turbines in the waters of the Delaware Bay would be problematic and not likely to be permitted. The University envisions such an offshore test facility as consisting of a common platform to which multiple, spread-out wind turbines could be connected. Preliminary siting criteria for possible locations include waters less than 25 meters deep, access to a power source and power lines, and being within State waters (that is, within the Delaware side of the Delaware Bay or within 3 miles of the shore along the Atlantic Coast). The University would like the site to be visible from shore, so areas with less population would be more desirable. It is currently assumed that staging activities for the offshore facility would be performed at the University's Lewes campus, so proximity to that location might also be a consideration. Finally, the site or sites should be those that minimize environmental and wildlife impacts. To this effect, the University has held meetings with personnel from the DNREC to discuss the project and possible environmental and wildlife concerns that could be associated with various locations. Also, the University and DOE's National Renewable Energy Laboratory have entered into a Cooperative Research and Development Agreement "to develop test procedures for wind turbines at one or more offshore wind turbine test sites in Delaware state waters to advance offshore wind turbine technology and to enhance competiveness of US industry and manufacturing" (NREL 2010).

Depending on the final location, or locations, the University selects for the offshore testing facility, it could have impacts cumulative with those of the wind turbine at the Lewes campus. Were the offshore facility to be located near Lewes, there would likely be construction activities within or near the community to extend power lines, possibly underground, to points where they would go underwater to the facility. There would also be increased traffic during construction and during operations as materials were shipped to and staged out of the University's facility. Since the wind turbine at the Lewes campus is already installed, impacts associated with these types of activities would not occur at the same time, but they could affect the same community or neighborhoods. Operation of the offshore wind turbines could result in impacts cumulative with those of the onshore turbine, but such cumulative impacts are expected to be limited to visual effects and those on birds and bats. Although the offshore facility likely would be close enough to the shore to be visible, it likely would be far enough away from the shore that sound and shadow flicker effects would not be a concern to individuals on land. Like the land-based wind turbine, operation of the offshore turbines likely would involve some amount of avian and bat collisions and fatalities. Specific species might be different than those most affected by the land-based turbine, but birds and bats still frequent the offshore areas and could be impacted. As described in Section 3.2.1, the Delmarva Peninsula has been documented as a major migration corridor during the fall and spring for many species of songbirds, shorebirds, raptors, and waterfowl. Recently, Important Bird Areas have been designated throughout the mid-Atlantic states due to unique foraging and nesting habitat found in these areas that are essential for reproduction and their continued survival. Since records of avian and bat fatalities are maintained on a "per turbine" basis, it is reasonable to assume that the multiple turbines anticipated for the offshore testing facility could have a greater impact on bird and bat populations than the single land-based wind turbine.

The University of Delaware would be responsible for obtaining all the necessary permits for the offshore testing facility and for assessing the potential environmental impacts associated with its construction and operation. According to the Cooperative Research and Development Agreement between DOE and the University, the funding to be provided by DOE is contingent upon the University undertaking "any necessary environmental reviews to satisfy NEPA and state environmental evaluation requirements" (NREL 2010).

4.3 Offshore Alternative Energy (Wind Farm) Programs

The DOI, Bureau of Ocean Energy Management, Regulation, and Enforcement formed an Offshore Energy Consortium with 11 coastal states, including Delaware, to pursue the potential for offshore wind farms (DNREC 2010e). In June 2009, DOI released a final EA (DOI 2009) that addressed issuing leases on seven specific blocks of ocean area on the outer continental shelf off the New Jersey and Delaware coasts. The proposed action addressed in the EA would allow initial site assessment activities, including the construction, operation, and decommissioning of meteorological towers with oceanographic data collection devices. According to the DOI's EA, the areas addressed by the proposed leases would be 8 to 17 miles from the nearest shoreline. Six of the lease blocks were identified as off the coast of New Jersey; the seventh block was shown as about 15 miles east of the Rehoboth Beach area of Delaware. In April 2010, DOE issued a Request for Interest to solicit proposals from offshore wind farm developers as well as comments on possible concerns with offshore development (DNREC 2010e). DOI and Delaware members of the consortium met in July 2010, and DOI updated the State on the status of the Request for Interest by informing the State that two offshore wind developers had provided proposals.

Also in July 2010, Delaware announced it was the first state delegated authority by the EPA to issue air quality permits for offshore projects, such as wind farming (DNREC 2010f). This authority extends to any sources located on or above the outer continental shelf, which is any area within 25 miles of the Delaware coast. The announcement noted that the first action to be addressed under its new authority would be the proposed meteorological tower associated with the wind farm project proposed by Bluewater Wind LLC (one of the offshore wind farm developers responding to the DOI's Request for Interest). The State indicated the permitting authority put them "one step closer to ensuring that the promise of offshore wind is realized in a timely fashion" (DNREC 2010f).

The Bluewater Wind project is still early in its development, with little detailed information available for consideration of cumulative impacts with the University of Delaware's Wind Energy Project. Given the distance of the potential wind farm area (about 15 miles) off the coast of Delaware, sound produced by wind turbines is expected to be negligible by the time it reached the coast and is not expected to be cumulative with sounds from the wind turbine at the University's Lewes campus. The offshore turbines might be visible from the coast, but at that distance, their visual impact to individuals on land would greatly diminish. However, for individuals opposed to the appearance or presence of the University wind turbine, offshore wind turbines could add to their discontent. Alternatively, such individuals could favor the offshore wind farm because of its distance in comparison to the proximity of the University wind turbine.

The greatest cumulative impact, however, is the potential for added, cumulative impacts to wildlife. As identified for the University's possible testing facility (Section 4.2), the Delmarva Peninsula represents a major migration corridor for many species of birds, and operation of the offshore wind farm would be expected to involve some amount of avian and bat collisions and fatalities. Specific species might be different than those most affected by the land-based turbine, but there is still the possibility that birds and bats will frequent the offshore areas, even at the greater distance proposed for the wind farm, and be impacted. It is also possible that some of the same flyways or migratory paths could be affected by both actions. Although bird and bat survey data are not available for the offshore location, it is possible that the large number of turbines anticipated for the offshore wind farm that might be built could have a greater impact on bird and bat populations than either the single land-based wind turbine or the relatively small number of turbines that would be associated with an offshore testing facility. From the analysis in this EA, DOE concluded that the single University of Delaware wind turbine, particularly in light of the commitments that the University has made with respect to monitoring and adopting management practices (see Section 2.2.5), would be unlikely to have any significant effect on the population of any bird or bat species.

USFWS comments on the Draft EA (USFWS August 17, 2010, letter in Appendix B) identified the importance of developing a means to minimize impacts from all wind turbine projects in an ecologically important region so the cumulative impacts do not reach a level that would be considered adverse to a population. In this regard, the USFWS also indicated it may be able to assess a threshold for a maximum number of wind energy projects in such a region.

Federal involvement, including that of the USFWS, is expected to continue for any potential offshore wind farm development. Therefore, a full evaluation of potential impacts to avian and bat species, as well as other wildlife and other resource areas, would occur pursuant to requirements under NEPA before the action was implemented.

5. CONCLUSIONS

DOE's Proposed Action would co-fund the University of Delaware's Wind Energy Project, under which the University has installed a single, 2-megawatt wind turbine in a previously disturbed area adjacent to its College of Earth, Ocean, and Environment campus in Lewes, Delaware. The University of Delaware would use DOE funding for costs associated with constructing the necessary foundation and support elements for the turbine, as well as installing the wind turbine, itself. The wind turbine interconnects with underground electrical conduit directly into University facilities. Turbine operation will facilitate University research and development, including studies on aspects of wind energy that are unique or prevalent in the coastal environment, and provide electricity to the University campus and the electrical grid.

The analyses for this EA considered all environmental disciplines, or resource areas, DOE typically includes in NEPA documents.

The wind turbine was installed in an area already heavily disturbed from use as a dredge spoils area. Much of the site is bordered by marshlands, which, particularly to the northwest, presents a large area of natural habitat. The wind turbine's presence and operation could result in occasional bird and bat collisions and fatalities but are not expected to threaten populations of birds in the area. However, the wind turbine is located in a significant bird migration corridor, and due to the lack of information on the presence of bats in the area, the University has committed to develop and implement an ABPP that addresses monitoring and evaluation protocols and adaptive management. (The University's other commitments with respect to bird and bat protection are listed in Section 2.2.5.) If DOE decides to fund the Wind Energy Project, it will incorporate the University's commitments into the grant agreement. Further, the USFWS stated it is requiring the University's commitments in order to support a FONSI for the project; DNREC requires these commitments in order to comply with the *Coastal Zone Management Act*.

The size of the wind turbine and the unique characteristics of shadows that can be generated at times during operation could result in visual impacts in the area. Some individuals might find the visual contrast presented by the wind turbine unpleasant, and some might find the minor exposure to shadow flicker annoying. However, visual impacts of a single wind turbine at the proposed location are expected to be within generally accepted levels. Similarly, the sound levels that would be generated from a single operating wind turbine are expected to be similar in magnitude to ambient conditions at the nearest private residences. DOE recognizes, however, that some individuals might be able to discern the unique sounds generated by a wind turbine from ambient sounds and, therefore, be more sensitive to them.

Under the No-Action Alternative, DOE would not provide funding to the University of Delaware and, for purposes of the analysis, assumes the wind turbine project would not be undertaken. Under this assumption, no impacts to the existing environment would occur and the potential beneficial impacts of generating energy from wind and providing a research and development tool for the University would not be realized.

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Appendix A
Distribution List

The Honorable Jack A. Markell
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Dover Office
Tatnall Building
William Penn Street, 2nd Floor
Dover, DE 19901

Ms. Cathy Wolf
Federal Aid Coordinator
Delaware Office of Management and Budget
State of Delaware
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Sussex County Department of Engineering
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Mr. Craig Koppie
Endangered Species Biologist
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Mr. Michael S. Powell
DNREC
Division of Soil and Water Conservation
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Dover, DE 19901

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City of Lewes
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P.O. Box 227
Lewes, DE 19958

The Lewes Historical Society
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Lewes, DE 19958

Mr. Kerry Holton, President
The Delaware Nation
P.O. Box 825
Anadarko, OK 73005

Ms. Tamara Francis, NAGPRA/Cultural Preservation Director
Delaware Nation
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Anadarko, OK 73005

Chief Dennis Coker
Lenape Indian Tribe of Delaware, Inc.
Lenape Indian Cultural Center
4164 North DuPont Highway
Dover, Delaware 19901

Chief Herman T. Robbins
Nanticoke Indian Association, Inc.
27073 John J. Williams Hwy.
Millsboro, DE 19966

Delaware Audubon Society
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Christiana, DE 19702

The Nature Conservancy
Delaware Field Office
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100 West 10th Street, Suite 1107
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Important Bird Area Coordinator and Staff Biologist
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Eric Glitzenstein
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Smyrna, DE 19977

Susan E. Love, Planner IV
Delaware Coastal Programs
5 East Reed St., Ste 201
Dover, DE 19901

Chief Jerry L. Douglas
Delaware Tribe of Indians
170 NE Barbara
Bartlesville, OK 74006

Dr. Brice Obermeyer, NAGPRA Representaive
Delaware Tribe of Indians
170 NE Barbara
Bartlesville, OK 74006

Appendix B
Consultation Letters and Other Correspondence

This appendix contains copies of correspondence associated with the University of Delaware Lewes Campus Onsite Wind Energy Project, including consultation letters between the DOE and the U.S. Fish and Wildlife Service (USFWS), the Delaware State Historic Preservation Officer (SHPO), and potentially affected Indian tribes. Correspondence included in this section is grouped by correspondent (for example, correspondence between DOE and the USFWS is grouped together) and presented in the following order:

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

OFFICE OF THE
SECRETARY

PHONE: (302) 739-9000
FAX: (302) 739-6242

August 31, 2009

Jeremy Firestone
Associate Professor, College of Earth, Ocean, and Environment
Senior Research Scientist, Center for Carbon-free Power Integration
University of Delaware
Newark, DE 19716 USA

Dear Mr. Firestone:

Thank you for giving the members of the Department of Natural Resources and Environmental Control (DNREC), Regulatory Advisory Service (RAS) the opportunity to comment on your proposed wind turbine project.

Attached is a summary of key points expressed. Information is included regarding environmental permit requirements, regulatory requirements, and other considerations and procedures that should be addressed. Please be advised that the report is advisory and may not include permits and regulatory requirements and restrictions for activities that our RAS members were unable to determine from the information provided.

Should you have any questions concerning the suggestions made by the RAS members, you may contact me or the individual members directly (names and phone numbers are included with comments).

Sincerely,

Kimberly Chesser
Ombudsman
Small Business Assistance Program
(302) 739-9909
Kimberly.Chesser@state.de.us

Delaware's Good Nature depends on you!

Regulatory Advisory Service
Advisory Project Report
University of Delaware
Wind Turbine – Lewes Campus
RAS Project #2009-05

Small Business Assistance Program, Office of the Secretary

Comments Provided by:	Kim Chesser
Phone:	(302) 739-9909
Fax:	(302) 739-6242
Email:	kimberly.chesser@state.de.us

The Small Business Assistance Program is responsible for the management of the Regulatory Advisory Service (RAS) and is responsible for preparing the RAS report. Please feel free to contact me for any questions or concerns you may have regarding the RAS meeting or this report. You may also contact me for any other questions that may arise regarding your environmental issues.

Wetlands and Subaqueous Lands Section, Division of Water Resources

Comments Provided by:	Laura Herr
Phone:	(302) 739-9943
E-Mail:	Laura.Herr@state.de.us

Comments:

The Wetlands and Subaqueous Lands Section supports the concept of building and deploying a wind turbine by the University and believes that such an effort could potentially offer valuable opportunities for study. Six possible locations for the turbine were presented at the meeting.

Locations 1 and 3 do not appear to involve any direct impacts to State-regulated wetlands or subaqueous lands and would not require permits from our office. While their close proximity to wetlands presents some concerns, it may also afford the chance to study some of the key potential adverse impacts associated with construction and operation of a wind turbine. However, this opportunity can only be seized if the University first obtains meaningful and comprehensive background data to characterize the existing condition and use of the marsh in the vicinity of the Lewes campus and Roosevelt Inlet, prior to construction of the turbine. We would recommend that the University commit to obtaining such information and data as part of their wind turbine deployment effort.

At Location 2, the turbine location itself does not appear to have any direct impacts to State-regulated wetlands, but access to the location from the south and east would necessitate construction of a road which might impact federal wetlands. We advised the University regarding the difficulty and expense of obtaining federal permits for work in waters and wetlands. As such, any location, or alternate access to a location, which avoids impacts to wetlands will reduce the considerable time and money required to get permits in place. As part of this discussion, I mentioned the "provisional JD" process which can reduce the amount of time required to get a jurisdictional determination from the Corps.

Locations 4 and 5 are in State-regulated wetlands. The WSLS cannot support the construction of a wind turbine and access road in State-regulated wetlands, as the turbine is not a water-dependent use and there is a presumption that land-based alternatives are available. Even if the water dependency requirement were not in place, we would still oppose these locations based on the adverse impacts to wetlands associated with construction, maintenance and access. We would also have to consider the precedent and potential cumulative impacts associated with permitting the first wind turbine to be constructed in State wetlands. The wetlands at these locations are also regulated by the Corps of Engineers. Even if permits could be granted, the expense associated with compensation for the wetland impacts would be considerable.

Location 6 is in the Beach Plum Island Nature Preserve. As such, the WSLS agrees with the position of the Division of Parks and Recreation, as presented by Phil Gallo at the August 12th meeting, that this is not an appropriate location for the wind turbine.

Coastal Zone Management Section, Division of Soil and Water

Comments Provided by: Susan Love
Phone: (302) 739-9283
E-Mail: Susan.Love@state.de.us

Comments:

Sarah Cooksey and Susan Love attended the August 12 RAS meeting to discuss siting of a 2MW wind turbine on or near the Lewes Campus. Based upon that discussion, we offer the following comments:

General Comments:

The site analysis that was conducted by UD's contractor on the six sites took into consideration land ownership, geotechnical concerns, some permitting issues and setbacks from residences. It did not take into consideration direct or secondary impacts to natural resources. Construction and operation of a utility scale wind turbine on any of the six sites presented at the meeting could have unforeseen impacts on local wildlife who use the adjacent marshes, dune systems and waterways for nesting, feeding and migration. Because four of the six sites included in the assessment are likely unfeasible due to permitting, resource and/or roadway issues, the University

2

is strongly encouraged to conduct assessments on additional unconstrained upland sites. Prior to selecting any site, the University should conduct a detailed assessment of wildlife use of the region and develop an analysis of potential impacts.

However, it is our understanding that at this time, the University is not planning detailed studies on wildlife impacts resulting from the operation of the turbines; rather, the studies will focus on operational and technical issues. We strongly encourage the university to conduct detailed pre- and post construction studies on wildlife nesting and foraging use; including radar studies. The US Fish and Wildlife Service has issued interim guidance for avoiding and minimizing impacts to wildlife from wind turbine development and committees are currently working to finalize a new document. These guidelines provide a minimum baseline for methods that should be followed to avoid and minimize impacts to wildlife. The document can be found online: http://www.fws.gov/habitatconservation/wind.html

Coastal Zone Federal Consistency

Federal permits and licenses, including Army Corps of Engineers permits and some Federal Energy Regulatory Commission licenses, must be consistent with the policies of Delaware's Coastal Zone Management Program. If any Federal permit or license is required, UD should consult with the Delaware Coastal Programs to determine whether a Consistency Certification will be required. Information on Coastal Zone Federal Consistency Certifications can be found online:
http://www.swc.dnrec.delaware.gov/coastal/Pages/DCMP%20Federal%20Consistency.aspx

Location 1&3

We support the comments provided by the Wetlands section and echo the need for pre and post installation studies of adjacent wildlife. UD should ensure that operations at the disposal facility are not disrupted by construction or operation of a wind turbine.

Location 2

We support and echo the comments provided by the Wetlands section. In addition, if a site is selected that requires Federal permits, a Coastal Zone Federal Consistency Certification will likely be required. This certification process is in addition to the State and Federal wetlands permitting processes.

Location 4 & 5

We support the comments submitted by the Wetlands section. Federal permits from the Army Corps would likely be required; this would also trigger the Coastal Zone Federal Consistency certification process. For reasons outlined by the Wetlands section, coupled with a high likelihood for wildlife impacts, these sites would have difficulty obtaining a Consistency Certification and their use was strongly discouraged by DNREC staff in attendance.

Location 6

Location 6 has significant potential for resource impacts, has potential funding limitations due to the Coastal Barrier Resources Act and would require permits under DNREC's regulations for beach protection and use of beaches. Due to its resource sensitivity, this location is strongly discouraged by DNREC staff in attendance at the meeting.

This site is within a designated State Nature Preserve, and is near a colony of nesting terns. DPR and DFW will be providing additional information about these issues.

Besides its location within a Nature Preserve, this site is also located on a Federally designated Barrier Island. The Federal Coastal Barrier Resources Act prohibits federal funds to be used for development projects on designated barrier islands. It is unclear how construction of a wind turbine would be viewed by the Federal government under this legislation, however, UD would be well advised to investigate this legislation and its potential impact on this and any future plans for constructing wind turbines directly on the coast.

DNREC's Regulations for Beach Protection and Use of Beaches prohibit any construction seaward of the DNREC building line – by state law, all construction must be located entirely landward of the building line. Construction on the beach landward of the building line requires a permit or letter of approval from the DNREC Shoreline and Waterway Management Section. An aerial photo with the building line depicted was provided to Dr. Firestone at the meeting. In addition, it should be noted that Section staff reported that the Beach Plum Island area has a history of erosion; and that a tower fell into the Bay during a storm in 1992.

Planning, Preservation and Development Section, Division of Parks & Recreation

Comments Provided by:	Phil Gallo
Phone:	302-739-9231
E-mail:	Phillip.Gallo@state.de.us

Comments:

The following comments pertain to the proposed wind turbine presented at the meeting of 8/12/09 and described in the report entitled *University of Delaware, Technical Analysis for On-Site Wind Generation, Lewes Campus, Summary of Project Status*, prepared by SED (Sustainable Energy Developments Inc.), dated Monday, July 27, 2009.

The Division of Parks and Recreation is generally supportive of the proposed wind turbine project and the many benefits it would provide.

General Comment: Locations 1, 2, 3, 4 and 6 are on property owned by the Division of Parks and Recreation.

Location 1 does not have adequate setback (600 feet) from the proposed Park Road realignment. (Note: The proposed realignment has been developed in a cooperative effort with the University to reroute through traffic to the west around the campus rather than through it as is currently the case. At the request of the University, the final alignment is as far away from the campus as feasible to minimize impact to the University and to preserve undeveloped space. It is anticipated that the road construction will begin next spring and be completed in summer of 2010.)

Location 2 does appear to have adequate setback from the proposed Park Road realignment.

Location 3 is within the proposed Park Road realignment and therefore not available as a location for the wind turbine.

Location 4 does not have adequate setback from the proposed Park Road realignment. It is in wetlands which are a designated State Natural Area and planned to be dedicated as a State Nature Preserve.

Location 5 is not on property owned by the Division of Parks and Recreation.

Location 6 is on Beach Plum Island, a dedicated State Nature Preserve. Construction of the turbine at this location would require approval of the General Assembly. It is recommended that, due to this location's status as a nature preserve and ecological importance, it be withdrawn from consideration.

Access to the dredge spoils area: As part of the Park Road realignment project, the existing access road to the spoils area is to be removed and regraded to create a stormwater filter strip. Any new access road to the spoils area should be connected to realigned Park Road.

Delaware Natural Heritage and Endangered Species Program, Division of Fish & Wildlife

Comments Provided by:	Anthony T. Gonzon, Jr.
Phone:	(302) 653-2880 ext. 123
e-mail:	Anthony.Gonzon@state.de.us

Comments:
Following the August 12 RAS meeting regarding the proposal by the University of Delaware for the installation of a 2 MW wind turbine near Lewes, Delaware, the Delaware Division of Fish and Wildlife offer the following comments:

The Delaware Division of Fish and Wildlife recognizes the importance in exploring possibilities for alternative energy sources and supports the concept of planning and constructing a wind-based power generation system by the University of Delaware at their Lewes campus. With the current initiatives in wind-generated power production, we believe this project would benefit all parties involved as state and national interests move forward in producing cleaner and more efficient energy sources.

The Delaware Division of Fish and Wildlife acknowledges that the proposed project may negatively impact native wildlife, in particular birds and bats. Regardless of the location of the tower, birds and bats are at risk of colliding with the structure or support hardware, may be attracted to the structure for nesting, roosting, or foraging, or may be discouraged from utilizing habitats impacted by the construction and operation of the project. However, we also acknowledge that this proposal is of a small scale (one turbine) and presents an opportunity to study the impacts of *land-based, coastal* wind turbines on birds and bats in DE. We agree that although we know there will likely be some impacts to birds and bats, we do not yet know the extent of those impacts or how to address potential threats to wildlife resources.

Bats:
Migrating bats, as opposed to resident bats, are most likely to be impacted by the proposed project as they are more likely to follow the shoreline during migration. Given the close proximity of the structure to the shoreline at Locations 4, 5 or 6, we would discourage placement at those sites.

Shorebirds and Beach-nesting Birds:
The NHESP does not have any significant concerns for migratory shorebird impacts. Regarding beach-nesting birds, Location 6 is ca. 500 feet from areas on Beach Plum Island Nature Preserve where least terns (*Sternula antillarum*) (S1)[1] have nested in recent years. The habitat in this area of the preserve is suitable for American oystercatcher (*Haematopus palliatus*) (S1) nesting. The turbine itself and the infrastructure needed for its upkeep would likely cause disturbance that would prevent oystercatchers from nesting nearby and may discourage least terns, from nesting at the site in the future. In addition, Location 5 overlooks shoreline that is used by American oystercatcher for foraging and resting. Placing a wind turbine at Location 5 might discourage oystercatchers from utilizing this location, and therefore, this location is not favored.

From a beach-nesting shorebird standpoint, all other proposed locations are not likely to cause any adverse impacts.

Neotropical Migrant Songbirds:
Because of the general location is near the coast, it is naturally within the flight path of many neotropical migrants. Although there is some probability of the structure being a strike hazard during nocturnal migration for many of these species, impacts from a single tower will likely not

[1] **State Rank**: S1- extremely rare within the state (typically 5 or fewer occurrences); S2 very rare within the state (6 to 20 occurrences);S3-rare to uncommon in Delaware, B - Breeding; N - Nonbreeding; SX-Extirpated or presumed extirpated from the state. All historical locations and/or potential habitat have been surveyed; SH- Historically known, but not verified for an extended period (usually 15+ years); there are expectations that the species may be rediscovered; SE-Non-native in the state (introduced through human influence); not a part of the native flora or fauna, SNR-not yet ranked in Delaware, SNA-occurences in DE of limited conservation value

have any population-level effects on many species. In addition, given the low density of forested habitat immediately around the general area, the site should not be considered a major draw for migrant songbirds during the spring and fall.

Raptors:
Raptors may be more of an issue with concerns particularly during migration. The Atlantic and Delaware Bay coastlines serve as a migratory corridor for several species, including American Kestrel, Merlin, and Peregrine Falcon. Coastal areas also host large numbers of migrating Osprey. However, since raptors are diurnal migrants, most birds should be able to avoid collision. One potential concern is that of strikes by raptors pursuing prey. Lastly, the structure should not encourage use by raptors, particularly Osprey, as a perch or nesting site. Overall, no raptor population-level effects are expected.

Waterfowl:
Negative impacts to waterfowl are likely to be minimal, as with many of the other avian groups. Collisions with the structure or associated hardware are the most direct threat. Large numbers of Snow Geese (*Chen caerulescens*) migrate through and overwinter near this site. This species, given the large number of individuals overwintering, is most likely to be involved in collisions; however, no population level impacts are expected.

Recommendations:
Overall, we believe that this is a good opportunity to study the impacts of wind energy on bats and birds. Our preferred site would be Location 1. There is less surrounding forest and fewer trees would need to be cleared. In addition, Location 1 would most likely result in the fewest impacts to adjacent wetlands, if any. From a wildlife perspective, this site would likely have the fewest cumulative negative impacts on migratory birds, waterfowl, and bats. Because of the distance from suitable nesting and roosting habitats for beach-nesting birds, Location 1 is not expected to produce any negative impacts for that group. However, if it is determined that major impacts to birds or bats are occurring as a result of this wind turbine, we recommend that a plan to reduce and minimize collisions and other threats be developed prior to construction.

With regard to bats, we also recommend the use of acoustic monitoring to evaluate bat species composition in the vicinity of the possible options.

We also recommend lighting that is consistent with reducing bird/bat collisions, reduction/elimination of guy wires, and the use of perch deterrents. We also discussed recommending the removal of trees around the turbine so there was less of a draw for birds (particularly migrants) ,but believe the learning opportunity overrides what would be an untested recommendation.

Lastly, we recommend intensive study of the turbine on the impacts it has on wildlife resources. Both pre- and post-monitoring for impacts to bats and birds should be conducted to fully assess impacts.

Because current University-proposed studies will focus on operational and technical issues and not necessarily on wildlife, we recommend that the University of Delaware plan for and initiate pre-construction studies on wildlife nesting and foraging use, including radar studies to assess area use. Such studies should be followed by post-construction monitoring to continue assessing use and possible avoidance. We strongly recommend the University review and implement guidance to reduce negative impacts on wildlife published by the US Fish and Wildlife Service. The guidelines can be found at http://www.fws.gov/habitatconservation/wind.html and should be considered prior to developing any studies or monitoring protocol. We also invite the University to contact the Division for further assistance in the development of such studies and monitoring procedures.

Sediment and Stormwater Management Section, Division of Soil and Water

Comments Provided by: Elaine Webb
Phone: (302) 739-9921
E-Mail: Elaine.Webb@state.de.us

Comments:

If the project will cause land disturbance exceeding 5,000 square feet for utility installation, building construction, parking lot construction, etc., a Sediment and Stormwater Plan must be approved prior to beginning the construction activity. In addition, if the construction activity requires a Sediment and Stormwater Plan, a Notice of Intent would also need to be submitted. Please contact Elaine Webb, DNREC Division of Soil and Water Conservation, at (302) 739-9921 for submittal requirements.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES &
ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

WETLANDS & SUBAQUEOUS
LANDS SECTION

TELEPHONE (302) 739-9943
FACSIMILE (302) 739-6304

December 22, 2009

Nancy M. Targett, Dean
University of Delaware
College of Earth, Ocean, and Environment
111 Robinson Hall
Newark, DE 19716

Re: Proposed location of a wind turbine in relation to State-regulated wetlands at the University of Delaware's Lewes Campus, 700 Pilottown Road, Lewes, Sussex County, Delaware.

Dear Ms. Targett:

The Wetlands and Subaqueous Lands Section (WSLS) received an e-mail request on your behalf from Matt Vanderbrook at Sustainable Energy Developments, Inc. dated December 17, 2009, requesting that we verify that a proposed wind turbine would be located outside of State-regulated wetlands. An aerial photograph was attached to the e-mail showing the proposed location. After review of the photo and the Department's wetland regulatory maps, it was determined that the proposed wind turbine, and the access to it as described in Matt's December 17th e:mail, are in an area outside of the State's wetland jurisdiction and thus no wetland permit will be required to erect the wind turbine at that designated location.

A copy of a portion of the relevant State wetland map (No. DNR 087) is attached for your records. Thank you for contacting the WSLS for this wetland determination. If you have any further questions regarding this matter, please contact our office at (302) 739-9943. Thank you.

Sincerely,

Laura M. Herr
Section Manager
Wetlands and Subaqueous
Lands Section

cc: Susan Love, Delaware Coastal Programs

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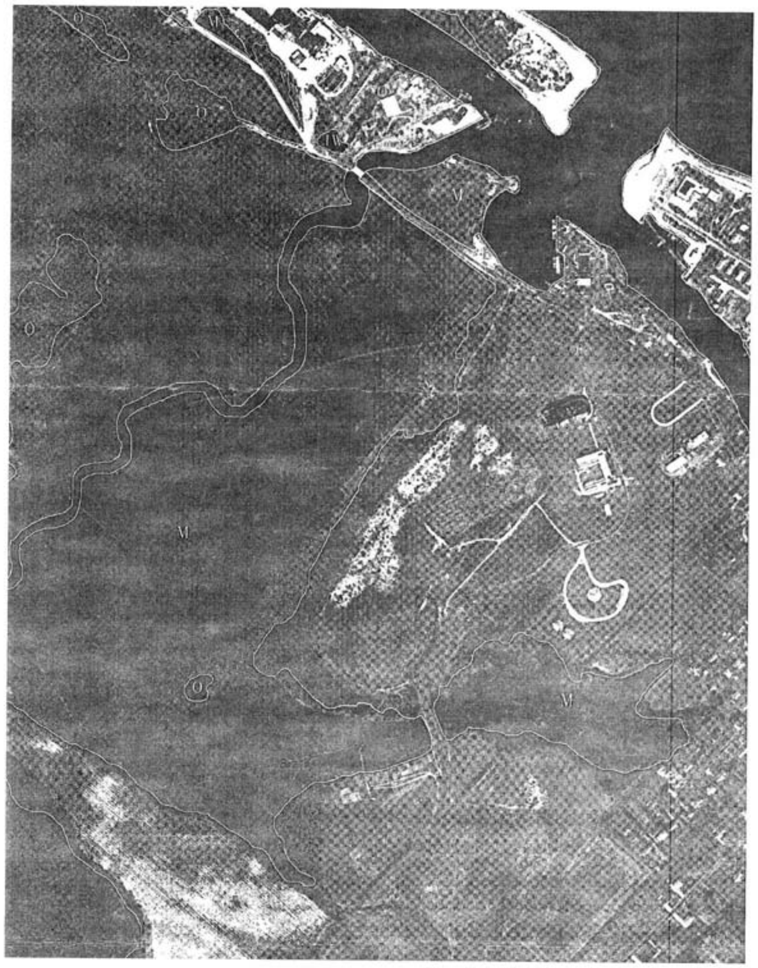

Section of State Regulatory Map # 87, which depicts the boundaries of the State's Wetland Jurisdiction.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

DELAWARE COASTAL
MANAGEMENT PROGRAM

TELEPHONE: (302) 739-9283
FAX: (302) 739-2048

December 23, 3009

Matthew Vanderbrook
Project & Policy Manager
Sustainable Energy Developments, Inc.
317 Route 104
Ontario, NY 14519

Re: Delaware Coastal Zone Management Program Comments
University of Delaware Proposed Wind Turbine Location (GC 09.017)

Dear Mr. Vanderbrook:

Thank you for following up with the Delaware Coastal Programs (DCP) regarding placement of the proposed University of Delaware wind turbine at the Lewes campus. At the August 12, 2009 meeting of the DNREC Regulatory Advisory Service, the University was seeking input on six potential sites; three of these sites had the potential for significant resource impacts. At the time, the DNREC encouraged selection of a site around the confined disposal facility or at another upland location.

The selected site, located between the original sites 1 & 2 and along the northern side of the confined disposal facility, will minimize potential impacts to significant coastal resources. However, birds and bats will continue to be at risk for collisions with turbine blades and support structures, and wildlife use of the surrounding area could be impacted by noise and increased human disturbance. While the DCP recognizes the importance of alternative energy and is generally supportive of the selected location, we wish to reiterate that the construction of this turbine represents an opportunity to fully study and characterize the potential resource impacts resulting from construction and operation of commercial scale wind turbines in coastal locations. We strongly encourage the University to conduct comprehensive wildlife and habitat use surveys prior to construction and during operation of the turbine. In addition, many potential impacts can be reduced or eliminated through thoughtful turbine design. We encourage you to use guidelines published by the U.S. Fish and Wildlife Service for land-based wind turbines (available online at www.fws.gov/habitatconservation/wind.html) to reduce potential impacts.

A Coastal Zone Federal Consistency Certification is required for certain Federal licenses and permits issued within the State of Delaware. According to the information provided to us, the selected site does not have any wetland impacts that would necessitate Federal permits and no

Susan E. Love
GC09.017
December 23, 2009

additional Federal authorities have been identified that would trigger Federal Consistency requirements. If you discover that Federal permits from the Federal Energy Regulatory Commission, Federal Aviation Administration or other Federal entities are required for this project, please contact us for further information about whether a Federal Consistency certification will be required. Additional information about Delaware's Coastal Zone Federal Consistency Certification program can be found on our website:
http://www.swc.dnrec.delaware.gov/coastal/Pages/DCMP%20Federal%20Consistency.aspx

We appreciate the opportunity to comment on the final turbine location and encourage you to continue to coordinate closely with this and other DNREC offices during the project planning and design phases, and throughout the monitoring phases. Information and experiences gathered from this pilot project will be extremely valuable as Delaware increases its energy production from renewable sources. Please contact me at (302) 739-9283 or Susan.Love@state.de.us if you have any questions or need additional information.

Sincerely

Susan E. Love, Planner
Delaware Coastal Programs

Cc: Kim Chesser, OTS
Phil Cherry, OTS
Anthony Gonzan, DFW
Laura Herr, DWR
Phil Gallo, DPR

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF FISH & WILDLIFE
NATURAL HERITAGE & ENDANGERED SPECIES
4876 HAY POINT LANDING ROAD
SMYRNA, DELAWARE 19977
TELEPHONE: (302) 653-2880
FAX: (302) 653-3431

December 23, 2009

Matthew Vanderbrook
Project & Policy Manager
Sustainable Energy Developments, Inc.
317 Route 104
Ontario, NY 14519

RE: University of Delaware Wind Energy Project located near Lewes, DE and Wildlife Threats

Dear Mr. Vanderbrook,

At your request in an email dated December 17, 2009, the Delaware Division of Fish and Wildlife respectfully submits this letter regarding threats and impacts to wildlife resulting from the development of the University of Delaware Wind Energy Project proposed near Pilottown Road in the town of Lewes, Delaware.

The Delaware Division of Fish and Wildlife recognizes the importance in exploring possibilities for alternative energy sources and supports the concept of planning and constructing a wind-based power generation system by the University of Delaware at their Lewes campus. With the current state and national initiatives in wind-generated power production, we believe this project would benefit all parties involved as state and national interests move forward in producing cleaner and more efficient energy sources.

The Division acknowledges that this project is small scale (one turbine) and presents an opportunity to study the impacts of *land-based, coastal* wind turbines on birds and bats in Delaware during all phases of the project. The Division believes this project will not have significant population-level effects on wildlife. However, we do anticipate that the proposed project is likely to affect individuals of local wildlife, particularly birds and bats. Regardless of the location of the facility within the project site, birds and bats are at risk of colliding with the structure or support hardware, may be attracted to the structure for nesting, roosting, or foraging, or may be discouraged from using habitats impacted by the construction and operation of the project. Although we do not yet know the magnitude of these impacts on a local scale, we expect the effects to be minimal. Again, this project represents an opportunity to study these effects, and resulting data can assist with guiding operation at this site and provide information to assist in development of future wind energy projects.

We also acknowledge that the selected location (between proposed Sites 1 and 2) was preferred by the Division over the other proposed sites, particularly given its distance from the immediate coastline. From a wildlife perspective, the selected site would likely have the least impact on migratory birds, marsh-nesting birds, raptors, waterfowl, and bats. Due to the distance from suitable nesting and

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FAX: (302) 653-3431

roosting habitats, the Division does not anticipate any negative impacts for beach-nesting birds. Additionally, the Division acknowledges that proposed intensive monitoring and study of wildlife threats and impacts serves in the greater interest of protecting native wildlife populations in Delaware and in the responsible planning of future wind energy development within the State.

The Division formally requests to be involved in the development and implementation of research and monitoring for native wildlife and to be included to receive any interim performance reports and final products as a result of the studies.

Lastly, the Division submits the following specific recommendations:

- With regard to bats, we recommend the use of acoustic monitoring to evaluate bat species composition in the vicinity of the possible options. The Division also recommends lighting that is consistent with reducing bird/bat collisions, reduction/elimination of guy wires, and the use of perch deterrents. Information regarding these recommendations can be found at the web address below. We request, prior to development and implementation of any study and monitoring of birds, bats, or other wildlife, that those responsible for these activities correspond with the Division so that we can provide technical assistance.

- We strongly recommend the developers review and implement guidance to reduce negative impacts on wildlife published by the US Fish and Wildlife Service. The federal guidelines can be reviewed at http://www.fws.gov/habitatconservation/wind.html and should be considered prior to developing any studies or monitoring protocol.

If you have any questions, please contact me at 302-653-2880 or at Anthony.Gonzon@state.de.us.

Sincerely,

Anthony T. Gonzon, Jr.
Environmental Scientist
DE Natural Heritage and Endangered Species Program
DE Division of Fish and Wildlife, DNREC
4876 Hay Point Landing Road
Smyrna, DE 19977

CC:	Eugene Moore, DFW	Karen Bennett, DFW	Edna Stetzar, DFW
	Susan Love, DCP	Laura Herr, DWR	Phillip Gallo, DPR
	Philip Cherry, OTS	Kim Chesser, OTS	

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DELAWARE COASTAL
MANAGEMENT PROGRAM

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FAX: (302) 739-2048

July 8, 2010

Jane Summerson
Office of Energy Efficiency and Renewable Energy
US Department of Energy
1000 Independence Ave. SW
Washington, DC 20585

RE: Draft EA, University of Delaware Wind Turbine
Comment Period Extension Request

Dear Dr. Summerson:

The Delaware Coastal Programs (DCP) has received and is currently reviewing the Draft Environmental Assessment for the University of Delaware Lewes Campus Onsite Wind Energy Project. In order to ensure that you receive the best information possible in response to the Draft EA, the DCP is coordinating comments from several sections of the Department of Natural Resources and Environmental Control. As you know, the document is lengthy, and contains several detailed reports in the Appendixes. Although we as a Department are attempting to expedite our comment period, the 30-day comment period does not allow for both review by specific programs and coordination of comments Department-wide. In addition, the document is still circulating within the stakeholder community and many stakeholders may not have yet had a chance to review thoroughly. As such, the DCP would like to formally request a 10 day comment period extension. This extension will allow for our Department to provide you with thoroughly coordinated and well-organized comments, as well as providing the stakeholder community with additional time to review and respond.

Thank you in advance for consideration of this request. Please do not hesitate to contact me at Sarah.Cooksey@state.de.us or (302) 739-9283 if you have any questions.

Sincerely,

Sarah W. Cooksey, Administrator
Delaware Coastal Programs

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
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DOVER, DELAWARE 19901

DELAWARE COASTAL
MANAGEMENT PROGRAM

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FAX: (302) 739-2048

August 13, 2010

Jane Summerson
Office of Energy Efficiency and Renewable Energy
US Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Re: Delaware Department of Natural Resources and Environmental Control comments regarding the Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project

Dear Dr. Summerson:

Thank you for the opportunity to review and provide input on the Draft Environmental Assessment for the University of Delaware Lewes Campus Onsite Wind Energy Project. As you are aware, the State of Delaware is a strong supporter of clean energy technologies and is actively seeking to improve its clean energy production capacity. The University of Delaware turbine is an important first step for the State.

It is our understanding that the Department of Energy is providing partial funding on a reimbursable basis for construction of the turbine at the Lewes Campus and that this Environmental Assessment is required by the National Environmental Policy Act as a part of funding requirements for the Department of Energy. As such, the Department of Natural Resources and Environmental Control (DNREC) would like to ensure that the Environmental Assessment contains accurate information and that impacts to surrounding resources are fully considered and discussed. The attached comments outline the views and expert opinion from the DNREC Division of Fish and Wildlife, Division of Parks and Recreation and the Delaware Coastal Programs.

The Draft EA concludes that this project has minimal potential for population level impacts to birds and bats and few impacts to cultural resources and surrounding landowners resulting from noise and visual disruptions (including shadow flicker). However, some impacts will be experienced as noted in the draft EA, including individual mortality to birds and bats. In order to both support a Finding of No Significant Impact (FONSI) and to increase the State's understanding of these potential resource impacts, the Department strongly encourages the Department of Energy to work with the University to jointly develop and implement a research and mitigation plan to offset any unavoidable impacts to cultural resources, adjacent landowners and avian and bat resources. During the development of this project, the University did meet with several programs within the Department of Natural Resources and Control in order to solicit comments on the proposed location, however, as very little site specific data was gathered prior to constructing the turbine, it is important that a scientifically based mitigation plan be developed and implemented.

The mitigation plan need not be included in the Final EA, however, it should be fully outlined and committed to in writing by the end of this calendar year and any funding provided by DOE should be granted contingent on development and implementation of the plan moving forward. This plan should contain monitoring for avian and bat mortality, and should contain adaptive management measures that would guide the operation of the turbine should mortality reach unacceptable limits for Federal or State listed rare and endangered species. Such mortality limits should be agreed to jointly by the U.S. Fish and Wildlife Service, the DNREC Natural Heritage Program, the Department of Energy and the University of Delaware. This plan should also contain mitigation measures and operational procedures that would reduce noise and shadow flicker impacts to nearby residents, should these impacts be determined to be unacceptable. My staff are available to work with you on development of mitigation actions and adaptive management measures.

In light of the importance of renewable energy to our environment, the Department of Energy should also strongly consider assisting in the funding of the requested monitoring activities, mitigation measures and adaptive management planning. Dedicated funding for these purposes will ensure that monitoring and mitigation can be accomplished.

Finally, the Coastal Zone Management Act of 1972 requires that State and local government activities utilizing Federal funding sources be consistent with State Coastal Zone Management Policies. As such, consistency with Delaware's approved Coastal Zone Management Policies should be discussed within the Environmental Assessment and a Federal Consistency Certification should be submitted to this office with the Final Environmental Assessment. Additional information about Delaware's Coastal Zone Federal Consistency Program, including our policy document and applicant instructions, is available online at http://www.swc.dnrec.delaware.gov/coastal/Pages/FederalConsistency.aspx.

Please contact me or my staff for more information. We look forward to working with the Department of Energy on this, and future, alternative energy development proposals.

Sincerely,

Sarah W. Cooksey, Administrator
Delaware Coastal Programs

Enclosure (1)

Cc: File GC09.017
Karen Bennett – DFW
Phil Cherry – OTS
Charles Salkin -- DPR

Comments compiled from the Delaware Department of Natural Resources and Environmental Control in response to the Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project

The following sections provide specific questions, amendments and additional information for particular sections of the EA as submitted by DNREC staff from the Division of Fish and Wildlife, Division of Parks and Recreation and the Delaware Coastal Programs:

1.1 NEPA and Related Procedures

The Coastal Zone Management Act of 1972 and compliance with the approved coastal zone management policies of Delaware should be described in this section. In addition, other federal statutes and compliance, such as the Endangered Species Act and Section 106, should also be described here.

1.2.2 UD Purpose and Need

We believe that this project could provide key research opportunities, particularly with regard to avian impacts from wind turbines in coastal settings; however, the research aspect of the project is not well described. In order to have a justifiable purpose and need, specific research that will be conducted within the first three years of turbine operation and how it fulfills research gaps should be clearly specified and described.

1.3.1 UD Actions

In this section and in several other sections throughout this document, the Department is incorrectly identified as the "Division of Natural Resources and Environmental Control." Please amend to read "Department of Natural Resources and Environmental Control."

1.3.2 DOE Actions

Coordination with the Delaware Coastal Programs in fulfillment of the Federal Coastal Zone Management Act should be included in this section.

1.3.2.2 State Historic Preservation Officer

The DNREC Department of Parks and Recreation conducted a cultural survey very close to the project site in the past year as part of Parks' due diligence on the connector road project (it was not done to meet any regulatory requirements). A copy of the report has been forwarded to DOE for consideration.

2.2.1 Wind Turbine

Section 2.2.1 locates the project in a "disturbed area adjacent to its College . . " It should be noted that this parcel is actually owned by DNREC, Division of Parks and Recreation. The

University has signed a Memorandum of Agreement with the Division that allows them use of this area for the turbine. Nowhere in the EA is this stated.

The paragraph at the top of page 2-7 refers to the "University of Delaware Road that starts at Road 266." In fact the southern portion of that road beginning at Road 266 (New Road) is owned by DNREC until it reaches the main campus.

2.2.3 Permits and Approvals

At the time of initial consultation with UD, the Delaware Coastal Programs indicated that a Coastal Zone Management Federal Consistency Certification was not required because there was no federal trigger. Since that time, the University secured the funding from the Department of Energy. As a result of this Federal funding action, a Coastal Zone Federal Consistency Certification should be submitted to the Delaware Coastal Programs office. Please update Table 2-1 to indicate that as the Federal funding agency, DOE will be fulfilling the requirements of the Federal Coastal Zone Management Act.

The University's consultation with the DNREC Division of Parks and Recreation should be included in Table 2-1. While the Division is not a regulatory agency, UD obtained approvals and formal permission to utilize Division property for the wind project.

As a point of clarification, it may be worthwhile to mention in the text of this section that Delaware does not have any specific Statewide or local regulations that guide or restrict the siting or operation of wind turbines.

2.3.3. Alternatives

It should be noted that several of the six potential locations initially reviewed by DNREC agencies were within State owned land, and that the final selected location is owned by the Division of Parks and Recreation.

3. Affected Environment and Environmental Consequences

This section should contain an analysis of the approved coastal zone management policies of the State of Delaware and discuss consistency with these policies as required under the Coastal Zone Management Act of 1972.

3.1.1. Affected Environment

Please refrain from using the term "swamp." Swamp has a negative connotation for the vast majority of the public. Please instead use a more technically correct term such as non-tidal wetland or palustrine wetland.

3.2.1 Affected Environment

The area of the Great Marsh near the turbine is owned by the State of Delaware and is a designated State Natural Area. State Natural Areas are areas of unusual natural significance placed on a statewide inventory for protection as laboratories for scientific research, as reservoirs of special natural resources, or as unique habitats for plant and animal species (7 Del Code 7303). Similarly, the nearby Beach Plum Island is also a DNREC property and is formally dedicated as a Nature Preserve. State Nature Preserves are Natural Areas that have been permanently protected by conservations easement and have the highest level of protection of any lands in the state (7 Del Code 7303, 7308). It is very important that the EA recognize and discuss these surrounding natural resources and the potential effect that the turbine may have on them.

3.2 Biological Resources

3.2.1.1 Avian Species

Raptors

This section identifies the Phase I Avian Risk Assessment Report (Appendix D) as the primary source for information on avian species. Overall, this assessment was thorough, incorporating multiple data sources to "*determine the potential for displacement and collision impacts to birds from the construction and operation of the Project*" (Appendix D, pg 1.). However, the report dismisses raptor migration as, "*[t]he Project site is sufficiently inland from Cape Henlopen and barrier beaches to be off the main raptor migration path...*" (Appendix D, pg 2). Consequently, the EA does not address raptor migration through the project site in any detail. Although no significant raptor mortalities are expected, it cannot be assumed that this site is outside the main raptor migration path. The site is located approximately 0.5 miles from the immediate Delaware Bay coast north of Cape Henlopen within an open expanse of saltmarsh, which makes this area suitable for raptor movement and migration *within* the main raptor migration path. Although many raptors migrate from Cape May, NJ to Cape Henlopen and Delaware's barrier beaches by crossing the Delaware Bay, some are likely to follow the western Delaware Bay coast south, passing over and through the project site. Additionally, for raptors crossing the Delaware Bay, some species may be more apt to make landfall to the northwest of Cape Henlopen, such as the American kestrel and the sharp-shinned hawk (Kerlinger 1989). Once migrant raptors cross the Bay from New Jersey, they may disperse in the local area, including around and near the turbine site, to forage before continuing south.

Additionally, the Phase I Avian Risk Assessment Report (Appendix D) indicates the area may be used by foraging raptors, including state rare breeding species. Neither the EA nor the Phase I Avian Risk Assessment Report identify how many foraging raptors would be expected; particularly during fall migration when higher numbers of several species would likely occur within and near the project area. Raptors may be more likely to strike turbines while focused on foraging rather than migration.

The U.S. Department of Energy (DOE) should consider reviewing hawk watch data for the past two years (2008 & 2009) during fall migration at the Cape Henlopen Hawk Watch (www.hawkcount.org). During that time, a dedicated compiler was present providing greater coverage and a more accurate snapshot of the species assemblage and abundance during that time.

3.2.1.2. Bats

The Draft EA states that a "*small number of bats might rest in the trees and dense shrubs around the perimeter of the project site,*" yet the applicant has not conducted any survey work to determine which bat species might be using the area. In 2009, six species of bats (and over 700 calls) were recorded with acoustics installed on the 'Hugh R. Sharp' research vessel docked at the University of Delaware's Lewes facilities (Angela Sjollema, pers. comm.) indicating that there could be more bat activity in the area than anticipated. Furthermore, the following statement is inaccurate: "*there are no structures or natural features on or within 0.5 mile of the site where large numbers of bats would roost or hibernate, and no unique features that would attract large numbers of foraging bats.*" The large marsh adjacent to the site could attract large numbers of foraging bats and nearby water bodies (Lewes Canal and Delaware Bay) could also attract foraging bats. Additionally, pathways for migrating bats are unknown in the area but bats could be funneled through the area and become attracted to the turbine and/or the nearby foraging opportunities. Bat foraging distances are related to location and abundance of prey. One study of red bats in Kentucky recorded foraging distances of up to 7.4 km from the roost site (Stringer et al. 1999). This evidence suggests that it is likely that bats are using the project area and it is impossible to guess the level of bat activity without studies at this site. Though the opportunity to conduct pre-construction bat activity at this site has passed, post-construction monitoring should now be incorporated into the mitigation plan to evaluate potential impacts.

3.2.1.3 Federally Listed Species

This section of the EA explains why the EA either does not address a particular federally listed species due to a lack of expected impacts or goes on to provide further details. The statement "*…sea turtles, which also are not further discussed because this project would not affect potential beach nesting areas, increase light emissions inland from nesting areas, or otherwise affect these species*" is somewhat misleading. Sea turtles are not known to nest in Delaware so impacts to nesting areas either directly or from light emissions is a non-issue. The reason the project will not impact sea turtles is because impacts to the Delaware Bay and Atlantic Ocean are not part of the project. Sea turtles are found in the Delaware Bay and in Atlantic Ocean waters of Delaware for foraging, but not for nesting.

On page 3-11, the EA mentions Delmarva fox squirrel and states that the only known population in Delaware is at "Big Hook National Wildlife Refuge" (the correct name of this refuge is "Prime Hook National Wildlife Refuge"). This information is incorrect; there are two populations in Delaware: a naturally occurring population at the Nanticoke Wildlife Area and a population that is persisting from a 1980s group of translocated individuals at Prime Hook National Wildlife Refuge.

Likewise, the document does not acknowledge seabeach amaranth (*Amaranthus pumilus*), which is listed as Threatened under the federal Endangered Species Act. This annual plant species currently occurs on Atlantic Ocean beaches in Delaware at Cape Henlopen State Park and Delaware Seashore State Park, well outside the project area. Habitat for this species is not found within the turbine project site.

Although these corrections regarding federally listed species are not vital to the purpose of the EA, it is important that basic facts regarding these species are accurate and that "no effect" determinations are based on correct and relevant habitat, distribution and other life history factors.

3.2.2.1.2. Avian Mortalities

Mortality Estimates
The EA acknowledges that an estimated 1-8 birds are killed per year (pg. 3-14) at wind energy projects in the United States, based on information provided in Appendix D, including literature and data referenced on pages 83 through 90. Additionally, the Avian Risk Assessment references avian mortality data collected in 2007 and 2008 at a wind turbine facility in New Jersey within a coastal setting, including saltmarsh. These are the only referenced data collected from wind turbines sited in or near a saltmarsh. However, in late 2009, an additional report was compiled for monitoring at this site, summarizing modeling data to account for the adjusted avian mortalities encountered. This report is not referenced by either the EA or the Avian Risk Assessment (Appendix D) (this report can be found at http://www.njcleanenergy.com/files/file/Renewable_Programs/Wind/ACUA_Quarterly%20report_to-date_Jan-Aug09_1c.pdf). A review of this most recent report indicates that, over 3 years, a range of approximately 16 to 31 birds were killed at each tower, including 4 osprey (only 3 reported found during the study) and a peregrine falcon. An examination of some simple statistics of this summary would produce a mean of 7.75 birds per tower per year. When you include one standard deviation, the result would range from 1.8 to 13.7 birds per tower per year. Because this 2009 report and other reports listed above for bats were conducted in a similar setting as the UD/Gamesa project and in relatively close proximity to Delaware, the DOE should place greater weight in their findings when addressing bird (and bat) mortality and risk.

Raptors
The majority of fall raptor migration occurring near the project site follows a path from Cape May, NJ to Cape Henlopen, DE and points south. As such, raptors (with the exception of bald eagles) are not discussed further in this section of the EA. However, as indicated above in comments for *3.2.1.1 Avian Species*, raptors will still occur within the vicinity of the project site, particularly during migratory periods. The New Jersey data indicates only four raptors were killed during their surveys, including 3 ospreys (one in July, two in August). Because coastal areas are suitable for both nesting and foraging for this species and because resident ospreys are likely to follow the bay shore south during fall migration, resident ospreys may experience a higher level of risk in comparison to other raptors. The DOE should indicate the potential for mortalities during higher periods of raptor abundance (spring and fall migration) and for ospreys throughout the migratory and breeding periods in Delaware.

5

Bald Eagles
Although we do not expect the take of a resident bald eagle, the DOE EA highlights the impact of an unintentional take under the federal Bald and Golden Eagle Protection Act. Although current resident nesting bald eagles are located 3 miles or greater from the project site, a resident adult still has potential to forage within the project area. Additionally, a resident eagle pair may establish a territory and/or nest site closer in proximity to the project site in the future. This would not only increase the risk of contact and use of the project area, but also increase the risk of consequential effects (i.e., direct mortality, injury, loss of nesting pair) if an eagle is taken. Loss of an adult from a nesting pair could result in nest failure and/or abandonment. Hatch-year eagles would also frequent the area within a nesting territory, placing them at greater risk if they forage within the project site.

Beach-nesting Birds
Shorelines along oceans and bays are dynamic and the habitats they contain may be subject to change. Should coastal storms substantially change habitats on Beach Plum Island Nature Preserve (BPINP), habitat may be created that is suitable for piping plover nesting. If piping plover nest at BPINP, potential plover foraging habitat in the vicinity of the turbine should be monitored closely for presence of piping plover.

Migratory Shorebirds, including Red Knot
The EA relies heavily on the Phase I Avian Risk Assessment Report (Appendix D) to determine potential consequences to avian resources from the wind turbine. This report concludes that migratory shorebirds, including red knots (Candidate for listing under the Federal Endangered Species Act), are primarily drawn to the region to feed on horseshoe crab eggs on bay shore beaches or utilize "the saltmarsh zone" and, therefore, would be not be impacted by the wind turbine. However, both the Phase I Avian Risk Assessment Report and the EA fail to recognize the potential threat to migratory shorebirds as they transition migratory flights from the ocean coast to bay shore beaches and marshes. Although there is uncertainty as to the exact flight paths of this transition, one path could bring migratory shorebirds in close proximity to the turbine. There is real potential for migratory shorebirds to come in close proximity to the wind turbine in the spring as they fly from the ocean beaches or arrive on migratory flights from Northern Brazil to Delaware Bay beaches. There is also reason to believe that migratory shorebirds could fly from the Delaware Bay shore marshes and beaches to Gordon's Pond and back during fall migration; the flight path these birds use is unknown and could take them through this project site area. Shorebird mortality at a nearby coastal wind turbine farm in New Jersey have been documented indicating a need to carefully monitor the impacts this turbine has on both migratory shorebirds during spring and fall migration as well as nesting shorebirds during the breeding season (see http://www.njcleanenergy.com/renewable-energy/technologies/wind/jersey-atlantic-wind). Although relatively few shorebird mortalities were recorded in New Jersey, the site is much different in Delaware as it attracts a larger proportion of migrating shorebirds during spring migration indicating that shorebird mortality could be much higher than what was observed at a similar site in New Jersey.

3.2.2.1.3. Bat Mortalities

The EA acknowledges that bats would be killed by this project and suggests the numbers killed would be similar to other non-forested areas (1-19 bats/year). In this same section it states that there is no data on bat mortalities from wind turbines in similar coastal marsh habitat. However, a study is being conducted on a wind farm in Atlantic City, NJ (reports can be found at http://www.njcleanenergy.com/renewable-energy/technologies/wind/jersey-atlantic-wind). This wind farm appears to be in a similar location; on uplands near an expansive salt marsh along the NJ coast. After a very cursory examination of their report, it is clear that bats are being impacted by the turbines. This study recorded 58 dead bats of two species (red and hoary) during their post construction surveys. Using models along with their data, they estimated mortality to be approximately 46 bats per turbine per year; higher than estimated bird mortality. The 2009 report discusses how number of animals killed varied with time of year (highest for bats during fall migration) and location of turbine (for birds). The information from this, and likely other, reports, should be used by UD to design their research and mitigation plan.

3.5 Noise

The discussion of the impact of noise should also include an evaluation of the potential effects of noise on habitat use in the adjacent Great Marsh, which is known to provide foraging and breeding habitat for a number of species, including State listed rare birds. Are there studies in other locations indicating the effects of increased noise on nesting and foraging use? Will noise likely change any habitat utilization?

3.6 Aesthetics and Visual Resources

There is no mention of the visual impact to properties to the north and west of the project site. To the north of the project site is a wide expanse of protected and conservation lands, including Beach Plum Island Nature Preserve and Prime Hook National Wildlife Refuge. The turbine is also visible from as far away as the New Jersey coast and Slaughter Beach, Delaware. Impacts to coastal residents north of the turbine and visitors to the natural areas of coastal Delaware should also be considered in this analysis and in making a determination whether an adverse effect exists.

3.12 Unavoidable Adverse Impacts

The EA identifies several unavoidable impacts to biological resources, cultural resources, visual resources and noise generation. A mitigation and avoidance plan for minimization of these impacts should be developed and implemented.

3.9.1 Land Use

This section is a bit misleading. UD does have an easement to use the area for dredge spoils. A separate agreement between UD and the Division of Parks and Recreation allows for the construction of the wind project; no other development at the site is allowed without a separate written agreement.

Rather than saying that "County records show . . ," the text of this section should simply acknowledge that the land is owned by DNREC.

The County would have no zoning noted for the property because it is in the City of Lewes. The City controls the zoning designation for this parcel. City zoning designation should be described in this section.

This section also contains misinformation about the Great Marsh Preserve. The wetlands immediately adjacent to the wind project site are part of the Great Marsh Natural Area, as noted above.

4. Cumulative Impacts

The text of the EA reports that the University knows of no other future projects in the area that would create impacts that could be cumulative with the subject of this EA. However, the University is actively seeking opportunities to develop a commercial scale wind turbine test facility and has signed a cooperative agreement with the National Renewable Energy Lab to move forward with planning of an offshore test facility in State waters. While any test site location has yet to be decided or designed, we should point out that impacts to bird and bat populations would certainly be cumulative if additional turbines were constructed within the Lewes area, and visual and noise impacts would also likely be cumulative. In addition, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM) recently received interest from two wind developers in response to its Request for Interest (RFI) for commercial wind development in Federal waters offshore Lewes and Rehoboth Beach. Because no bird or bat survey data is yet available for the project, the potential for cumulative impacts is not yet known, but should be a consideration.

Appendix D

On pages 1, 12, 23 and 59, least terns are said to be listed under the federal Endangered Species Act (ESA). In fact, only the California and Interior populations are covered under the ESA.

Section 3.0
Least terns nest regularly on BPINP. Most recent nesting areas have been within 150 meters of Roosevelt Inlet. Nesting at this location should be noted on the bulleted list on pages 12 and 13.

Section 5.2
BPINP should be included as a state protected area.

Literature Cited:

Kerlinger, P. 1989. *Flight strategies of migrating hawks.* University of Chicago Press. Chicago, Ill. 375 pp.

Sjollema, A., email communication with Holly Niederriter, DNREC Natural Heritage Program January, 2010

Stringer, Jeffrey W.; Loftis, David L., eds. 1999. Proceedings, 12th central hardwood forest conference; 1999 February 28-March 1-2; Lexington, KY. Gen. Tech. Rep. SRS-24. Asheville,NC: U.S. Department of Agriculture, Forest Service.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
89 KINGS HIGHWAY
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OFFICE OF THE SECRETARY

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August 27, 2010

Dr. Jane Summerson
Office of Energy Efficiency and Renewable Energy
US Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Re: Delaware Department of Natural Resources and Environmental Control comments regarding the Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project - **Supplemental**

Dear Dr. Summerson:

This letter is a supplement to comments filed by DNREC on August 13, 2010 regarding the Draft Environmental Assessment (EA) for the University of Delaware Lewes Campus Onsite Wind Energy Project. I would like to add to and clarify some statements made in the aforementioned letter.

This agency wholeheartedly supports moving Delaware's energy generation portfolio toward a greater reliance on renewable sources. The University of Delaware wind turbine that is the subject of the EA is another important element in this goal. You may know that DNREC was instrumental in the passage of legislation this year that establishes a goal of having 25 percent of our energy supply generated by renewable sources by 2025 – one of the most aggressive goals in the nation. Our previous letter perhaps did not strongly enough endorse the project or the importance we place on finding clean renewable energy sources upon which to base our future – and our appreciation to the University for its leadership in this arena.

We do not believe that the environmental or other issues we raised in our previous comments rise to a level of significance whereby a Finding of No Significant Impact could not be issued by DOE.

We should also clarify our suggestions for mitigation and additional study to determine environmental impacts. The EA correctly points out several areas, especially with respect to avian and bat issues, where additional research on the impacts of the facility is needed. We support that research and the development of a monitoring plan for the future and stand ready to assist the University where requested. It is premature to suggest that any mitigation is warranted at this time, but should data suggest unanticipated impacts beyond those identified in the EA and

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that rise to a level of significant concern, DNREC would be willing to work with the University to determine if any measures could be reasonably implemented to minimize those impacts.

With respect to shadow flicker and noise, the EA notes that neither of these issues is expected to be at all significant, nor do these impacts appear to violate any state standards or protocols with respect to these issues. We noted these minimal impacts in our comments, and therefore our suggestion for mitigation is inconsistent and unwarranted at this time.

Our comments on Section 3.6 of the EA (Aesthetics and Visual Resources) require clarification. In our comments we note that the EA failed to consider visual impacts to the north and west of the subject property and as far away as New Jersey. We did not mean to suggest that such impacts were, in the opinion of this agency, at all significant, simply that they were not mentioned in the EA.

Finally, in our comments concerning cumulative impacts, we failed to note for DOE that we have, in recent communications with the University, informed it that any additional development of turbines in the waters of the Delaware Bay would be problematic and not likely to be permitted given the lack of resource data and the sensitivity of environmental, transportation and other issues. In addition, we understand that the University has no additional plans for another on-shore unit. Though the University desires to develop an offshore test site in state jurisdictional ocean waters, we believe the likelihood of cumulative impacts from other turbines in the Lewes vicinity is minimal but would be better able to make a judgment about cumulative impacts with additional avian and bat survey data once a site is selected.

Thank you for the opportunity to furnish additional comments.

Sincerely,

David S. Small
Deputy Secretary

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Delaware Coastal Zone Management Zone Program
Federal Consistency Certification

Applicant: University of Delaware

Contact: Dr. Nancy Targett, Dean
University of Delaware
College of Earth, Ocean, and Environment
111 Robinson Hall
302.831.2841

State of Consistency: The University of Delaware (UD) has determined that the UD Lewes Wind Turbine Project complies with Delaware's approved Coastal Management Program and has been conducted in a manner consistent with such program.

Necessary Data and Information: Below is a list of information compiled to comply first with state and then federal NEPA requirements.

1. ***Activity.*** The activity consisted of the installation of a single, 2-megawatt Gamesa G-90 wind turbine on a dredge spoils area adjacent to UD's College of Earth, Ocean, and Environment (CEOE) campus in Lewes, Delaware. UD owned the dredge spoils area until July 19, 2002, when it was conveyed to the State. At that time, UD retained an easement on the dredge spoils area. DNREC Division of Parks and Recreation manages the conveyed property. On February 2, 2010, DNREC and UD entered into an agreement confirming and clarifying that under the easement UD could utilize the dredge spoils area for any lawful purpose, including the placement of a wind turbine. The Great Marsh borders the dredge spoils area and Canary Creek is approximately 0.2 mile to the northwest, and the Roosevelt Inlet of Delaware Bay, about 0.3 mile to the northeast. Land disturbance for the project was limited to the dredge spoils area. It included a foundation and an approximate 3,200 square-foot pad associated with the foundation, and a construction laydown area of approximately 200 by 100 feet. There was an existing gravel road that runs from Pilottown Road to the dredge spoils area; this road was upgraded to support delivery of the wind turbine. There are no regulated wetlands on the project site, although DNREC has indicated that the existing access road crosses a small, non-jurisdictional wetland that does not trigger state or federal permitting. UD initially considered six possible locations for the wind turbine project and

met with DNREC Regulatory Advisory Service (RAS) in August 2009, As documented in an August 31, 2009 letter and memorandum from DNREC, DNREC preferred that the project be located between proposed locations 1 and 2, and that the site be accessed by the existing road so as to avoid sensitive habitat, including wetlands, and to accommodate DNREC's desire to construct a boat access road on a portion of the dredge spoil site. UD modified the location of the project consistent with DNREC's preferences. The Coastal Management Program by letter dated December 23, 3009 (we assume, 2009), stated that the location selected will "minimize potential impacts to significant coastal resources." Also by letter dated December 23, DNREC's Division of Fish and Wildlife stated that it believed that the project "will not have significant population-level effects on wildlife" and later described the expected effects as "minimal." DNREC's Wetland and Subaqueous Lands Section determined on December 22, 2009, that the turbine location and access road are outside of any regulatory wetlands. DNREC approved UD's Sediment and Stormwater Plan on March 1, 2010 (No. 2010-006). After the project was complete, DNREC concluded its stormwater review on July 1, 2010, noting that "All disturbed areas were seeded, stabilized, and have reached acceptable vegetation stabilization. The site was in excellent condition at the time of review." DNREC issued the project a dewatering permit (No. 230685) on March 30, 2010. By letter dated August 27, 2010, DNREC Deputy Director David Small informed the US Department of Energy, that DNREC had no objections to DOE issuing a Finding of No Significant Impact (FONSI) under the NEPA process.

2. ***Review of DCMP Comprehensive Update and Routine Program Implementation.*** This indicates that the project is consistent with DCMP policies, including:

   a. *Coastal Waters Management*—DNREC approved UD's Sediment and Stormwater Plan on March 1, 2010 (No. 2010-006). After the project was complete, DNREC concluded its stormwater review on July 1, 2010, noting that "All disturbed areas were seeded, stabilized, and have reached acceptable vegetation stabilization. The site was in excellent condition at the time of review."

   b. *Subaqueous Lands and Coastal Strip*—DNREC's Wetland and Subaqueous Lands Section determined on December 22, 2009, that the turbine location and access road are outside of any regulatory wetlands.

   c. *Public Lands Management*—UD owned the dredge spoils area until July 19, 2002, when it was conveyed to the State. At that time, UD retained an easement on the dredge spoils area. DNREC Division of Parks and Recreation Manages the conveyed property. On February 2, 2010, DNREC and UD entered into an agreement confirming and clarifying that under the easement UD could utilize the dredge spoils area for any lawful purposes, including the placement of a wind turbine.

   d. *Historical and Cultural Areas*—The State Historical Preservation Officer concluded that the project activities "did not disturb any archeological resources." (July 19, 2010) letter.

e. *Living Resources*—Studies conducted prior to construction indicated that there would be no population level impact on wildlife. However, in a letter dated, September 30, 2010, from Nancy Targett, Dean, to US FWS, UD committed to undertaking a post-construction avian and bat monitoring beginning in spring 2011 and to set up an advisory committee that will include US FWS and DNREC. UD also agreed to institute adaptive management if species-specific thresholds are exceeded.

f. *Air Quality Management*—No permits were required.

3. ***Other Issues Relevant to the CZMA Consistency Request.***
   a. Under the CZMA, state coastal zone management plans may only include enforceable policies (as embodied, e.g., in laws and regulations). In other words, the CZMA does not provide DNREC with additional policies to regulate the activities in the coastal zone, it merely ensures that activities that would otherwise not be required to go through state processes to be consistent with state policies. As the state process concluded prior to the federal process, and UD was in compliance with all enforceable state policies, as recognized by DNREC in that state process, UD also is in compliance with the requirements of the CZMA.

   b. While DNREC encouraged UD to undertake pre- and post-construction avian and bat monitoring studies, in the state process, no such studies were required as a matter of law. Nevertheless, UD employed an experienced contractor to undertake a Phase 1 Avian Risk Assessment. That assessment concluded that "impacts are likely to be minimal and not biologically significant." UD also employed contractors to undertake visual, acoustic, and shadow flicker studies. These and other studies can be found at http://www.ceoe.udel.edu/lewesturbine/background.shtml and at http://nepa.energy.gov/1469.htm. Information on public fora organized by and public outreach undertaken by UD can be found at http://www.ceoe.udel.edu/lewesturbine/news.shtml. By letter dated, September 30, 2010, from Nancy Targett, Dean, to US FWS, UD committed to undertaking post-construction avian and bat monitoring beginning in spring 2011. With this, UD has gone beyond the DCMP.

4. **Determination of Consistency with Requirements.** Based on a review above, the UD Wind Turbine Project proposed by UD (applicant), its associated facilities and their effects are all consistent with the enforceable policies of the Delaware Coastal Management Program.

Signature **October 15, 2010**

Nancy Targett
Dean, College of Earth, Ocean, and Environment
University of Delaware

3

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
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DELAWARE COASTAL
MANAGEMENT PROGRAM

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October 29, 2010

Dr. Nancy Targett
Dean, College of Earth, Ocean and Environment
University of Delaware
111 Robinson Hall
Newark, DE 19716-3501

**RE: Delaware Coastal Management Federal Consistency Certification
University of Delaware Lewes Wind Turbine (FC 11.006)**

Dear Dr. Targett:

The Delaware Coastal Management Program (DCMP) has received and reviewed your consistency determination request and supplemental material for the above referenced project. Based upon our review and pursuant to National Oceanic & Atmospheric Administration regulations (15 CFR 930), the DCMP conditionally concurs with your consistency determination for federal funding from the U.S. Department of Energy for the construction of a 2-megawatt Gamesa G-90 wind turbine on a State-owned dredge spoils area adjacent to the University's campus in Lewes, Sussex County, Delaware. The intended purpose of this project is to provide research opportunities on technical aspects of wind turbine operations in coastal environments and to provide a carbon-free source of energy for the Lewes campus.

This concurrence is based upon the following conditions:

1. The University will develop and implement a monitoring plan to assess impacts to birds and bats resulting from the operation of this turbine, as set forth in your letter dated September 30, 2010 to Dr. Leopoldo Miranda, Supervisor of the U.S. Fish and Wildlife Service Chesapeake Bay Field Office. This study will commence no later than spring, 2011.

2. The University shall institute adaptive management practices should impacts exceed thresholds for species of concern, as set forth in your letter dated September 30, 2010 to Dr. Leopoldo Miranda, Supervisor of the U.S. Fish and Wildlife Service Chesapeake Bay Field Office.

October 29, 2010
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Page 2 of 2

3. The University shall convene an advisory committee to provide guidance and assistance with the development of the monitoring plan, assessment of impact thresholds and implementation of adaptive management practices as set forth in your letter dated September 30, 2010 to Dr. Leopoldo Miranda, Supervisor of the U.S. Fish and Wildlife Service Chesapeake Bay Field Office.

4. The University shall provide copies of monitoring reports to this office.

If you have any questions please do not hesitate to contact me or Susan Love of my staff at (302) 739-9283.

Sincerely,

Sarah W. Cooksey, Administrator
Delaware Coastal Programs

SWC/sel

Cc: David Small, OTS
Phil Cherry, OTS
Lee Ann Walling, OTS
Karen Bennett, DFW
Eugene Moore, DFW
Jane Summerson, USDOE

Federal Aviation Administration
Air Traffic Airspace Branch, ASW-520
2601 Meacham Blvd.
Fort Worth, TX 76137-0520

Aeronautical Study No.
2009-WTE-10287-OE

Issued Date: 12/30/2009

Nancy Targett
University of Delaware
111 Robinson Hall
Newark, DE 19716

**** DETERMINATION OF NO HAZARD TO AIR NAVIGATION ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Wind Turbine University of Delaware - Lewes Wind Turbine
Location:	Lewes, DE
Latitude:	38-46-58.55N NAD 83
Longitude:	75-09-53.92W
Heights:	415 feet above ground level (AGL) 426 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure does not exceed obstruction standards and would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

As a condition to this Determination, the structure is marked and/or lighted in accordance with FAA Advisory circular 70/7460-1 K Change 2, Obstruction Marking and Lighting, white paint/synchronized red lights - Chapters 4,12&13(Turbines).

It is required that FAA Form 7460-2, Notice of Actual Construction or Alteration, be completed and returned to this office any time the project is abandoned or:

_____ At least 10 days prior to start of construction (7460-2, Part I)
__X__ Within 5 days after the construction reaches its greatest height (7460-2, Part II)

While the structure does not constitute a hazard to air navigation, it would be located within or near a military training area and/or route.

This determination expires on 12/30/2011 unless:

(a) extended, revised or terminated by the issuing office.
(b) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case, the determination expires on the date prescribed by the FCC for completion of construction, or the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE POSTMARKED OR DELIVERED TO THIS OFFICE AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE.

Additional wind turbines or met towers proposed in the future may cause a cumulative effect on the national airspace system. This determination is based, in part, on the foregoing description which includes specific coordinates and heights . Any changes in coordinates will void this determination. Any future construction or alteration requires separate notice to the FAA.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

If we can be of further assistance, please contact our office at (404) 305-7081. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2009-WTE-10287-OE.

Signature Control No: 659536-121164066 (DNE -WT)
Michael Blaich
Specialist

Page 2 of 2

Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, Colorado 80401-3393

April 30, 2010

Timothy A. Slavin, Director, State Historic Preservation Officer
Delaware Department of State, Division of Historic and Cultural Affairs
21 The Green
Dover, DE 19901

Dear Mr. Slavin:

SUBJECT: University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

The U.S. Department of Energy (DOE) is proposing to provide funding to the University of Delaware (UD) to install a 1- to 2-megawatt wind turbine adjacent to its College of Marine and Earth Studies campus in Lewes, Delaware. Because a portion of the project would be funded by an appropriation through DOE, this project must meet requirements for federal actions under Section 106 of the National Historic Preservation Act.

The wind turbine would be interconnected to the UD facility and would be used for research and development purposes as well as supplying electrical energy to the campus and electrical grid. Attachment 1 to this letter shows the proposed location of the turbine on the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map. The hub of the wind generator would be at a height of 80 meters (262 feet) above the ground surface. The diameter of the rotor would be 90 meters (295 feet); so the top of the rotor would extend half that distance above the hub (409 feet). The proposed construction, or installation, location is an existing dredge spoils area to the west of the UD campus, roughly 1,200 feet from the nearest campus facility. In addition, it is at least 1,200 feet from the nearest residence. Land disturbance at the turbine site would include a 1,200-square-foot pad with a deep foundation system, a transformer, and a construction laydown area of roughly 200 by 100 feet in size. The project would include a new access road from the northeast into the wind turbine location. This new access road would either connect to a proposed road running between the wind turbine location and the UD campus and extending to Pilottown Road, or it would follow the existing gravel access road that currently extends to Pilottown Road. The proposed road, running between the wind turbine location and the UD campus, is not part of this proposed action. Attachments 2 and 3 provide aerial views of the project site: the first showing the location of the University of Delaware campus in the general Lewes area, and the second showing a closer view of the campus and its relation to the proposed wind turbine location.

DOE has no reason to believe the project would cause any effects to historic or archaeological resources in the Lewes area; the site is vacant land that has been used as a dredge spoils area. The wind turbine would, however, be visible from a relatively large area. An environmental assessment currently is being prepared for this project to meet the requirements of the National Environmental Policy Act. A copy of the assessment will be sent to your office for review and comment later this year.

To aid in the preparation of this environmental assessment, and to meet obligations under Section 106 of the National Historic Preservation Act to take into account the effects of undertakings by federal agencies on historic properties, DOE is requesting any additional information your office has on historic properties that are present within 1 mile of the proposed project site. Please respond to Jane Summerson at the following address:

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
202-287-6188
jane.summerson@hq.doe.gov

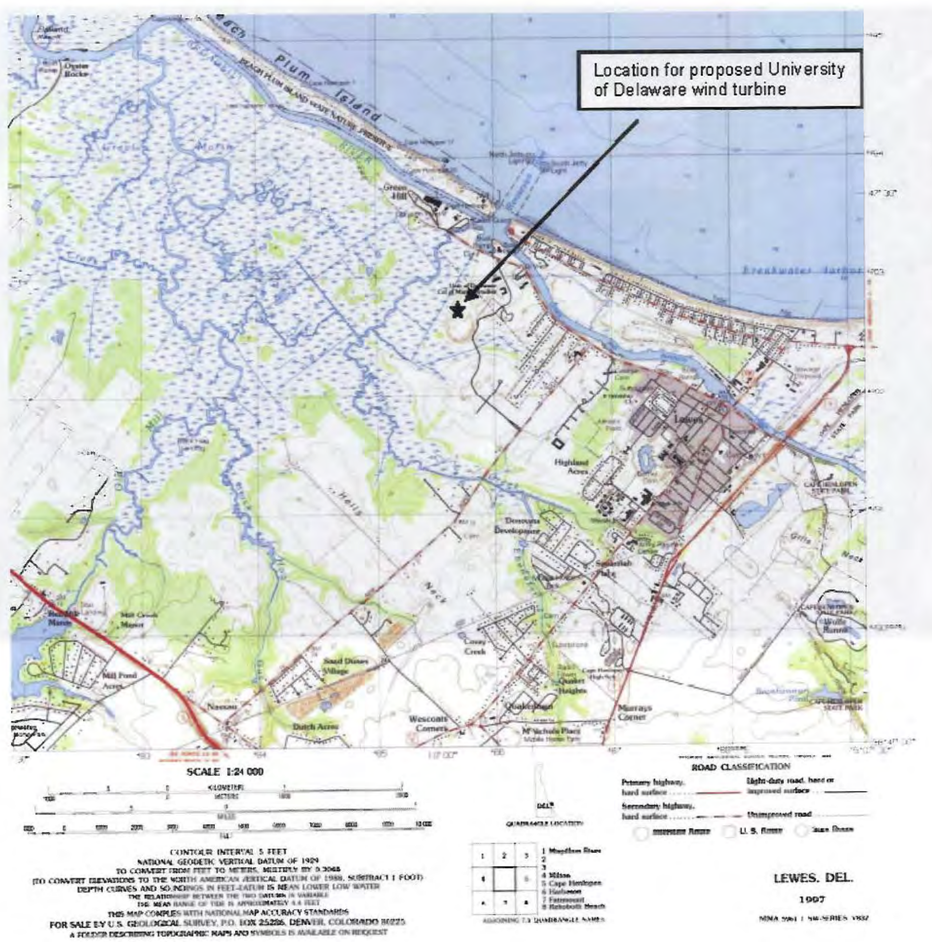
Sincerely,

Carol Battershell
Acting Executive Director of Field Operations
Golden Field Office

Attachments
1. Site Location Map
2. Aerial view of the Lewes, Delaware area
3. Aerial view of the University of Delaware Campus

CC w/attachments: Mr. Dan Parsons, Historic Preservation Planner
Sussex County Department of Engineering

Attachment 1: Site Location Map



Attachment 2: Aerial view of the Lewes, Delaware area

Attachment 3: Aerial view of the University of Delaware Campus

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611
Phone: (302) 736.7400 Fax: (302) 739.5660

May 11, 2010

Ms. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

RE: Wind Energy Project, University of Delaware Campus, Lewes, Sussex County, DE

Dear Ms. Summerson:

On May 5, 2010, our office received a letter from your Golden Field Office initiating consultation on a project to install a 1- to 2-megawatt wind turbine adjacent to its College of Marine and Earth Studies Campus in Lewes, DE. The letter described the dimensions and location of the wind turbine and requested information from our office on the historic properties located within a one-mile radius of the wind turbine's location.

There are seven properties listed in the National Register of Historic Places which are within one mile of the turbine's location (see enclosed map). They are:

- Lewes Historic District (S-290) – portion of the district along Pilottown Road between Queen and Marina Streets
- William Russell House (S-160) – 410 Pilottown Road (listed individually but also within the Lewes Historic District boundaries)
- Thomas Maull House (S-175) – 542 Pilottown Road
- Fisher's Paradise (S-140) – 624 Pilottown Road
- DeVries Pallisade Site (S-174) – Southeast side of Pilottown Road, north of New Road
- Pagan Creek Dike (S-314) – Canary Creek, north of New Road
- Roosevelt Inlet Shipwreck Underwater Archaeological Site (S-10147) – Lewes Harbor

Seven additional historic buildings and structures have been identified within the one-mile radius; we believe these are not eligible for the National Register. Nine additional archaeological sites have been identified within this area; their eligibility for the National Register has not been evaluated.

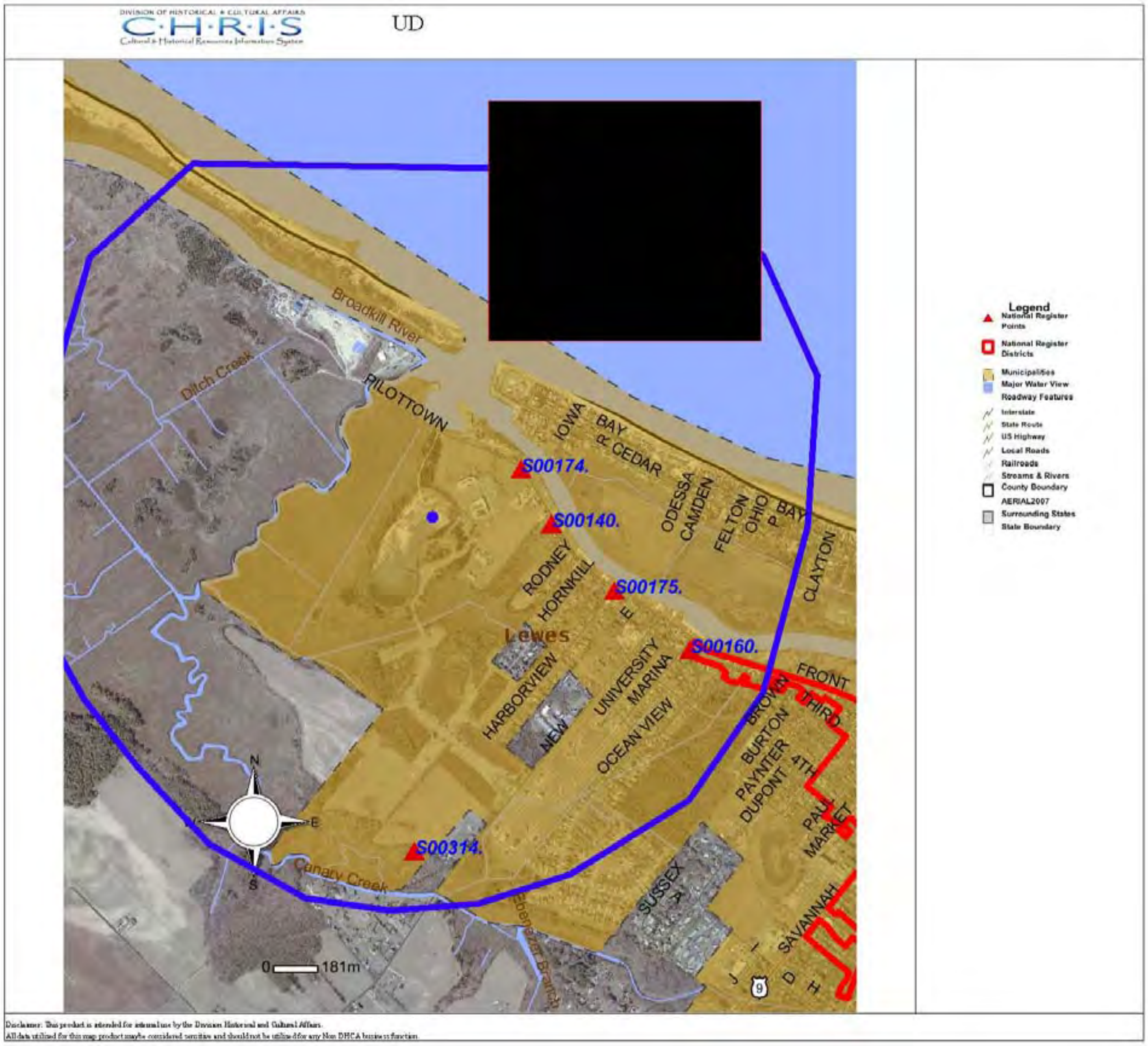
If you require further information or have additional questions, please contact me. I can be reached at 302-736-7400 or timothy.slavin@state.de.us.

Sincerely,

Timothy A. Slavin
Director and State Historic Preservation Officer

SAVING DELAWARE HISTORY

c: Carol Battershell, DOE, Golden Field Office
Dan Parsons, Sussex County


C·H·R·I·S
UD
Broadkill River
Ditch Creek
PILOTTOWN
IOWA
BAY
CEDAR
S00174.
S00140.
S00175.
S00160.
S00314.
ODESSA
CAMDEN
FELTON
OHIO
CLAYTON
RODNEY
HORNKILL
Lewes
HARBORVIEW
NEW
UNIVERSITY
MARINA
OCEAN VIEW
FRONT
THIRD
BROWN
BURTON
PAYNTER
DUPONT
4TH
PAUL
MARKET
SUSSEX
SAVANNAH
Canary Creek
0 181m
Legend
National Register Points
National Register Districts
Municipalities
Major Water View
Roadway Features
Interstate
State Route
US Highway
Local Roads
Railroads
Streams & Rivers
County Boundary
AERIAL2007
Surrounding States
State Boundary
Disclaimer: This product is intended for internal use by the Division Historical and Cultural Affairs.
All data utilized for this map product maybe considered sensitive and should not be utilized for any Non DHCA business function.

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611
Phone: (302) 736.7400 Fax: (302) 739.5660

May 24, 2010

Ms. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

RE: Wind Energy Project, University of Delaware Campus, Lewes, Sussex County, Delaware

Dear Ms. Summerson:

On May 18, 2010 a field review was conducted by two archaeologists from the Delaware Division of Historical and Cultural Affairs on the site of the installed wind turbine that is adjacent to the University of Delaware's College of Marine and Earth Studies Campus in Lewes, Delaware. The purpose of this site visit was to evaluate concerns that archaeological properties may have been disturbed by the construction of the wind turbine and its access road.

Based on their findings, the archaeologists' have concluded that the wind turbine itself is located on a dredge spoil area which has been in use for several decades, and that the access road to the wind turbine site is on the same alignment as the road which allowed access to the dredge spoil site. As a result, a determination has been made that the construction of the wind turbine and access road are located on soils which have been previously disturbed, and that there are no adverse impacts to archaeological resources from this aspect of the construction.

The archaeologists did not have an opportunity to test the infrastructure and associated right-of-way related to connecting the electricity to the college or any other part of the electrical grid. Consequently, we do not know if this is above or below ground or if it is in previously disturbed corridors. When further information on this aspect of the project is provided, we will be happy to undertake an additional archaeological field review.

If you require further information or have additional questions, please contact me. I can be reached at 302-736-7400 or tim.slavin@state.de.us.

Sincerely,

Timothy A. Slavin, Director
and State Historic Preservation Officer

CC: Dan Parsons, Sussex County Preservation Planner

SAVING DELAWARE HISTORY

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611

Phone: (302) 736.7400 Fax: (302) 739.5660

June 5, 2010

Ms. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

RE: Wind Energy Project, University of Delaware Campus, Lewes, Sussex County, DE

Dear Ms. Summerson:

On June 3, 2010, we conducted a field review to assess the visibility of the Lewes Wind Turbine on the seven properties which we named in our letter of May 11, 2010 as those within a one mile radius of the site that were listed on the National Register of Historic Places. All visual assessments were from street level.

The visibility of the wind turbine at the University of Delaware Lewes Campus from the historic properties is as follows:

- Lewes Historic District (only a portion of the historic district located along Pillottown Road is within the one mile radius but other locations throughout the district were assessed) –
  - along Pilottown Road - not visible
  - along the streets running northwest from Savannah Road - not visible
  - along the streets running southeast from Savannah Road to Kings Highway - top only visible at 1½ mile distance
  - when viewing the Lewes Historic District from its eastern boundary at the bridge over the Lewes and Rehoboth Canal – top half visible at 1½ mile distance
- William Russell House (410 Pilottown Road which is listed individually but also within the Lewes Historic District boundaries) – see comments above for Pilottown Road
- Thomas Maull House (542 Pilottown Road) – not visible as it is blocked by houses and trees
- Fisher's Paradise (624 Pilottown Road) – visible through trees; visibility may be greater in winter
- DeVries Pallisade Site (SE side of Pilottown Road) – fully visible from St. Peter's cemetery and commemorative monument
- Pagan Creek Dike (Canary Creek, north of New Road0 – slightly visible through trees, seasonal loss of vegetation will increase visibility
- Roosevelt Inlet Shipwreck Underwater Archaeological Site (Lewes Harbor) – visibility not assessed

If you require further information or have additional questions, please contact me. I can be reached at 302-736-7400

or tim.slavin@state.de.us.

Sincerely,

Timothy A. Slavin
Director and State Historic Preservation Officer

c: Carol Battershell, DOE, Golden Field Office

SAVING DELAWARE HISTORY

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611

Phone: (302) 736.7400 Fax: (302) 739.5660

Dan Parsons, Sussex County

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611
Phone: (302) 736.7400 Fax: (302) 739.5660

July 19, 2010

Ms. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

RE: Wind Energy Project, University of Delaware Campus, Lewes, Sussex County, DE

Dear Ms. Summerson:

On July 16 , Mr. Craig Lukezic, an archaeologist from our office visited the site of the wind turbine adjacent to the College of Marine and Earth Studies Campus in Lewes, DE. The Assistant Director, Mr. Joseph Scudlark, met with Mr. Lukezic and walked him through the buried utility corridor. Mr. Lukezic observed that the installation of the utility connection occurred in an area that was previously disturbed by the dredging operations and the wind turbine project did not disturb any archaeological resources.

If you require further information or have additional questions, please contact me. I can be reached at 302-736-7400 or timothy.slavin@state.de.us.

Sincerely,

Timothy A. Slavin
Director and State Historic Preservation Officer

c: Carol Battershell, DOE, Golden Field Office
Dan Parsons, Sussex County

SAVING DELAWARE HISTORY

Department of Energy
Washington, DC 20585

October 18, 2010

Timothy A. Slavin
Director, State of Delaware Historical and Cultural Affairs
State Historic Preservation Officer
21 The Green
Dover, DE 19901-3611

Re: Wind Energy Project, University of Delaware Campus, Lewes, Sussex County, DE

Dear Mr. Slavin:

The U.S. Department of Energy (DOE) is in the process of completing its final Environmental Assessment (EA) of the *University of Delaware, Lewes Campus Onsite Wind Energy Project* (DOE/EA-1782). DOE has prepared this EA pursuant to its obligations under the *National Environmental Policy Act* (NEPA) to evaluate the environmental impacts of providing Federal financial assistance to the University of Delaware (UD) for an onsite wind turbine (Wind Energy Project) adjacent to the College of Earth, Ocean, and Environment Campus located in Lewes, Delaware. DOE is coordinating its NEPA efforts with its responsibilities under Section 106 of the *National Historic Preservation Act* (NHPA), and this EA reflects scoping, identification of historic and cultural properties, assessment of effects on them from the construction and operation of the Wind Energy Project, and consultation efforts as prescribed in the Advisory Council on Historic Properties' implementing regulations for the NHPA found at 36 Code of Federal Regulations (CFR) 800.8.

In this letter, DOE provides you with a summary of actions that DOE undertook to comply with the requirements of Section 106 and seeks concurrence from the Delaware State Historic Preservation Office (SHPO) on a proposed determination by DOE of "no adverse effects" for this Federal undertaking. DOE would like to conclude consultation and therefore would appreciate your reply as soon as possible.

Background

As you are aware from your July 2010 review, the Draft EA analyzed impacts that occurred during construction of the wind turbine as well as potential environmental impacts that may occur during the turbine's operation. At the time the Draft EA was finalized, the University of Delaware had already completed construction of a single, 2-megawatt wind turbine and associated project components (including a transformer and construction pad) in an existing dredge spoils area adjacent to the campus; construction of an access road to the turbine site; and installation of an underground electric conduit directly into University facilities. The Area of Potential Effects (APE), used to determine possible effects to historic and cultural properties from the Wind Energy Project, is a 1-mile radius around the project site. DOE received one comment during the 60-day public comment period for the Draft EA that raised potential concerns about impacts on historic properties, namely visual impacts of the wind turbine on the Town of Lewes.

DOE initiated Section 106 consultation in an April 30, 2010, letter from DOE's Golden Field Office to the Delaware SHPO. In early 2009, a cultural resources survey and report was prepared for the project's APE to identify historic properties. Initial findings in the EA were based on conclusions from that report and on the information contained in your letter of May 11, 2010. That letter identified seven properties[1] listed in the *National Register of Historic Places* (National Register) and also listed seven additional historic buildings and structures within the APE not believed to be eligible for the National Register and nine archaeological sites for which eligibility had not yet been evaluated.

Moreover, in May and July 2010, archaeologists from your office conducted site visits in order to determine whether adverse impacts to archaeological resources resulted from the construction of the wind turbine and its access road or from installation of its utility connection. Your letters dated May 24, 2010 and July 19, 2010 confirmed that neither activity disturbed archaeological resources.

Your office also conducted a field review to assess the visibility of the Wind Energy project on the seven properties listed in the May 11, 2010 letter. Your letter of June 5, 2010 recounted that the Wind Energy Project is visible to portions of the Lewes Historic District and DeVries Pallisade and may be visible seasonally at the William Russell House, Fisher's Paradise, and Pagan Creek Dike sites.

Eagles, Eagle Habitation, and American Indian Tribes

Because the Wind Energy Project is located near important salt marsh habitat, DOE/EA-1782 addresses the potential impacts to raptors, including eagles, as well as other birds. The potential impacts to eagles is of particular importance to DOE's Section 106 consultation effort because eagles or eagles nests, or both, may be sacred sites to American Indian Tribes, thus making the landscape associated with them eligible for the National Register and subject to protection under Section 101(d)(6)(a) of the NHPA.

In May and June 2010, DOE contacted Tribes that may have had a current or historic presence near the Wind Energy Project site in an effort to determine whether potential eagle habitation nearby might render the landscape a potential historic property of religious and cultural importance. In letters sent to three Federally-recognized Tribes (The Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge-Munsee Community of Wisconsin), and two State-recognized Tribes (the Nanticoke Indian Association and the Lenape Indian Tribe of Delaware), DOE asked the Tribes if eagle habitation is sacred to them. Only the Lenape Indian Tribe responded in the affirmative. In an August 17, 2010, letter to DOE, the Lenape Indian Tribe explained that the Lenape people hold eagles and eagle habitat in high regard and shared that some Lenape men wore a single eagle feather in their headdresses to display reverence to the animal. The letter also stated, however, that the Tribe's review indicated no religious or culturally significant sites in the project area.[2]

Because of the uncertainty about potential impacts to birds and bats by the operating wind turbine generally, and in an effort to minimize impacts to eagles, which are religiously and culturally significant to the Lenape people, DOE will require as a condition of funding that UD implement a monitoring and adaptive management plan for reducing impacts to wildlife. The plan will be developed jointly with the

[1] Historic properties within the APE are identified as follows: Lewes Historic District, William Russell House, Thomas Maull House, Fisher's Paradise, DeVries Pallisade Site, Pagan Creek Dike, and Roosevelt Inlet Shipwreck Underwater Archeological Site.

[2] In a response dated May 25, 2010, the Stockbridge-Munsee Tribal Historic Preservation Officer indicated the University of Delaware wind turbine location was not an area of the Tribes concern. The Delaware Nation responded in a letter dated June 16, 2010, that they would be a consulting party on the project and that the Cultural Preservation Director would be making a determination after review of the project. In a letter dated August 4, 2010, the Tribe Historic Preservation Office of the Delaware Tribe of Indians responded that their review indicated no religious or culturally significant sites in the project area, so they would defer any comments in that regard to the State Historic Preservation Office or the State Archaeologist. The Delaware Tribe of Indians' letter also indicated the Tribe wished to continue as a consulting party and asked that project development be ceased immediately and the Tribe be notified if any human remains were uncovered.

University, US FWS, Delaware Department of Natural Resources and Environmental Control, and nongovernmental conservation groups interested in the Federal undertaking. DOE is in communication with the Lenape Indian Tribe regarding this effort and will provide all five Tribes with which it consulted with a final EA as documentation of UD's efforts to minimize potential adverse effects to sacred cultural resources of American Indian Tribes.

Visual Impacts

Your letter of June 5, 2010 concluded that the UD Wind Energy Project is visible to portions of the Lewes Historic District and DeVries Pallisade and may be visible seasonally at the William Russell House, Fisher's Paradise, and Pagan Creek Dike sites. However, the letter did not characterize these effects as adverse (36 CFR Part 800.5(a)(1)), and DOE received one comment that raised potential concerns about impacts on historic properties, namely visual impacts of the wind turbine on the Town of Lewes. Therefore, DOE seeks your concurrence on a finding of "no adverse effect" for the Wind Energy Project, University of Delaware Campus, Lewes, Delaware, under the provisions of Section 106 of the NHPA. Please provide your concurrence in writing so that it may be added to the administrative record to evidence DOE's full compliance with its Section 106 consultation responsibilities.

If you have any questions or concerns, you may contact me at Jane.Summerson@EE.doe.gov or 202-340-3626. Please accept my thanks for your cooperation and assistance.

Sincerely,

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611
Phone: (302) 736.7400 Fax: (302) 739.5660

October 22, 2010

Ms. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

RE: Wind Energy Project, University of Delaware Campus, Lewes, DE

Dear Ms. Summerson:

Thank you for your letter of October 15 in which you have provided us with a summary of the actions which the Department of Energy (DOE) took to comply with the requirements of Section 106 of the National Historic Preservation Act of 1966, as amended. In a letter dated May 10, 2010, our office provided a list of seven (7) historic properties which were within a one-mile radius of the wind turbine. In subsequent letters we provided you with comments on both the visual effect of the wind turbine on these historic properties, one of which is an historic district, and of potential impacts to archaeological sites in the areas where the project resulted in ground disturbing activities. In your letter you indicate that only one person has objected to the visual effects of the project during the public comment period allowed for in your Draft Environmental Assessment. Our findings are that there has been no disturbance to any significant archaeological sites.

Therefore, we concur with your finding that the construction of the wind turbine will not adversely effect any properties listed on or eligible for listing on the National Register of Historic Places.

If you have questions, please contact me. I can be reached at timothy.slavin@state.de.us or 302-736-7400.

Sincerely,

Timothy A. Slavin
State Historic Preservation Officer

c: C. Daniel Parsons, Sussex County Preservation Planner

SAVING DELAWARE HISTORY

Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, Colorado 80401-3393

April 30, 2010

Mr. Devon Ray
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

Dear Mr. Ray:

SUBJECT: U.S. Department of Energy Request for Species and Critical Habitat List for University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

The U.S. Department of Energy (DOE) is proposing to provide financial assistance to the University of Delaware (UD) for the installation of a 1- to 2-megawatt wind turbine adjacent to its College of Marine and Earth Studies campus in Lewes, Delaware. To comply with Section 7(a)(2) of the Endangered Species Act, and the implementing regulations at 50 CFR 402.12(c,d), the DOE is requesting a list of any listed or proposed species or designated or proposed critical habitat that may be present in the project area.

The wind turbine would be located just west of the UD Lewes Campus. The proposed location is shown in the attached map (Attachment 1), which was copied from the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map.

The wind turbine would be interconnected directly into the UD facility and its operation would include use for research and development purposes as well as providing electrical energy to the campus and to the electrical grid. The hub of the wind generator would be at a height of 80 meters (262 feet) above the ground surface. The diameter of the rotor would be 90 meters (295 feet); so the top of the rotor would extend half that distance above the hub (409 feet). The proposed construction, or installation location is an existing dredge spoils area to the west of the UD campus, roughly 1,200 feet from the nearest campus facility. In addition, it is at least 1,200 feet from the nearest residence. Land disturbance at the turbine site would include a 1,200-square-foot pad with a deep foundation system, a transformer, and a construction laydown area of roughly 200 by 100 feet in size. The project would include a new access road from the northeast into the wind turbine location. This new access road would either connect to a proposed road running between the wind turbine location and the UD campus and extending to Pilottown Road, or it would follow the existing gravel access road that currently extends to Pilottown Road. The proposed road, running between the wind turbine location and the UD campus, is not part of this proposed action. Attachment 2 and 3 provide aerial views of the project site: the first showing the location of the University of Delaware campus in the general Lewes area, and the second showing a closer view of the campus and its relation to the proposed wind turbine location.

Please forward that list to Jane Summerson at jane.summerson@hq.doe.gov.

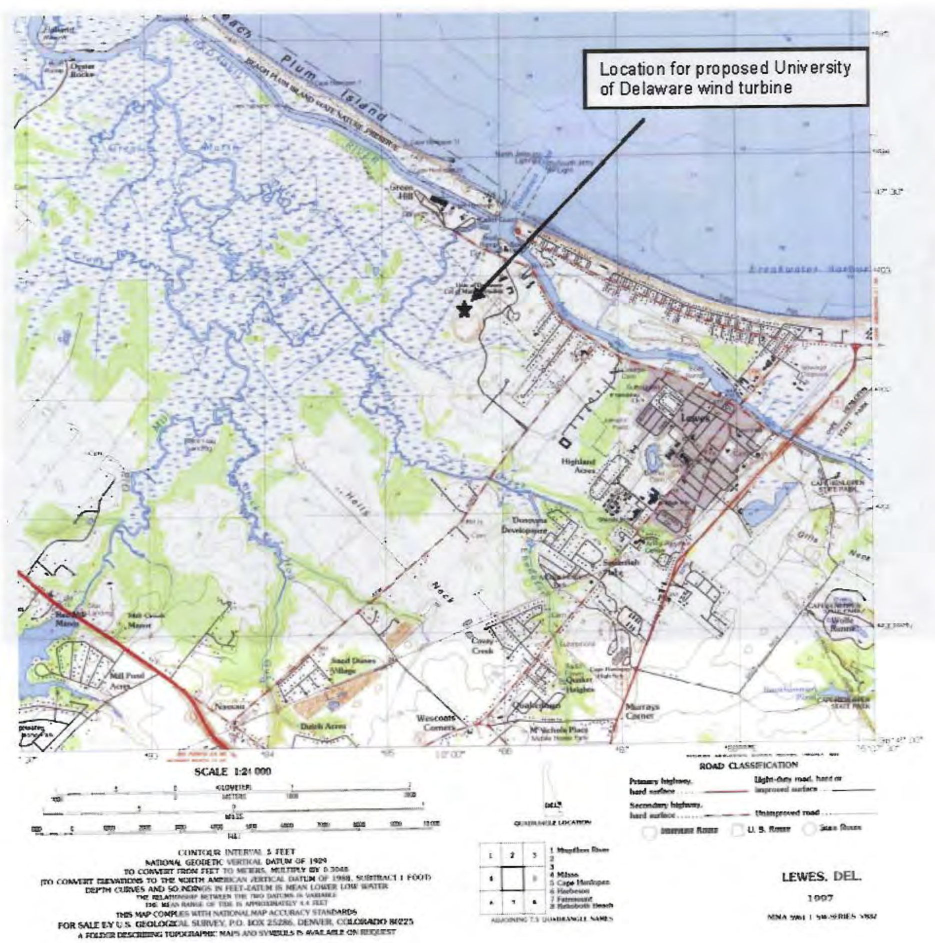
If you have any comments or questions about this request or the associated project, please contact Dr. Summerson at 202-287-6188.

Sincerely,

Carol Battershell
Acting Executive Director of Field Operations
Golden Field Office

Attachments
1. Site Location Map
2. Aerial view of the Lewes, Delaware area
3. Aerial view of the University of Delaware Campus

Attachment 1: Site Location Map



Attachment 2: Aerial view of the Lewes, Delaware area

Attachment 3: Aerial view of the University of Delaware Campus

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401
410/573-4575

July 15, 2010

Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, Colorado 80401-3393

RE: U.S. department of Energy Request for Species and Critical Habitat List for University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County Delaware

Dear Carol Battershell:

This responds to your letter, received May 5, 2010, requesting information on the presence of species which are federally listed or proposed for listing as endangered or threatened within the above referenced project area. We have reviewed the information you enclosed and are providing comments in accordance with section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*).

The federally threatened piping plover (*Charadrius melodus*) nests within the vicinity of the above referenced project area. Piping plovers nest above the high tide line on coastal beaches, sandflats at the ends of sandspits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes. Feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes. The most up to date information regarding piping plover activity or location may be obtained by contacting Holly Niederriter of the Delaware Natural Heritage Program. Data on the location of piping plover nests generally becomes available in late spring. Potential impacts on piping plover habitat should be analyzed as a part of your environmental assessment. If such impacts may occur, further section 7 consultation with the U.S. Fish and Wildlife Service may be required.

Except for occasional transient individuals, no other federally proposed or listed endangered or threatened species are known to exist within the project impact area. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For information on the presence of other rare species, you should contact Edna Stetzar of the Delaware Natural Heritage and Endangered Species Program at (302) 653-2883 ext. 126. You may also obtain information on how to make such a request by visiting the Program website at www.dnrec.state.de.us/nhp.

Effective August 8, 2007, under the authority of the Endangered Species Act of 1973, as amended, the U.S. Fish and Wildlife Service (Service) removed (delist) the bald eagle in the lower 48 States of the United States from the Federal List of Endangered and Threatened Wildlife. However, the bald eagle will still be protected by the Bald and Golden Eagle Protection Act, Lacey Act and the Migratory Bird Treaty Act. As a result, starting on August 8, 2007, if your project may cause "disturbance" to the bald eagle, please consult the "National Bald Eagle Management Guidelines" dated May 2007.

If any planned or ongoing activities cannot be conducted in compliance with the National Bald Eagle Management Guidelines (Eagle Management Guidelines), please contact the Chesapeake Bay Ecological Services Field Office at 410-573-4573 for technical assistance. The Eagle Management Guidelines can be found at:
http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf.

In the future, if your project can not avoid disturbance to the bald eagle by complying with the Eagle Management Guidelines, you will be able to apply for a permit that authorizes the take of bald and golden eagles under the Bald and Golden Eagle Protection Act, generally where the take to be authorized is associated with otherwise lawful activities. This proposed permit process will not be available until the Service issues a final rule for the issuance of these take permits under the Bald and Golden Eagle Protection Act.

An additional concern of the Service is wetlands protection. The Service's wetlands policy has the interim goal of no overall net loss of Delaware Bay's remaining wetlands, and the long term goal of increasing the quality and quantity of the Basin's wetlands resource base. Because of this policy and the functions and values wetlands perform, the Service recommends avoiding wetland impacts. All wetlands within the project area should be identified, and if construction in wetlands proposed, the U.S. Army Corps of Engineers, Philadelphia District should be contacted for permit requirements. They can be reached at (215) 656-6728.

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Andy Moser at (410) 573-4537.

Sincerely,

Leopoldo Miranda
Field Supervisor

cc: Richard Hassel, Chief, Application Section I, COE, Philadelphia, PA
Holly Niederriter, Delaware Division of Fish & Wildlife, Smyrna, DE

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

July 29, 2010

Dr. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

RE: *Endangered Species Act review of Environmental Assessment for the University of Delaware Lewes Campus Wind Energy Project (DOE/EA-1782D)*

Dear Ms. Summerson:

We have reviewed the referenced document and are providing comments in accordance with Section 7 of the Endangered Species Act (87 Stat.884, as amended; 16 U.S.C. 1531 *et seq.).*
Based on the information in the Environmental Assessment and other available information, we concur with the conclusion that the proposed project is not likely to adversely affect the Federally listed piping plover (*Charadrius melodus*). Available information on piping plover habitat use and limited information on plover migratory routes is consistent with the document's conclusion that it is unlikely that piping plovers would be struck or otherwise harmed by the turbine.

However, such mortality or harm cannot be entirely ruled out based on the very limited data concerning plover movement through the area occupied or affected by the turbine. Therefore, the Fish and Wildlife Service (Service) strongly recommends the implementation of a bird mortality monitoring program during operation of the turbine. Should piping plover mortality be determined to occur at the turbine site, further consultation with the Service would be required.

Should you have any questions regarding this response, please contact Andy Moser of my Endangered Species staff at (410) 573-4537.

Sincerely,

Leopoldo Miranda
Supervisor

Cc: Karen Bennett, Delaware Division of Fish and Wildlife

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

August 17, 2010

Dr. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

RE: *Bald and Golden Eagle Act and Migratory Bird Treaty Act review of Environmental Assessment for the University of Delaware Lewes Campus Wind Energy Project (DoE/EA-1782D)*

Dear Ms. Summerson:

Thank you for the 30-day extension to provide comments for the University of Delaware Lewes Campus Onsite Wind Energy Project. Our review and subsequent comments are in accordance with the Migratory Bird Treaty Act (MBTA)(16 U.S.C. 703-712), Bald and Golden Eagle Protection Act (BGEPA)(16 U.S.C. 668-668c) and Executive Order 13186. Comments specific to federally listed species under the Endangered Species Act that may be affected, were previously submitted by this office under separate cover.

Based on the information provided in the draft Environmental Assessment (EA), we have concerns specific to the current placement and long term operation of the 2.0-megawatt Gamesa wind turbine at the Lewes University of Delaware (UD) campus. The Service has serious concerns as to why representatives from the University of Delaware and Department of Energy (DoE) did not involve the Service with this project until well after the wind tower construction was completed. In fact, it was not until the wind turbine was in operation that a site visit was initiated with the Service. Because the wind turbine is now sited within a distinct migratory bird travel corridor of the Atlantic Flyway, there is an increased likelihood that mortality of migratory birds and bats will result. For this reason, the Service cannot support a Finding of No Significant Impact (FONSI). The Draft EA concludes that the project will have minimal potential for impacts to bird and bat populations. The Service believes that potential adverse impacts to migratory bird and bat species, and possibly bald eagles, are likely to occur given the current location of the wind turbine.

The attached comments will hopefully provide measures for UD and DoE to consider for this, and future alternative energy development proposals in order to minimize long-term adverse impacts to migratory bird and bat populations. We recommend UD to develop a research project to monitor and measure the effects of wind turbines on avian and bat species in the Delaware Coastal Bay. Please contact Craig Koppie of my staff at 410/573-4534 should you have any additional questions or concerns.

Sincerely,

for Leopoldo Miranda,
Field Office Supervisor

cc: Karen Bennett, DNREC

Comments from the U.S. Fish and Wildlife Service, Chesapeake Bay Ecological Field Office, Annapolis, MD 21401 in response to the Draft Environmental Assessment of the University of Delaware's Wind Energy Project, Lewes, Delaware

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1.1 NEPA and Related Procedures

The draft EA should identify and implement this Executive Order to protect migratory bird population as follows:

Executive Order 13186 - Established on January 10, 2001, identifies the responsibility of federal agencies to protect migratory birds and their habitats, and directs executive departments and agencies to undertake actions that will further implement the Migratory Bird Treaty Act. Executive Order 13186 includes a directive for federal agencies to develop a memorandum of understanding (MOU) with the Service to promote the conservation of migratory bird populations, including their habitats, when their actions have, or are likely to have, a measurable negative effect on migratory bird populations. Whereas the MBTA only protects migratory birds, Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. The Order encourages federal agencies to undertake several types of conservation actions for migratory birds including: avoiding or minimizing, to the extent practicable, adverse impacts to migratory bird resources when conducting agency activities;.........(*in part*)... and to inventory and monitor bird habitat and populations with the agency's capabilities and authorities to the extent feasible.

1.2.2 UD Purpose and Need

The purpose and need as indicated by the University does not articulate the type of research they anticipate to implement specific to wind energy. The Service recommends the following research priorities: 1) monitoring for avian and bat mortality, and 2) develop potential designs to reduce avian and bat mortality at land and off shore wind projects.

1.3.2. Department of Energy Actions

DoE did not involve all pertinent federal agencies *(i.e.,* U.S. Fish and Wildlife Service) until the project was completed, which greatly reduced opportunities to provide the full range of potential alternatives to reduce impacts to avian and bat populations from the onset. In the future, DOE needs to involve the Service during the preliminary scoping phase and not late in the process.

3.2 Biological Resources

3.2.1.1 Avian Species (Raptors)

We believe the draft EA dismisses the importance of the lower mouth of the Delaware Bay, near Lewes, as a continuing migration corridor from Cape May, NJ. It should be noted that there are several documented migration corridors throughout the United States. Within the eastern United

States, migratory birds follow natural topographic land features each spring and fall season as they trek to breeding or winter grounds in northern or southern latitudes. During these distinct periods, migratory birds follow the contours of mountain ridges and/or coastal bay shoreline formations. Birds migrating along the coast line, become more concentrated as they funnel toward the narrowing peninsula.

Within the mid-Atlantic region, two highly acclaimed bird passage areas have been monitored for decades, north and south of Lewes, Delaware. Many thousands of migrating songbirds and raptors are observed, counted and banded each year at the Cape May Bird Observatory at Cape May, New Jersey, north of Lewes. South of the Lewes Campus is an observation center located at the mouth of the Chesapeake Bay (Kiptopeake) near Cape Charles, Virginia. There, several thousand migratory birds including raptors are captured, banded and released each year, too. Previously banded birds have been encountered at both north and south banding stations over successive annual migration periods, substantiating the regular use of the migration corridor.

The UD wind tower is located near Cape Henlopen State Park at Lewes, Delaware, which is situated near the mouth of Delaware Bay. Birds traveling across the bay heading south from Cape May orient themselves to the nearest land point which is Cape Henlopen and adjacent areas including Lewes. Since 2002, bird counts have been conducted and systematically recorded at this location. Monthly and annual raptor counts at Cape Henlopen including Cape May and Kiptopeake can be found at **www.hawkcount.org**.

Species Protected Under the Bald and Golden Eagle Protection Act

The draft EA provides information specific to nesting bald eagles. According to information provided by DNREC, the nearest two nests are 3 to 5 miles from the wind turbine. We concur with DNREC that within the life of the turbine, there is the possibility of a nesting adult and/or their young to be killed by the wind turbine, especially if new nesting territories become established closer to the tower. Currently, there is not enough information on migratory bald and golden eagles in this area to determine potential frequency of mortality, if any, due to the wind turbine. The Service believes that annual (post construction) monitoring is necessary to determine mortality trends of migratory birds including eagles.

3.2.2 Environmental Consequences

3.2.2.1.2 Avian Mortalities

The southern Delaware Coastal Bay area near Lewes is a mix of inter-tidal marsh, low shrub and interspersed forest communities and open agricultural fields. These areas provide resting and feeding areas for migratory songbirds, raptors and waterfowl. The Service believes that migratory birds, including seasonal nesting birds, are vulnerable to mortality from collision with the rotor-swept area of the wind turbine. During the fall migration, the Service anticipates a higher level of mortality based on the increased numbers of birds moving through the area. Key periods of potential mortality are likely to occur during the months of September-early November as this the peak movement of the fall migration. Weather conditions and time of day play a role in the flight level in which migrating birds will travel near the wind turbine. Windy conditions and thermals during sunny days, present conditions favorable for high level soaring. However, birds are generally found at lower altitudes in the early and late afternoon hours of the day with a greater likelihood for collision. Raptor species such as merlins, peregrine falcon, sharp-shinned and Cooper's hawks are more likely to be injured or killed as they prey on smaller birds in and around vegetative cover. Low shrub and medium height forest stands create shelter for migratory birds which currently exist close to the active wind turbine.

3.2.2.1.3 Bat Mortalities

The Service concurs with the statement in the draft EA that bats would be killed at some level. We understand that DNREC is familiar with a wind energy project similar to UD's which is located in Atlantic City area of New Jersey's shoreline. It appears that the surveys conducted there have shown 58 dead bats of two species. Using this information, they modeled an estimated mortality of 46 bats per year. We recommend that UD review their model and post construction monitoring plan including information found on the Serivce's web link specific to development of an avian and bat protection plan at http://www.fws.gov.migbird/wind).

4.0 Cumulative Impacts

The Service and DNREC anticipate other entities to surface with interest to pursue alternative energy projects here in Delaware and other near and off-shore areas of Maryland and Virginia. The Delmarva peninsula has been documented as a major migration corridor during the fall and spring for many species of songbirds, shorebirds, raptors and waterfowl. Recently, Important Bird Areas have been designated throughout the mid-Atlantic States due to unique foraging and nesting habitat found in these areas which are essential for reproduction and their continued survival.

It is imperative that as we explore new energy alternatives, appropriate minimization and mitigation plans are developed to insure that cumulative impacts are curtailed to a level not considered adverse at the population level. In this manner, the Service may be able to asses a threshold for a maximum number of wind energy projects in an ecologically important region.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

September 24, 2010

Nancy M. Targett, Ph.D.
Dean, College of Earth, Ocean, and Environment
University of Delaware
111 Robinson Hall
Newark, DE 19716-3501

RE: *University of Delaware Wind Turbine in Lewes, DE*

Dear Dr. Targett:

Thank you for meeting with us on September 13, 2010 to discuss our concerns over bird and bat impacts from the operation of the 2.0-magawatt Gamesa wind turbine at the Lewes University of Delaware campus. We certainly support renewable energy sources such as windpower, and we acknowledge that the University will be conducting research and educating students with this turbine and future turbines to be erected in offshore waters of Delaware.

In an August 17, 2010 letter to the U.S. Department of Energy, we stated, "Because the wind turbine is now sited within a distinct migratory bird corridor of the Atlantic Flyway, there is an increased likelihood that mortality of migratory birds and bats will result." Because of this reason we did not support a Finding of No Significant Impact (FONSI) for the Draft Environmental Assessment.

After meeting and discussing our concerns with you and Dr. Firestone, we are encouraged by your willingness to monitor and evaluate impacts to bird and bat species as a result of this wind turbine project. As discussed in our meeting, if the University develops an Avian and Bat Protection Plan (ABPP) addressing monitoring and evaluation protocols and how the University will minimize impacts to bird and bats, the Service will be in a position to support a FONSI. This plan should outline an adaptive management approach for further minimization of impacts to bat and bird species if monitoring data shows "significant levels" of bird and bat mortality. The monitoring plan should also include clear methods, objectives, and timelines for post-construction monitoring.

During our meeting, you agreed to form an advisory group that would provide input in the development of this plan and would be comprised, at a minimum, of individuals from the Service, DNREC, and the University of Delaware. We strongly recommend that this group be

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officially formed within 30 days.

In addition to the development of an ABPP by the University, we recommend that the advisory group develops a future research plan that addresses some of the pending questions related to wildlife and windpower. We understand that, at this time, the University may not be able to make a commitment to conduct all of the research identified by this group but would consider implementing studies if funding was available. We will be glad to help you and the University with the development of future proposals and with the identification of potential funding sources to implement research projects.

If you have any questions don't hesitate to contact me at 410-573-4577 or Julie Slacum of my staff at 410-573-4517.

Sincerely,

Leopoldo Miranda
Supervisor

cc: Sarah W. Cooksey, Delaware Coastal Programs, Delaware Department of Natural Resources and Environmental Control
Scott Blake Harris, U.S. Department of Energy
Eugene Greg Moore, State of Delaware, Division of Fish and Wildlife

UNIVERSITY OF DELAWARE

COLLEGE OF EARTH, OCEAN, AND ENVIRONMENT

OFFICE OF THE DEAN

111 Robinson Hall
University of Delaware
Newark, DE 19716-3501 U.S.A.
Ph: 302/831-2841
Fax: 302/831-4389
E-Mail: ntargett@udel.edu
URL: www.ceoe.udel.edu

September 30, 2010

Dr. Leopoldo Miranda
Fish and Wildlife Service
United States Department of Interior
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

Dear Dr. Miranda,

Thank you very much for your letter of September 24 concerning the environmental assessment of University of Delaware's wind turbine in Lewes, Delaware. I want to reiterate that the University appreciates your comments on steps to be taken from here. Lest there be any misunderstanding, the University is committed to the following, as discussed during your visit to the Hugh R. Sharp campus in Lewes on 13 September 2010.

- **Avian and bat monitoring.** As you know, prior to construction of the turbine we commissioned an evaluation of the impact of a single turbine in the dredge spoil area adjacent to our campus. The conclusion of that evaluation was that we should not expect to have a population level impact on any avian species found in or migrating through the area. However, that evaluation recommended that, post-construction, there be an assessment of avian and bat impacts. That became our highest post-construction research priority and we have already committed funds to such a study. In August we reached out to Greg Shriver, a coastal bird specialist in the University's College of Agriculture and Natural Resources, to ask his help in developing and implementing a study plan/protocol. You may recall that, at our September 13 meeting, Greg Moore from the Division of Fish and Wildlife, Delaware Department of Natural Resources and Environmental Control, spoke highly of Dr. Shriver. We will begin the study no later than spring 2011.

- **Advisory group.** At our meeting I suggested that an advisory group would be helpful in providing guidance as we develop and implement the plan. It would also ensure a mechanism for formal communication around this issue. We plan to create such an advisory group. Its membership will include representatives from FWS and Delaware's DNREC. Other interested parties (such as the Delaware chapter of the Audubon Society) will be welcome to participate. DNREC has already designated Greg Moore as its representative to the group. I will be in contact with you to determine who from FWS should be included. The goal is to identify the group as soon as possible (but before the end of October) and to schedule the first meeting of the advisory group by mid-November. At the meeting the advisory group will be asked to comment on the draft plan for avian and bat monitoring and assessment. We can also hear an overview of the wind-wildlife conference that Jeremy Firestone is attending from 19-21 October.

Dr. Leopoldo Miranda
Page 2
September 30, 2010

- **Adaptive Management.** The original evaluation on avian impact suggested that the wind turbine would be well below any thresholds for population level avian and bat impact. As we collect and analyze the data, we will have seasonal place-based information that we can use to evaluate the actual impact (as opposed to projected impact). When we met, we talked about the fact that different species have different impact thresholds. The data collected through the study will allow us to evaluate this in a species specific way, and in consultation with FWS and the rest of the advisory group, to determine if species specific thresholds are being exceeded. If yes, we are prepared to institute adaptive management practices.

I look forward to working with the FWS as we move forward on this project. The UD coastal wind turbine provides an opportunity to conduct research on a host of issues relevant to the next generation of wind power technologies in the US and to provide real data assessments that will inform other projects. It is our hope and expectation that, in light of the commitments we made at our September 13 meeting and reiterate in this letter, the FWS will now support a Finding of No Significant Impact and will communicate that support to the United States Department of Energy so that the environmental assessment can be completed.

We thank you for your assistance and cooperation.

Sincerely,

Nancy M. Targett

Nancy Targett
Dean, College of Earth, Ocean, and Environment

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

November 3, 2010

Dr. Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

RE: Support of a FONSI for the Environmental Assessment for the University of Delaware Lewes Campus Wind Energy Project (DoE/EA-1782D)

Dear Dr. Summerson:

In our previous letter to you dated August 17, 2010, we stated that we could not support a Finding of No Significant Impact (FONSI) for the Environmental Assessment (EA) for the Delaware Lewes Campus Wind Energy Project due to potential impacts on birds and bats. On September 13, 2010 we met with Dr. Nancy Targett and Dr. Jeremy Firestone from the University of Delaware to discuss our issues and concerns about siting, constructing, and operating the wind turbine before consulting with the Fish and Wildlife Service (Service) under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

We requested that the University develop an Avian and Bat Protection Plan, addressing monitoring and evaluation protocols, and adaptive management. We also requested that there be an Advisory Group formed this winter, which would include representation from the Service, DNREC, and DE Audubon Society. This group would provide input in the development of the plan and would also assess whether minimization measures (curtailment) would need to be implemented as post construction data becomes available.

In a September 30, 2010 letter from the University of Delaware, they committed to develop an Avian and Bat Protection Plan, and have agreed to form an Advisory group by mid-November.
We believe that the University's commitment to do these things will enable us to support a FONSI for the draft EA developed for this project. If you have any questions feel free to call me at 410-573-4577 or Julie Slacum of my staff at 410-573-4517.

Sincerely,

Leopoldo Miranda

TAKE PRIDE IN AMERICA

Department of Energy
Washington, DC 20585

May 20, 2010

Mr. Kerry Holton, President
The Delaware Nation
P.O. Box 825
Anadarko, Oklahoma 73005

SUBJECT: University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

Dear Mr. Holton:

The U.S. Department of Energy (DOE) is proposing to provide funding to the University of Delaware (UD) to install a 2-megawatt wind turbine adjacent to the College of Earth, Ocean, and Environment campus located in Lewes, Delaware. The UD recently completed installation of the wind turbine, but DOE must fulfill its obligations under the *National Environmental Policy Act* (NEPA), the *National Historic Preservation Act*, and the *Native American Graves Protection and Repatriation Act* before a decision can be finalized on whether to provide funding in support of the project. This letter is to inform you of DOE's intent to prepare and release for public review an environmental assessment addressing the potential environmental consequences of the wind turbine action.

The wind turbine will be interconnected to the UD facility and will be used for research and development purposes as well as supplying electrical energy to the campus and electrical grid. Attachment 1 to this letter shows the location of the turbine on the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map. The hub of the wind generator is at a height of 262 feet above the ground surface. The diameter of the rotor is 295 feet; so the top of the rotor extends half that distance above the hub. The construction, or installation location is an existing dredge spoils area to the west of the UD campus. This is roughly 1,200 feet from the nearest campus facility, and further from any Lewes residences. Land disturbance at the turbine site includes a 3,200-square-foot octagonal foundation, a transformer, and a construction laydown area of roughly 200 by 100 feet in size.

The project site is accessible by an existing access road extending from Pilottown Road in the northeast to the wind turbine location. Some improvements to this road were necessary in order to transport the wind turbine and other components from Pilottown Road to the wind turbine location. At the completion of the project, the access road will either remain as is, or connect to a new road proposed by the State of Delaware that will run between the campus and the wind turbine and connect at Pilottown Road. The proposed new State road is being built to provide greater access to a boat launch and is not part of this proposed project. Attachment 2 provides two aerial views of the project site: the first shows the location of the University of Delaware campus in the general Lewes area, and the second shows a closer view of the campus and its relation to the wind turbine location.

DOE does not have any reason to believe the project would affect tribal resources or artifacts; however, the State Historic Preservation Officer has indicated there are nine archeological sites within one mile of the turbine location. None of these sites have been evaluated for their eligibility for the National Register. An environmental assessment currently is being prepared for this project to meet the requirements of the National Environmental Policy Act. A copy of the assessment will be sent to you for your review and comment.

DOE is initiating consultation and requesting information your tribe may have on properties of traditional religious and cultural significance within the vicinity of the UD Wind Energy Project and any comments or concerns you have on the potential for this Project to affect these properties. This information is being requested to aid in the preparation of the environmental assessment and to meet DOE's obligations under Section 106 of the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act of 1990. If you have any such information, require additional information, or have any questions or comments about the UD Wind Energy Project, please contact Jane Summerson of the DOE as soon as possible at the address listed in the signature block below.

Sincerely,

J Summerson PhD

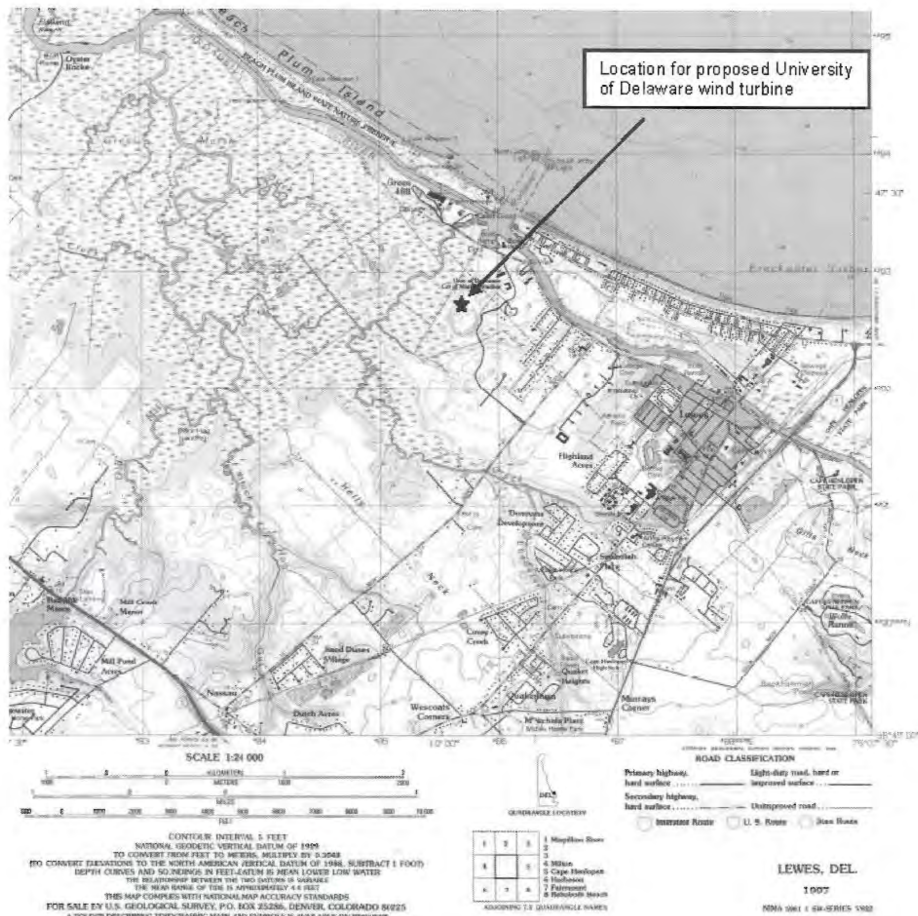
Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 340-9626
Jane.Summerson@EE.Doe.Gov

Attachments

1. Site Location Map
2. Aerial views of the Lewes, Delaware area and of the University of Delaware Campus

CC w/attachments: Ms. Tamara Francis, NAGPRA/Cultural Preservation Director
Delaware Nation
P.O. Box 825
Anadarko, OK 73005

Attachment 1: Site Location Map



Attachment 2: Aerial view of the Lewes, Delaware area

Aerial view of the University of Delaware Campus

From: Jason Ross <JRoss@delawarenation.com>
To: Summerson, Jane
Sent: Wed Jun 16 11:38:03 2010
Subject: re: Lewes Campus Onsite Wind Energy Project

Hello Ms. Summerson,

The Delaware Nation received information May 25th, 2010 regarding the project below.

University of Delaware â€“ Lewes Campus Onsite Wind Energy Project
Sussex County, Delaware

The Cultural Preservation Director, Ms. Tamara Francis has reviewed the project and has determined that the Delaware Nation will be a consulting party on this project and would like any updates you have on the project so that Ms. Francis can make a determination of the review.

The Delaware Nation commends you on taking the time and effort to consult, Also we look forward to working with you in order for the Department of Energy to complete this project in a timely manner.

Sincerely,

Jason Ross
Museum/Section 106 Assistant
Cultural Preservation Department
The Delaware Nation
P.O. Box 825
Anadarko, OK 73005
PH# 405) 247-2448
FAX# 405) 247-8905
www.delawarenation.com

Department of Energy
Washington, DC 20585

May 20, 2010

Mr. Robert Chicks, President
Stockbridge Munsee Community of Wisconsin
N8476 Moh-He-Con-Nuck Road
P.O. Box 70
Bowler, Wisconsin 54416

SUBJECT: University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

Dear Mr. Chicks:

The U.S. Department of Energy (DOE) is proposing to provide funding to the University of Delaware (UD) to install a 2-megawatt wind turbine adjacent to the College of Earth, Ocean, and Environment campus located in Lewes, Delaware. The UD recently completed installation of the wind turbine, but DOE must fulfill its obligations under the *National Environmental Policy Act* (NEPA), the *National Historic Preservation Act*, and the *Native American Graves Protection and Repatriation Act* before a decision can be finalized on whether to provide funding in support of the project. This letter is to inform you of DOE's intent to prepare and release for public review an environmental assessment addressing the potential environmental consequences of the wind turbine action.

The wind turbine will be interconnected to the UD facility and will be used for research and development purposes as well as supplying electrical energy to the campus and electrical grid. Attachment 1 to this letter shows the location of the turbine on the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map. The hub of the wind generator is at a height of 262 feet above the ground surface. The diameter of the rotor is 295 feet; so the top of the rotor extends half that distance above the hub. The construction, or installation location is an existing dredge spoils area to the west of the UD campus. This is roughly 1,200 feet from the nearest campus facility, and further from any Lewes residences. Land disturbance at the turbine site includes a 3,200-square-foot octagonal foundation, a transformer, and a construction laydown area of roughly 200 by 100 feet in size.

The project site is accessible by an existing access road extending from Pilottown Road in the northeast to the wind turbine location. Some improvements to this road were necessary in order to transport the wind turbine and other components from Pilottown Road to the wind turbine location. At the completion of the project, the access road will either remain as is, or connect to a new road proposed by the State of Delaware that will run between the campus and the wind turbine and connect at Pilottown Road. The proposed new State road is being built to provide greater access to a boat launch and is not part of this proposed project. Attachment 2 provides two aerial views of the project site: the first shows the location of the University of Delaware campus in the general Lewes area, and the second shows a closer view of the campus and its relation to the wind turbine location.

DOE does not have any reason to believe the project would affect tribal resources or artifacts; however, the State Historic Preservation Officer has indicated there are nine archeological sites within one mile of the turbine location. None of these sites have been evaluated for their eligibility for the National Register. An environmental assessment currently is being prepared for this project to meet the requirements of the National Environmental Policy Act. A copy of the assessment will be sent to you for your review and comment.

DOE is initiating consultation and requesting information your tribe may have on properties of traditional religious and cultural significance within the vicinity of the UD Wind Energy Project and any comments or concerns you have on the potential for this Project to affect these properties. This information is being requested to aid in the preparation of the environmental assessment and to meet DOE's obligations under Section 106 of the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act of 1990. If you have any such information, require additional information, or have any questions or comments about the UD Wind Energy Project, please contact Jane Summerson of the DOE as soon as possible at the address listed in the signature block below.

Sincerely,

J Summerson, PhD

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 340-9626
Jane.Summerson@EE.Doe.Gov

Attachments
1. Site Location Map
2. Aerial views of the Lewes, Delaware area and of the University of Delaware Campus

CC w/attachments: Ms. Sherry White, Tribal Historic Preservation Officer
W13447 Camp 14 Road
P.O. Box 70
Bowler, Wisconsin 54416

Note: Attachments to this letter were the same as those shown for The Delaware Nation letter and are not repeated here.

Stockbridge-Munsee Tribal Historic Preservation Office

Sherry White - Tribal Historic Preservation Officer
W13447 Camp 14 Road
P.O. Box 70
Bowler, WI 54416

TCNS#________________ DATE 5/25/10
PROJECT # University of Delaware Lewes Campus, Wind Project
COMPANY NAME Department of Energy

ADDITIONAL INFORMATION NEEDED

- ________Site visit by Tribal Historic Preservation Officer
- ________Archeological survey, phase 1
- ________Literature/record search including colored maps
- ________Pictures of site
- ________SHPO report
- ________Project does not appear to endanger archaeological sites of interest to the Stockbridge-Munsee Tribe.
- ___X___Out of area

Has site been previously disturbed? _____ Yes _____ No

If yes, to what extent and when? ______________________

Will the proposed action adversely affect properties listed, or eligible for, listing on the National Register of Historic Places? (buildings, archaeological sites; objects of significance to a Tribe including graves, funerary objects, and traditional cultural properties) _____ Yes _____ No

Should this project inadvertently uncover a Native American site, even after an archaeological survey or if there is a change to the project, we ask that you halt all construction and notify the Stockbridge-Munsee Tribe immediately.

Sincerely,

Sherry White

Sherry White
Tribal Historic Preservation Officer

(715) 793-3970 Email: sherry.white@mohican-nsn.gov

Department of Energy
Washington, DC 20585

May 20, 2010

Chief Dennis Coker
Lenape Indian Tribe of Delaware, Inc.
Lenape Indian Cultural Center
4164 North DuPont Highway
Dover, Delaware 19901

SUBJECT: University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

Dear Chief Coker:

The U.S. Department of Energy (DOE) is proposing to provide funding to the University of Delaware (UD) to install a 2-megawatt wind turbine adjacent to the College of Earth, Ocean, and Environment campus located in Lewes, Delaware. The UD recently completed installation of the wind turbine, but DOE must fulfill its obligations under the *National Environmental Policy Act* (NEPA), the *National Historic Preservation Act*, and the *Native American Graves Protection and Repatriation Act* before a decision can be finalized on whether to provide funding in support of the project. This letter is to inform you of DOE's intent to prepare and release for public review an environmental assessment addressing the potential environmental consequences of the wind turbine action.

The wind turbine will be interconnected to the UD facility and will be used for research and development purposes as well as supplying electrical energy to the campus and electrical grid. Attachment 1 to this letter shows the location of the turbine on the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map. The hub of the wind generator is at a height of 262 feet above the ground surface. The diameter of the rotor is 295 feet; so the top of the rotor extends half that distance above the hub. The construction, or installation location is an existing dredge spoils area to the west of the UD campus. This is roughly 1,200 feet from the nearest campus facility, and further from any Lewes residences. Land disturbance at the turbine site includes a 3,200-square-foot octagonal foundation, a transformer, and a construction laydown area of roughly 200 by 100 feet in size.

The project site is accessible by an existing access road extending from Pilottown Road in the northeast to the wind turbine location. Some improvements to this road were necessary in order to transport the wind turbine and other components from Pilottown Road to the wind turbine location. At the completion of the project, the access road will either remain as is, or connect to a new road proposed by the State of Delaware that will run between the campus and the wind turbine and connect at Pilottown Road. The proposed new State road is being built to provide greater access to a boat launch and is not part of this proposed project. Attachment 2 provides two aerial views of the project site: the first shows the location of the University of Delaware campus in the general Lewes area, and the second shows a closer view of the campus and its relation to the wind turbine location.

DOE does not have any reason to believe the project would affect tribal resources or artifacts; however, the State Historic Preservation Officer has indicated there are nine archeological sites within one mile of the turbine location. None of these sites have been evaluated for their eligibility for the National Register. An environmental assessment currently is being prepared for this project to meet the requirements of the National Environmental Policy Act. A copy of the assessment will be sent to you for your review and comment.

DOE is initiating consultation and requesting information your tribe may have on properties of traditional religious and cultural significance within the vicinity of the UD Wind Energy Project and any comments or concerns you have on the potential for this Project to affect these properties. This information is being requested to aid in the preparation of the environmental assessment and to meet DOE's obligations under Section 106 of the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act of 1990. If you have any such information, require additional information, or have any questions or comments about the UD Wind Energy Project, please contact Jane Summerson of the DOE as soon as possible at the address listed in the signature block below.

Sincerely,

J. Summerson PhD

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 340-9626
Jane.Summerson@EE.Doe.Gov

Attachments

1. Site Location Map
2. Aerial views of the Lewes, Delaware area and of the University of Delaware Campus

Note: Attachments to this letter were the same as those shown for The Delaware Nation letter and are not repeated here.

LENAPE INDIAN TRIBE OF DELAWARE

August 17, 2010

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
1000 Independence Ave., SW
Washington, DC 20585

Attn: Dr. Jane Summerson
Re: UD Wind Energy Project Draft EA Comments

Thank you for the opportunity to comment on the above referenced project.

The historic record confirms the area in question is rich in American Indian culturally sensitive materials including ancestral burials. It is hard to imagine the Lenape were not drawn to this site for reasons including worship and resource gathering.

Since this project has already been completed, I assume that sensitive materials were not uncovered or disturbed during the construction process.

We share your agency's concern for our winged brothers and sisters. It is virtually impossible to hold an Eagle in high regard and then not honor the Eagle's habitat. I disagree with the reports assessment that "There is currently no reason to believe that tribes that have a current or historic presence near the University Wind Energy Project site consider eagle habitation (which includes eagles and eagle nests) sacred." Some Lenape men wore a single Eagle feather in their headdress to display their reverence for this magnificent creation.

If I can be of further assistance to you in this matter, please do not hesitate to contact me. I can be reached at 302-730-4601 or lenapedelaware@comcast.net.

Wani'shi (thank you),

Dennis J. Coker

Dennis J. Coker, Chief
Lenape Indian Tribe of Delaware

P.O. Box 79, Cheswold, Delaware 19936

Department of Energy
Washington, DC 20585

October 18, 2010

Dennis J. Coker, Chief
Lenape Indian Tribe of Delaware
P.O. Box 79
Cheswold, Delaware 19936

Dear Chief Coker,

The U.S. Department of Energy (DOE) respectfully thanks you for your review and comment on the *Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project* (DOE/EA-1782D). The input that you provided to the Department in your August 17, 2010, letter, has been very helpful in DOE's effort to fully identify properties of traditional religious and cultural significance within the vicinity of the University of Delaware Wind Energy Project. Your willingness to share this information has assisted DOE in meeting its responsibilities under Section 106 of the *National Historic Preservation Act* and the *Native American Graves Protection and Repatriation Act of 1990*. Please be assured that DOE will take all information you have provided through our consultation seriously in making the Department's funding decision.

DOE is currently in the process of completing its final Environmental Assessment (EA) of the *University of Delaware, Lewes Campus Onsite Wind Energy Project*. DOE has prepared this EA pursuant to its obligations under the *National Environmental Policy Act* (NEPA) to evaluate the environmental impacts of providing Federal financial assistance to the University of Delaware (UD) for an onsite wind turbine (Wind Energy Project) adjacent to the College of Earth, Ocean, and Environment Campus located in Lewes, Delaware. The purpose of this letter is to allow DOE to respond to concerns from your August 17, 2010, letter with regard to potential effects on resources of traditional, religious or cultural importance to the Lenape Tribe and to inform you that DOE will require as a condition of funding that UD implement a monitoring and adaptive management plan for reducing impacts to wildlife and, in particular, to eagles.

As you are aware from your July 2010 review, the Draft EA analyzed impacts that occurred during construction of the wind turbine as well as potential environmental impacts that may occur during the turbine's operation. At the time the Draft EA was finalized, the University of Delaware had already completed construction of a single, 2-megawatt wind turbine and associated project components (including a transformer and construction pad) in an existing dredge spoils area adjacent to the campus; construction of an access road to the turbine site; and installation of an underground electric conduit directly into University facilities.

In response to your first concern, DOE can confirm that no sensitive materials were uncovered or disturbed during the construction of the UD Wind Energy Project. As part of the Section 106 consultation process, archaeologists from the Delaware State Historic Preservation Office (SHPO) conducted two site visits (following construction) in May and July 2010 in order to ascertain that no adverse impacts to archaeological resources resulted from the construction of the wind turbine and its access road or from installation of its utility connection. The Delaware SHPO confirmed by letter dated May 24, 2010 and July 19, 2010 that neither activity disturbed archaeological resources.

In response to your second concern, because the Wind Energy Project is located near important salt marsh habitat, DOE/EA-1782 addresses the potential impacts to raptors, including eagles, as well as other birds. Potential adverse impacts to birds, and specifically to eagles, are of particular importance to the Department due to the biological importance of this wildlife as well as due to the importance that eagles or eagle's nests hold in the cultural and religious traditions of American Indian Tribes. The potential impacts to eagles is also of particular importance to DOE's Section 106 consultation effort because eagles or eagles nests, or both, may potentially be sacred sites to American Indian Tribes, thus making the landscape associated with them eligible for the National Register and subject to protection under Section 101(d)(6)(a) of the NHPA.

Because of the uncertainty about potential impacts to birds and bats by the operating wind turbine generally, and in an effort to minimize impacts to eagles, which are religiously and culturally significant to the Lenape people, DOE will require as a condition of funding that UD implement a monitoring and adaptive management plan for reducing impacts to wildlife. The implementation of an adaptive management plan would enable adjustments in the operation of the wind turbine should eagle mortality be observed at the UD turbine site. The monitoring and adaptive management plan will be developed jointly with the University, US FWS, Delaware Department of Natural Resources and Environmental Control, and nongovernmental conservation groups interested in the Federal undertaking. DOE believes that holding the University to this standard will result in the minimization of potential adverse effects to eagles and their nests, and will thus provide sufficient protection to the landscape associated with eagle habitation as sacred site under Section 101(d)(6)(a) of the NHPA.

With regard to the *Bald and Golden Eagle Protection Act*, the U.S. Fish and Wildlife Service (US FWS) has indicated that if the project could not avoid disturbance to the bald eagle, a proposed permit program, authorizing the take of bald or golden eagles under specific conditions, may be available to UD once the Service has issued a final rule.

If you have concerns related to this letter, please contact me at Jane.Summerson@EE.doe.gov or 202-340-3626. DOE will provide you with a copy of the final EA for the UD wind turbine project once finalized. Please accept my sincere gratitude for your continued assistance in this effort.

Sincerely,

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Department of Energy
Washington, DC 20585

May 20, 2010

Chief Herman T. Robbins
Nanticoke Indian Association, Inc.
27073 John J. Williams Hwy.
Millsboro, Delaware 19966

SUBJECT: University of Delaware – Lewes Campus Onsite Wind Energy Project, Sussex County, Delaware

Dear Chief Robbins:

The U.S. Department of Energy (DOE) is proposing to provide funding to the University of Delaware (UD) to install a 2-megawatt wind turbine adjacent to the College of Earth, Ocean, and Environment campus located in Lewes, Delaware. The UD recently completed installation of the wind turbine, but DOE must fulfill its obligations under the *National Environmental Policy Act* (NEPA), the *National Historic Preservation Act*, and the *Native American Graves Protection and Repatriation Act* before a decision can be finalized on whether to provide funding in support of the project. This letter is to inform you of DOE's intent to prepare and release for public review an environmental assessment addressing the potential environmental consequences of the wind turbine action.

The wind turbine will be interconnected to the UD facility and will be used for research and development purposes as well as supplying electrical energy to the campus and electrical grid. Attachment 1 to this letter shows the location of the turbine on the U.S. Geological Survey's Lewes Quadrangle, 7.5 Minute Series map. The hub of the wind generator is at a height of 262 feet above the ground surface. The diameter of the rotor is 295 feet; so the top of the rotor extends half that distance above the hub. The construction, or installation location is an existing dredge spoils area to the west of the UD campus. This is roughly 1,200 feet from the nearest campus facility, and further from any Lewes residences. Land disturbance at the turbine site includes a 3,200-square-foot octagonal foundation, a transformer, and a construction laydown area of roughly 200 by 100 feet in size.

The project site is accessible by an existing access road extending from Pilottown Road in the northeast to the wind turbine location. Some improvements to this road were necessary in order to transport the wind turbine and other components from Pilottown Road to the wind turbine location. At the completion of the project, the access road will either remain as is, or connect to a new road proposed by the State of Delaware that will run between the campus and the wind turbine and connect at Pilottown Road. The proposed new State road is being built to provide greater access to a boat launch and is not part of this proposed project. Attachment 2 provides two aerial views of the project site: the first shows the location of the University of Delaware campus in the general Lewes area, and the second shows a closer view of the campus and its relation to the wind turbine location.

DOE does not have any reason to believe the project would affect tribal resources or artifacts; however, the State Historic Preservation Officer has indicated there are nine archeological sites within one mile of the turbine location. None of these sites have been evaluated for their eligibility for the National Register. An environmental assessment currently is being prepared for this project to meet the requirements of the National Environmental Policy Act. A copy of the assessment will be sent to you for your review and comment.

DOE is initiating consultation and requesting information your tribe may have on properties of traditional religious and cultural significance within the vicinity of the UD Wind Energy Project and any comments or concerns you have on the potential for this Project to affect these properties. This information is being requested to aid in the preparation of the environmental assessment and to meet DOE's obligations under Section 106 of the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act of 1990. If you have any such information, require additional information, or have any questions or comments about the UD Wind Energy Project, please contact Jane Summerson of the DOE as soon as possible at the address listed in the signature block below.

Sincerely,

R Summerson PhD

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 340-9626
Jane.Summerson@EE.Doe.Gov

Attachments

1. Site Location Map
2. Aerial views of the Lewes, Delaware area and of the University of Delaware Campus

Note: Attachments to this letter were the same as those shown for The Delaware Nation letter and are not repeated here.

Department of Energy
Washington, DC 20585

July 22, 2010

Chief Jerry L. Douglas
Delaware Tribe of Indians
170 NE Barbara
Bartlesville, Oklahoma 74006

Dear Chief Douglas:

Enclosed is the U.S. Department of Energy's (DOE's) *Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project* (DOE/EA-1782D) for your review and comment.

DOE prepared this Draft Environmental Assessment (EA) pursuant to its obligations under the *National Environmental Policy Act* to evaluate the environmental impacts of providing Federal financial assistance to the University of Delaware. DOE proposes to provide $2.43 million to the University of Delaware for an onsite wind turbine adjacent to the College of Earth, Ocean, and Environment Campus located in Lewes, Delaware. This Draft EA analyzes the impacts that occurred during construction of the wind turbine and potential environmental impacts that might occur during the turbine's operation.

At the time this Draft EA was finalized, the University of Delaware had already completed the wind turbine installation. The University constructed a single, 2-megawatt wind turbine and installed associated project components (for example, electrical line, transformer, and construction pad) in an existing dredge spoils area adjacent to the campus. The location of the turbine, on the northwest edge of the City of Lewes, is shown in Figures 2-1 and 2-2 in the Draft EA. The project site is accessible by an existing access road from Pilottown Road (to the north), extending south to the wind turbine location.

The wind turbine interconnects directly into University facilities with underground electrical conduit, and the turbine's operation will include use for research and development purposes as well as providing electrical energy to the University campus and the local electrical grid. The hub of the wind generator is 262 feet above the ground surface and the diameter of the rotor is 295 feet, so the total maximum height of the turbine measured from the top of the rotor to the ground is 410 feet. Land disturbance at the turbine site includes a 3,200-square-foot octagonal foundation, a transformer, and a construction lay down area of approximately 200 by 100 feet in size.

In this draft EA, DOE evaluated potential impacts to surface water; biological, cultural, aesthetic, and visual resources; occupational and public safety and health; noise; utilities, energy, and materials; and transportation. DOE's analysis found that there may be potential impacts in the following areas:

- The wind turbine's presence and operation could result in occasional bird and bat collisions and fatalities.
- Some individuals may be located in areas of shadow flicker generated by the wind turbine when sun angles are low.
- Some individual may be able to discern the unique sounds generated by a wind turbine.

DOE does not have reason to believe the project affects tribal resources or artifacts; however, the State Historic Preservation Officer has indicated there are nine archaeological sites within 1 mile of the turbine location, and upon inspection of the project site, has verified that the wind turbine project did not disturb any archeological resources. None of these sites has been evaluated for eligibility for the National Register.

DOE, therefore, respectfully asks for information that your tribe might have on properties of traditional religious and cultural significance within the vicinity of the University of Delaware Wind Energy Project and any comments or concerns you have on the potential for this project to affect these properties. This information is being requested to meet DOE's responsibilities under Section 106 of the *National Historic Preservation Act* and the *Native American Graves Protection and Repatriation Act of 1990*. Please be assured that DOE values your input and will take into consideration all information you provide in preparation of the final EA and in making the funding decision.

In addition, DOE has a specific request for Indian tribes with current or historic interest in the project location. Is there any reason your tribe might consider the landscape of the wind turbine a potential historic property of religious and cultural importance due to eagle habitation in the area?

DOE currently has no reason to believe this is a concern for the wind turbine site, but is asking you to identify whether eagle habitation in the project area is sacred to you. DOE is also inviting you and all interested parties to comment on the enclosed draft EA. The draft EA outlines the public comment period as beginning June 18, 2010 and ending July 18, 2010. Please note that DOE has extended the public comment period to August 17, 2010. Comments received after the close of the comment period will be considered to the extent practicable.

Chief Jerry L. Douglas letter -3-

If you have information on the religious and cultural significance of the project site you would be willing to share, require additional information, or have any questions or comments about the UD Wind Energy Project, please contact Jane Summerson of the DOE as soon as possible at the address listed in the signature block below. If you would like to comment on the Draft EA, comments can be submitted via email to Jane.Summerson@ee.doe.gov, by letter to Dr. Jane Summerson at the address below, or by fax to 1-202-586-8177. Envelopes and the subject line of emails and faxes should be labeled "UD Wind Energy Project Draft EA Comments."

Sincerely

Jane K. Summerson

Jane Summerson
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
(202) 340-9626
Jane.Summerson@ec.doe.gov

Attachment
Draft Environmental Assessment of the University of Delaware Lewes Campus Onsite Wind Energy Project (Draft EA; DOE/EA-1782D)

cc w/attachment: Dr. Brice Obemeyer, NAGPRA Representative/Cultural Resources Contact
Delaware Tribe of Indians
170 NE Barbara
Bartlesville, Oklahoma 74006

Delaware Tribe of Indians
170 NE Barbara
Bartlesville, Oklahoma 74006
(918) 336-5272 FAX (918) 337-6591

August 4, 2010

Jane Summerson
Office of Energy Efficient and Renewable Energy
U.S. Dept. of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Re: UD Wind Energy Project Draft EA Comments

Dear Jane Summerson:

Thank you for informing the Delaware Tribe on the proposed construction and providing us with the archaeological survey report associated with the above referenced project. Our review indicates that there are no religious or culturally significant sites in the project area. As such, we defer comment to your office as well as to the State Historic Preservation Office and/or the State Archaeologist.

We wish to continue as a consulting party on this project and we ask that if any human remains are accidentally unearthed during the course of the construction project that you cease development immediately and inform the Delaware Tribe of Indians of the inadvertent discovery.

If you have any questions, please feel free to contact this office by phone at (918) 335-7026 or by e-mail at bobermey@emporia.edu.

Sincerely,

Brice Obermeyer

Brice Obermeyer
Delaware Tribe Historic Preservation Office
1417 West St
Emporia, KS 66801

Appendix C
Common and Scientific Names of Plants and Animals

This appendix contains the common and scientific names of plants and animals identified in Section 3.2, Biological Resources, of the EA

Plants	
Cordgrass	*Spartina spp.*
seabeach amaranth	*Amaranthus pumilus*
swamp pink	*Helonius bullata*
white cedar	*Chamaecyparis thyoides*
wild indigo	*Baptisia spp.*
Insects	
frosted elfin	*Incisalia irus*
little white tiger beetle	*Cicindela lepida*
rare skipper	*Problema bulenta*
white tiger beetle	*Cincindela doralis*
Reptiles	
Corn snake	*Elaphe guttata*
Amphibians	
barking treefrog	*Hyla gratiosa*
eastern tiger salamander	*Ambystoma tigrinum*
Birds	
American black duck	*Anis rubripes*
American kestrel	*Falco sparverius*
American robin	*Turdus migratorius*
bald eagle	*Haliaeetus leucocephalus*
Baltimore oriole	*Icterus galbula*
barn owl	*Tyto alba*
barred owl	*Strix varia*
black-crowned night-heron	*Nycticorax nycticorax*
brown thrasher	*Toxostoma rufum*
Canada goose	*Branta canadensis*
Clapper rail	*Rallus longirostris*
common grackle	*Quiscalus quiscula*
Cooper's hawk	*Accipiter cooperii*
eastern kingbird	*Tyrannus tyrannus*
eastern towhee	*Pipilo erythrophthalmus*

European starling	*Sturnus vulgaris*
field sparrow	*Spizella pusilla*
herring gull	*Larus argentatus*
marsh wren	*Cistothorus palustris*
merlin	*Falco columbarius*
northern harrier	*Circus cyaneus*
northern pintail	*Anas acuta*
Osprey	*Pandion haliaetus*
peregrine falcon	*Falco peregrinus*
piping plover	*Charadrius melodus*
prairie warbler	*Dendroica discolor*
red knot	*Calidris canutus*
red-shouldered hawk	*Buteo lineatus*
red-winged blackbird	*Agelaius phoeniceus*
ring-billed gull	*Larus delawarensis*
ruddy turnstone	*Arenaria interpres*
saltmarsh sparrow	*Ammodramus caudacutus*
seaside sparrow	*Ammodramus maritimus*
sharp-skinned hawk	*Accipiter striatus*
swamp sparrow	*Melospiza georgiana*
turkey vulture	*Cathartes aura*
Willet	*Trigna semipalmata*
willow flycatcher	*Empidonax traillii*
yellow-breasted chat	*Icteria virens*
yellow-crowned night-heron	*Nyctanassa violacea*

Mammals

big brown bat	*Eptescifus fuscus*
Dellmarva Peninsula fox squirrel	*Sciurus niger cinereus*
eastern red bat	*lasiurus borealis*
eastern small-footed bat	*Myotis leibii*
evening bat	*Nycticeius humeralis*
horary bat	*Lasiurus cinereus*
little brown bat	*Myotis lucifugus*
northern long-eared bat	*Myotis septentrionalis*
silver-haried bat	*lasionycteris noctivagans*
tri-colored bat	*Perimyotis subflavous*

Appendix D
Phase I Avian Risk Assessment

PHASE I AVIAN RISK ASSESSMENT

University of Delaware Wind Turbine Project

Sussex County, Delaware

Report Prepared for:

University of Delaware

January 2010

Report Prepared by:

Paul Kerlinger, Ph.D. and John Guarnaccia

Curry & Kerlinger, LLC
P.O. Box 453
Cape May Point, NJ 08212
(609) 884-2842, fax 884-4569
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Phase I Avian Risk Assessment

University of Delaware Wind Turbine Project

Sussex County, Delaware

Executive Summary

The University of Delaware is proposing to construct a single, utility scale wind turbine at its campus in Lewes, Sussex County. This turbine will likely have a hub height of about 80 m (262 feet) above ground level (agl) and a rotor diameter of about 90 m (295 feet). Thus, the rotor tip would sweep as high as about 125 m (410 feet) agl, and as low as about 35 m (115 feet) agl. The turbine would be mounted on a steel tubular tower and would probably be lit with an L-864 flashing-red light (Federal Aviation Administration [FAA]) mounted on the nacelle at a height of about 82 m (269 feet) agl. The electrical line from the turbine would likely be underground, connecting to an above ground distribution line nearby.

This report details a Phase I Avian Risk Assessment of the University of Delaware Wind Turbine Project (hereafter referred to as the "Project"). Its purpose is to determine the potential for displacement and collision impacts to birds from the construction and operation of the Project. The risk-assessment is informed by: 1) a site visit, 2) a literature search, and 3) written consultations with the U.S. Fish and Wildlife Service (USFWS) and the Delaware Division of Fish and Wildlife (DDFW) regarding special-status species[1] and other wildlife concerns.

The wind turbine would be constructed in flat terrain on what appears to be barren fill bordering a 10-acre (4-ha) patch of disturbed shrubby woodland. An extensive salt marsh of many hundreds of acres is about 200 feet (60 m) from the turbine base. Tidal creeks and rivers are found within 0.5 miles (0.8 km) of the Project site, notably, Canary Creek to the west, the Broadkill River to the north, and the Lewes and Rehoboth Canal to the east. These creeks and rivers connect to Delaware Bay through the Roosevelt Inlet, located about 0.5 miles (0.8 km) north of the site. Cape Henlopen and the Atlantic Ocean are located about 4 miles (6.4 km) east of the site.

The site visit's assessment of habitat and analyses of Breeding Bird Atlas (BBA) and Breeding Bird Survey (BBS) data indicate that no Delaware-endangered species is expected to nest in the vicinity of the proposed turbine, but a number of endangered species may forage near or fly in the vicinity of the turbine. These include Black-crowned Night-Heron, Yellow-crowned Night-Heron, Bald Eagle, Northern Harrier, American Oystercatcher (also ***Yellow WatchList***), Common Tern, Forster's Tern, Least Tern (also federally endangered and ***Red WatchList***), and Black Skimmer (also ***Yellow WatchList***). Species of Greatest Conservation Need (SGCN) foraging or flying near the proposed turbine during the breeding season would be limited to raptors, saltmarsh specialists, and shrubland/edge species. These Black Vulture, Osprey, Red-shouldered

[1] These would be species listed federally and in Delaware as endangered or threatened, and species featured in the Delaware Wildlife Action Plan (DWAP) as Species of Greatest Conservation Need (SGCN, tiers 1 and 2). We also track ***WatchList*** species; see the discussion in Section 4.1.

Hawk, Peregrine Falcon, and Barn Owl among raptors; American Black Duck, Clapper Rail (***Yellow WatchList***), Willet, Marsh Wren, Saltmarsh Sparrow (also ***Red WatchList***), Seaside Sparrow (also ***Red WatchList***), and the coastal race of Swamp Sparrow among saltmarsh specialists; and Willow Flycatcher (also ***Yellow WatchList***), Eastern Kingbird, Brown Thrasher, Prairie Warbler (also ***Yellow WatchList***), Yellow-breasted Chat, Eastern Towhee, Field Sparrow, and Baltimore Oriole among shrubland/edge species.

Regarding migration, songbirds are expected to migrate nocturnally on broad fronts above the Project site, with most birds flying well above the sweep of wind-turbine rotors. In fall migration, however, fallout events may occasionally concentrate night-migrating songbirds in coastal woodland habitats, including the shrubland near the proposed turbine. Given that the Project site is inland and that coastal woodlands and shrublands are well distributed along the Delaware coastal plain, the limited shrubland at the Project site is not expected to attract particularly large numbers of songbird migrants.

Concentrated raptor migration has been documented in fall at Cape Henlopen, with Sharp-shinned Hawk and Osprey (both SGCN-1) most abundant. The Project site is sufficiently inland from Cape Henlopen and barrier beaches to be off the main raptor migration path, but migrating Osprey, Sharp-shinned Hawks, falcons, and other species may hunt in the vicinity of the proposed turbine.

Delaware Bay is of hemispheric importance as a staging site for Ruddy Turnstone (SGCN-1), Red Knot (SGCN-1 and ***Yellow WatchList***), Sanderling (SGCN-1 and ***Yellow WatchList***), and Semipalmated Sandpiper (***Yellow WatchList***) in spring migration. They mostly forage for horseshoe crab eggs in Delaware Bay, but they also forage and roost in saltmarshes. Nonetheless, given the location of the proposed turbine adjacent to the saltmarsh zone and slightly inland of Delaware Bay and the Atlantic Ocean, it is likely that relatively small numbers of these shorebirds, or other coastally migrating waterbirds, will fly in the vicinity of the turbine.

Christmas Bird Count (CBC) data indicate that Snow Geese are extremely abundant winter visitors in the Cape Henlopen-Prime Hook region. As they feed in saltmarshes, they will at times frequent the vicinity of the proposed turbine and probably attract endangered Bald Eagle to prey on them. Northern Harrier (Delaware endangered as a breeder) will also frequent adjacent marshes in winter, and the endangered Forster's Tern may occasionally forage there too.

The Project site is located in the Delaware Coastal Zone, which Delaware Audubon has classified as an Important Bird Area (IBA). The Project site is also located between Prime Hook National Wildlife Refuge and Cape Henlopen State Park, which the American Bird Conservancy (ABC) has classified as IBAs. The IBA descriptions emphasize the importance of Delaware Bay to the special-status shorebirds mentioned above that stage there in spring migration, and to a number of special-status breeders. Nonetheless, the Project site is not located immediately on Delaware Bayshore where the shorebirds concentrate, and it lacks habitats that would attract large numbers of special-status breeding birds.

Regarding displacement risk, biologically significant impacts are not indicated for any species likely to inhabit the Project site and vicinity because the likeliest species have large populations that have withstood significant environmental disturbance. Possible exceptions would be endangered species, because they have small populations and generally require less disturbed habitats. However, data sources indicate that no endangered species is likely to nest close enough to the proposed turbine to be displaced by it.

Regarding collision risk fatality numbers and species impacted are likely to be similar, on a per turbine per year basis, to those found at Eastern U.S. wind farms. Those fatalities are not likely to be biologically significant because they will be distributed among various species. Collision risk to night-migrating songbirds is likely to be similar to other sites examined because migration occurs on broad fronts at altitudes mostly above the rotor-swept zone; in addition, habitat at the Project site is unlikely to attract large numbers of songbirds in coastal fallout events. Collision risk factors for raptors appear to be minimal, given that raptor abundance is generally low, the Project is removed from coastal migration paths, and the topography of the proposed turbine site does not favor habitual soaring. The Project may incur greater waterbird mortality, particularly among gulls, than inland wind farms because of its coastal location. Among listed species, the Delaware-endangered Bald Eagle may be at minor risk of collision risk, a result of the fact that some eagles may hunt Snow Geese and other waterbirds in the saltmarsh near the turbine.

Because the Project will consist of only one turbine, impacts are likely to be minimal and not biologically significant. The basis for this statement is the information gathered during this study combined with the fact that no wind power project in the U.S. has proven to have significant impacts to birds, with the possible exception of a 5,400 turbine project in California. Thus, it is improbable that the University of Delaware single turbine project will result in significant impacts to birds.

The Delaware Natural History and Endangered Species Program (NHESP) has commented on the Project in a letter dated 31 August 2009 from the Delaware Department of Natural Resources and Environmental Control (DNREC) to the University of Delaware. NHESP is on record as saying that this one-turbine Project is a good opportunity to study the impacts of wind energy on birds and bats. It finds the Project site (which we assume to be Location 1) to have the least potential for environmental impacts than five other proposed sites because it is surrounded by less woodland that would attract night-migrating songbirds, it is likely to result in the fewest impacts to adjacent wetlands, and it is distant from suitable nesting and roosting habitat for beach-nesting birds. NHESP requests a plan to reduce and minimize collisions and other threats to birds prior to construction in the event a major impact occurs. The letter does not define "major impacts." It also recommends that the site be studied both pre- and post-construction to assess impacts fully.

The following recommendations are designed to improve the assessment of, and minimize, avian risk.

Pre-construction Studies

- A seasonal flight-use study may be considered, although the project is so small as to make impacts minimal and, therefore, preconstruction studies cannot predict risk precisely or reliably. Such a study would measure flight use of the site (particularly at altitudes equivalent to the rotor-swept zone) by raptors, waterbirds, and landbirds, paying particular attention to the endangered Bald Eagle and other special-status species.

Construction Guidelines

- Electrical lines within the Project site should be underground. Any new above-ground lines from the site to a substation or transmission line should follow Avian Power Line Interaction Committee (APLIC) guidelines for insulation, spacing, and obstruction marking.
- Permanent meteorology towers, if any are proposed, should be freestanding (i.e., without guy wires) to prevent the potential for avian collisions.
- Size of roads and turbine pads should be minimized to disturb as little habitat as possible. After construction, the area around the turbine should be maintained as mowed lawn to facilitate a mortality study.
- Lighting of turbines and other infrastructure should be minimal to reduce potential for attracting night-migrating songbirds and other species. Federal Aviation Administration (FAA) night-obstruction lighting should only be flashing beacons (L-864 red or white strobe [or LED], or red-flashing L-810) with the longest permissible off cycle. Steady-burning (L-810) red FAA lights should not be used. Sodium vapor lamps and spotlights should not be used at any facility (e.g., lay-down area or substation) at night except when emergency maintenance is needed.

Post-construction Studies

- A mortality study following best practices should be conducted over a two-year period, with the second year contingent on what is found during the first year. In other words, if fatalities in the first year are construed as biologically significant, a second year of study would be conducted.
- Results of the mortality study should be compared with cradle-to-grave (life-cycle) cumulative impacts to birds from other types of power generation now supplying electricity in Delaware. This comparison would facilitate long-term planning with respect to electrical generation and wildlife impacts. The study should seek information from USFWS, DDFW, and environmental organizations regarding existing energy-generation impacts to wildlife in Delaware. If information is not available, these agencies and organizations should consider funding such studies.

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Figures

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Appendices

Figure 1. Project location in Delaware. Note location of ACUA wind farm discussed in Section 7.2.

Figure 2. Project location in Sussex County.

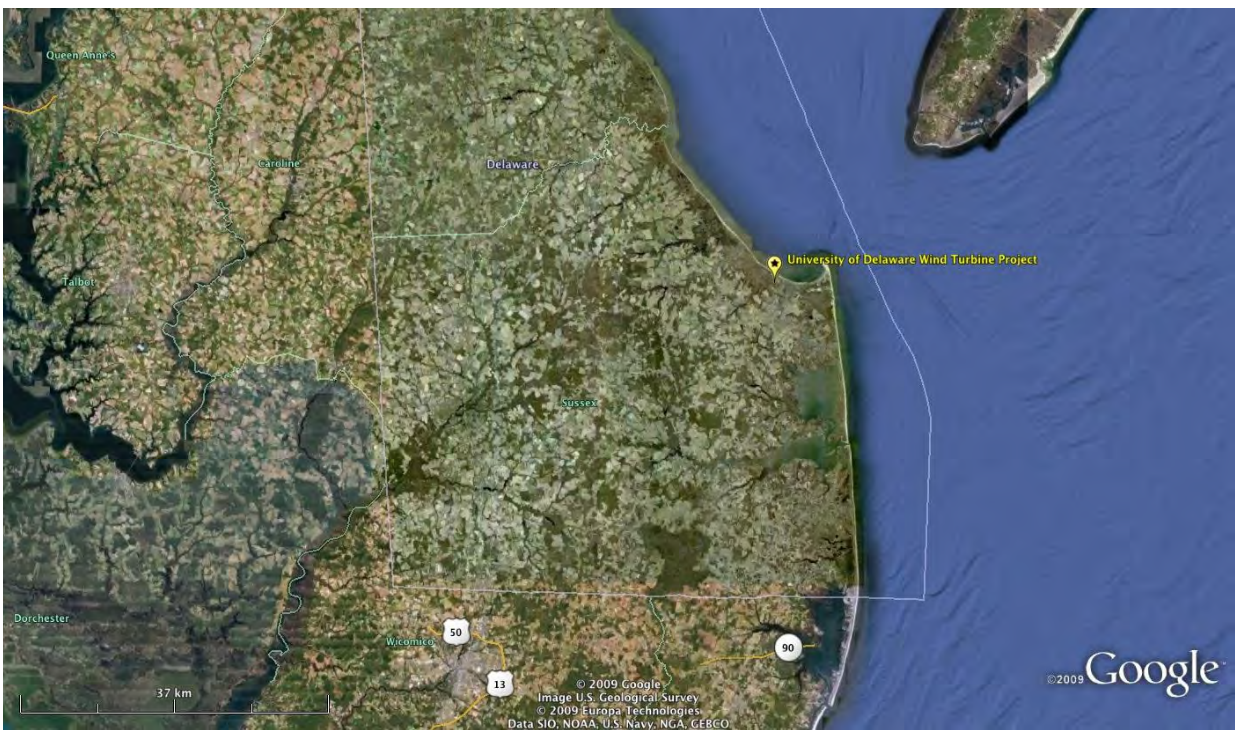

Figure 3. Satellite view of Project site and vicinity.

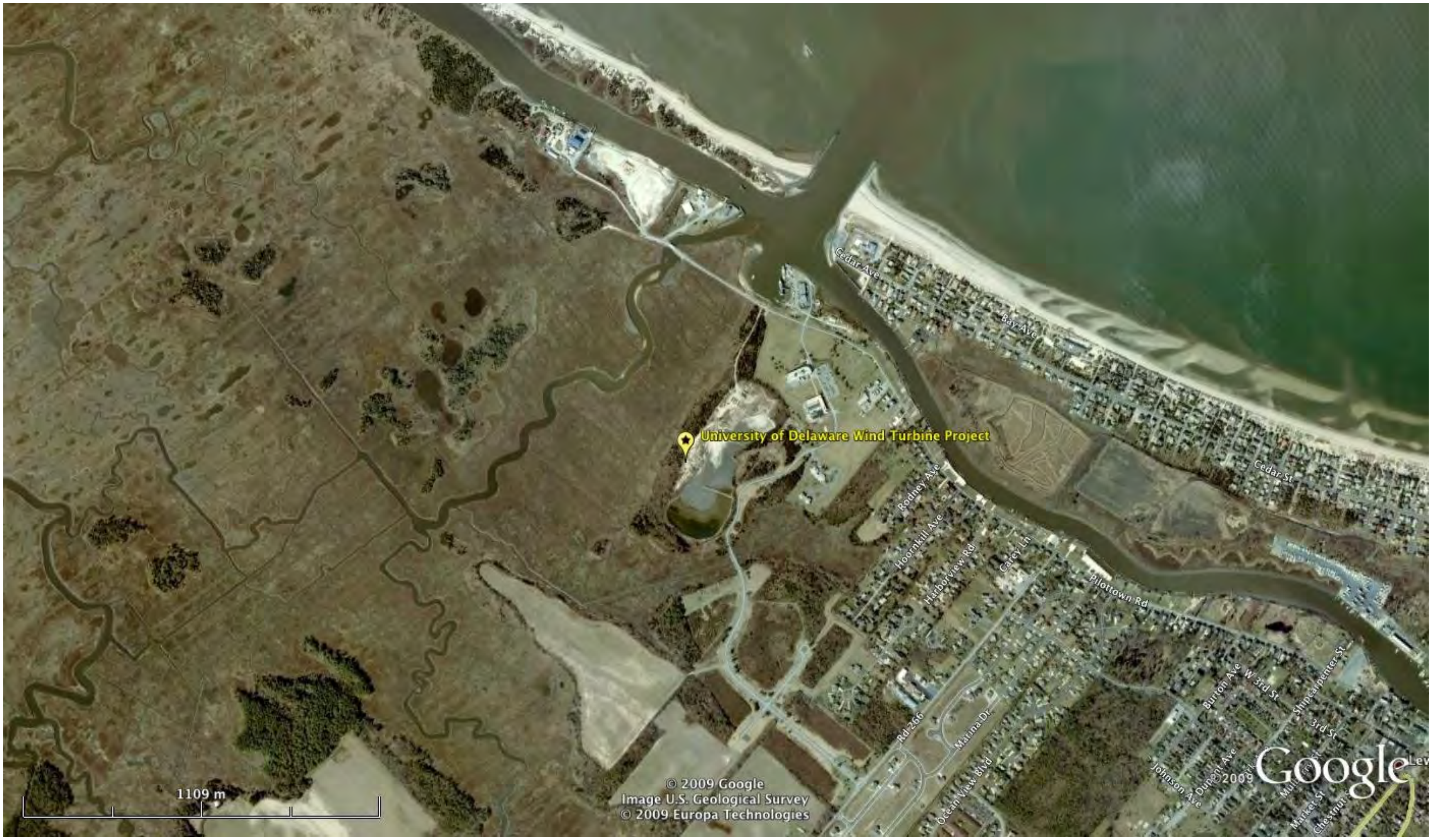

Figure 4. Topographic map view of Project site.

1.0 Introduction

The University of Delaware is proposing to construct a single wind turbine at its campus in Lewes, Sussex Count (see Figures 1-4). This report details a Phase I Avian Risk Assessment of the University of Delaware Wind Turbine Project (hereafter referred to as the "Project").

The purpose of a Phase I Avian Risk Assessment is to determine potential risk to birds from wind farm construction and operation at a proposed site. Birds are generally at risk of colliding with turbine rotors and of being displaced by construction activities and new, large infrastructure. The Phase I Avian Risk Assessment walks developers, regulators, environmentalists, and other stakeholders through a risk assessment process, including how evaluation of potential impacts may require further study. The process is based on: 1) a site visit, 2) a literature review, and 3) consultations with applicable wildlife agencies. The Phase I also follows relevant guidance for avoiding or minimizing impacts to birds and their habitats as set forth by the U.S. Fish and Wildlife Service (USFWS) in its ***Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines*** (USFWS 2003).

A field ornithologist skilled in bird identification and habitat evaluation conducts the site visit. This expert tours the site thoroughly by car and on foot recording birds seen or heard and evaluating habitats and topography with special consideration for: 1) federal and state-listed endangered, threatened, and other special-status bird species; and 2) probable avian use during the nesting, spring and fall migration, and winter seasons. The site visit is not intended to be an exhaustive inventory of species presence and use. Nonetheless, it analyzes habitat and topographic features so that a list of species that might conceivably be present at different times of the year can be assembled; thus, potential risk to those birds can be assessed.

The literature review has a number of objectives. One is to profile the seasonal avifauna and determine the likelihood of encountering special-status species. This is accomplished by examining the state's Breeding Bird Atlas (BBA) and Important Bird Area (IBA) program, as well as nearby Breeding Bird Survey (BBS) routes, Christmas Bird Counts (CBCs), hawk watches (available at HawkCount.org), and other relevant databases. Another objective is to reveal what is known about migration patterns, habitat use, and other avian phenomena. Finally, the literature review thoroughly summarizes empirical studies of wind-farm impacts. These empirical findings are the most important tool for assessing risk at prospective wind power facilities.

Consultations are conducted via letter with wildlife agencies – in this case, the USFWS and the Delaware Division of Fish and Wildlife (DDFW) – to request information on listed species at or near the Project site and to document agency concerns. Such consultations sometimes determine the need for additional research (e.g., breeding bird studies, raptor migration studies, etc.) to improve knowledge of avian use for completing the risk assessment.

Based on the process outlined above, this report: 1) summarizes known and likely bird use of the Project site's habitats throughout the year, 2) compares the Project site with wind-energy projects where avian impacts have been determined empirically, 3) determines potential risks that birds may face from the construction and operation of wind turbines at the site, and 4) presents recommendations for additional studies or mitigation, if indicated.

2.0 Project and Site Description

2.1 Project Description

The University of Delaware Wind Turbine Project is proposed for the campus of the University of Delaware in Lewes, Sussex County (Figures 1-4). The University of Delaware proposes to erect one wind turbine. Typically, wind turbines have hub heights of about 80 m (262 feet) above ground level (agl) and rotor diameters of about 90 m (2 feet). Rotor tips would sweep as high as about 125 m (410 feet) agl, and as low as about 35 m (115 feet) agl.

The turbine would be mounted on a steel tubular tower. It would probably be lit with an L-864 flashing red light (approved by the Federal Aviation Administration [FAA]; see guidelines at http://www.windaction.org/documents/7912) mounted on the nacelle at a height of about 82 m (269 feet) agl. The electrical collection line would likely be underground, but the connection to a substation could be above ground.

2.2 Site Description

Satellite imagery viewable through Google Earth Pro, USGS topographic maps viewable through National Geographic's TOPO! mapping software, and various literature sources and Internet sites were consulted in order to understand the Project site's topography, physiography, and land use. This information was checked during a site visit conducted by a field ornithologist on 4 December 2009.

The wind turbine site is located on the Coastal Plain (Hess et al. 2000) at an elevation of about 7 feet (2 m) above mean sea level within 0.5 miles (0.8 km) of Delaware Bay, which i
s located to the north. Cape Henlopen and the Atlantic Ocean are located about 4 miles (6.4 km) east of the site. Topography around the site is essentially flat.

The Project site appears to be a manmade upland created by filling saltmarsh. Indeed, it abuts an extensive saltmarsh that extends to the west behind Beach Plum Island, a barrier beach. Tidal creeks and rivers are found within 0.5 miles (0.8 km) of the Project site, notably, Canary Creek to the west, the Broadkill River to the north, and the Lewes and Rehoboth Canal to the east. These creeks and rivers connect to Delaware Bay through the Roosevelt Inlet, located about 0.5 miles (0.8 km) north.

Land use in the vicinity of the Project site is educational (University of Delaware), industrial (filtration plant), and residential (City of Lewes and houses along barrier beach to the east of Roosevelt Inlet). Maps indicate that the Prime Hook National Wildlife Refuge (NWR) approaches within about 2 miles (3.2 km) of the site and includes extensive saltmarshes.

3.0 Results of Site Visit

An experienced field ornithologist visited the Project site on 4 December 2009. He explored the site and vicinity on foot and by car. Photographs in Appendix A show the main habitats and landscape features.

Habitat where the wind turbine would be constructed was dredge spoil/fill. Areas with recent fill were mud with no plant growth. Where there was vegetation, it ranged from dense ***Phragmites*** and grassy areas to dense shrubby thickets with some larger trees, which were mainly around the perimeter of the site. Extensive saltmarsh was located immediately adjacent to the northwest, west, southwest, and south of the site. Roosevelt Inlet and Delaware Bay were approximately 0.5 miles (0.8 km) north of the site. Canary Creek, a large tidal creek, was located as close as 0.2 miles (0.3 km) west of the site.

Trees and shrubs noted were red cedar (some dense stands), black tupelo, red maple, sassafras, southern red oak, willow oak, hackberry, tulip tree, American holly, black cherry (very common), loblolly pine, pitch pine, persimmon, red mulberry, Osage orange, black willow, wax myrtle/bayberry, winged sumac, marsh elder, and multiflora rose. There were also dense growths of Japanese honeysuckle and greenbriar in some areas.

The site visit took place during late fall migration/early winter and recorded 58 species (see Appendix B for a list). One Delaware endangered species was recorded: Bald Eagle. One Bald Eagle was observed in flight above the site, while three were observed in flight over the adjacent saltmarsh. Two Northern Harriers and one Cooper's Hawk were observed. These species are listed as endangered in Delaware when breeding.

Based on an assessment of available habitat, the following Delaware-endangered species may occur at the Project site or vicinity:

- **Black-crowned Night-Heron:** Could use the site for roosting/nesting, but no old nests noted. It is likely to use the nearby marsh and tidal creeks for foraging.
- **Yellow-crowned Night-Heron:** Could use the site for roosting/nesting, but no old nests noted. It is likely to use the nearby marsh and tidal creeks for foraging.
- **Bald Eagle:** Likely to occur throughout the year, and likely to nest nearby.
- **Northern Harrier:** Could nest in extensive saltmarsh nearby.
- **Cooper's Hawk:** Not likely to nest on site, but could nest in more extensive woods/woodlots south of site.
- **Black Rail (also *Red WatchList*):** Could occur in adjacent saltmarsh.
- **Piping Plover (also federally threatened and *Red WatchList*):** Not likely to occur at site, but known to nest at Cape Henlopen State Park, which is 4 miles (6.4 km) distant.
- **American Oystercatcher:** Could occur in nearby saltmarsh and in flight over site.
- **Upland Sandpiper:** Possible during migration as a fly-over.
- **Common Tern:** Possible as fly-over, and may forage in tidal creeks, saltmarsh, and nearby harbor.
- **Forster's Tern:** Possible as fly-over, and may forage in tidal creeks, saltmarsh, and nearby harbor.

- **Least Tern (also federally endangered and *Red WatchList*):** Possible as fly-over, moving between tidal creeks/marsh, harbor, and Delaware Bay.
- **Black Skimmer (also *Yellow WatchList*):** Could occur along nearby tidal creeks and harbor.
- **Red-headed Woodpecker (also *Yellow WatchList*):** Possible in migration.
- **Sedge Wren:** Possible during migration.
- **Henslow's Sparrow (also *Red WatchList*):** Possible as rare migrant.

4.0 Avian Overview of the University of Delaware Wind Turbine Project Site

The North American Landbird Conservation Plan (Rich et al. 2004) locates the Project site within the New England/Mid-Atlantic Coast Bird Conservation Region (BCR 30). The North American Bird Conservation Initiative (NABCI), describes this BCR as follows (see http://www.nabci-us.org/bcr30.htm):

> This area has the densest human population of any region in the country. Much of what was formerly cleared for agriculture is now either in forest or in residential use. The highest priority birds are in coastal wetland and beach habitats, including the Saltmarsh Sharp-tailed Sparrow and Nelson's Sharp-tailed Sparrow, Seaside Sparrow, Piping Plover, American Oystercatcher, American Black Duck, and Black Rail. The region includes critical migration sites for Red Knot, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, and Dunlin. Most of the continental population of the endangered Roseate Tern nests on islands off the southern New England states. Other terns and gulls nest in large numbers, and large mixed colonies of herons, egrets, and ibis may form on islands in the Delaware and Chesapeake Bay regions. Estuarine complexes and embayments created behind barrier beaches in this region are extremely important to wintering and migrating waterfowl, including approximately 65 percent of the total wintering American Black Duck population, along with large numbers of Greater Scaup, Tundra Swan, Gadwall, Brant, and Canvasback. Exploitation and pollution of Chesapeake Bay and other coastal zones, and the accompanying loss of submerged aquatic vegetation, have significantly reduced their value to waterfowl.

Curry & Kerlinger has not yet received responses from the USFWS and DDFW to our written inquiries about records of listed species in the Project vicinity. When they are received, they will be found in Appendix D and summarized here. Nonetheless, the Delaware Natural Heritage and Endangered Species Program (NHESP) of the DDFW has commented on the Project in a letter dated 31 August 2009 from the Delaware Department of Natural Resources and Environmental Control (DNREC) to the University of Delaware. In this letter, six proposed turbine locations were evaluated. Location 1 was NHESP's preferred site for the wind turbine. The turbine site would be 600 feet south of this location.

The NHESP acknowledged that a small-scale (one-turbine) project presents an opportunity to study the impacts of land-based, coastal wind turbines on birds and bats in Delaware. It did not have any significant concerns for migratory shorebird impacts, but some proposed turbine locations (not Location 1) were discouraged because they were near nesting sites of Delaware-endangered Least Terns (also ***Red WatchList***) and American Oystercatchers. Regarding night-migrating songbirds, the NHESP acknowledged that mortality from a single turbine was not likely to have any population-level effect. Moreover, it found that migrant songbirds were unlikely to concentrate around proposed turbine sites because there was little woodland habitat to attract them. Migratory raptors were a concern, however, because the coastline serves as a leading line for several species, particularly falcons and Osprey. Negative population impacts to waterfowl populations were deemed unlikely.

In the recommendations section of the above letter, NHESP reiterated that the Project is a good opportunity to study the impacts of wind energy on birds and bats. Its preferred site would be Location 1, which is surrounded by less woodland that would attract night-migrating songbirds, would most likely result in the fewest impacts to adjacent wetlands, and is distant from suitable nesting and roosting habitat for beach-nesting birds. NHESP did point out, however, that a plan to reduce and minimize collisions and other threats be developed prior to construction in the event a major impact occurs. It also recommended that the site be studied both pre and post-construction to assess impacts fully.

A seasonal look at the avifauna likely to occur at the University of Delaware site follows.

4.1 Breeding Birds

Table 4.1-1 summarizes the DDFW and USFWS lists of endangered and threatened species. Given their high conservation status, these species have been given particular attention in assessing avian risk at the Project site. Based on the site visit and other data sources (see below), Table 4.1-1 also grades the suitability of Project site's habitats for nesting.

DDFW has also approved the ***Delaware Wildlife Action Plan, 2007-2017*** (Allen et al. 2006; http://www.dnrec.state.de.us/nhp/information/dewaptoc.shtml). In addition to the 24 endangered species listed above, the Delaware Wildlife Action Plan (DWAP) lists an additional 123 avian species as Species of Greatest Conservation Need (SGCN), of which 24 are assigned to Tier 1 and 99 are assigned to Tier 2, with Tier 1 indicating a greater conservation priority. Where these species are encountered in data sources, they are indicated as SGCN-1 and SGCN-2.

In addition, some Delaware endangered and SGCN species are also included in the recently published ***2007 WatchList for United States Birds*** (Butcher et al. 2007). Developed collaboratively by Audubon and the American Bird Conservancy (ABC), the ***WatchList*** highlights all the highest priority birds for conservation in the United States. It is based on the species assessment methodology that Partners in Flight (PIF; see Rich et al. 2004) has employed to rate the conservation status of landbirds. Audubon and ABC have taken PIF's standards and applied them to the other bird groups.

The ***WatchList*** is divided into two categories: 1) ***Red WatchList: Highest National Concern*** (59 species, including Black Rail, Piping Plover, Least Tern, and Henslow's Sparrow on the Delaware endangered list) and 2) ***Yellow WatchList: Declining or Rare Species*** (119 species, including Black Skimmer, Short-eared Owl, Red-headed Woodpecker, Cerulean Warbler, and Swainson's Warbler on the Delaware endangered list). Some SGCN species are also on the ***WatchList***, as are some non-SGCN species. ***WatchList*** species will be indicated when they are encountered in the data sources checked for this report.

Table. 4.1-1. Habitat suitability for nesting by Delaware endangered species

Delaware Endangered[1]	Recorded in BBA?	Recorded in BBS?	Habitat Suitability for Nesting?[2]
Pied-billed Grebe	Yes	Yes	NS
Black-crowned Night-Heron		Yes	MS?
Yellow-crowned Night-Heron			MS?
Bald Eagle	Yes	Yes	NS
Northern Harrier	Yes	Yes	NS
Cooper's Hawk	Yes	Yes	NS
Black Rail (*Red WatchList*)	Yes		NS
Piping Plover (US-T, *Red WatchList*)	Yes		NS
American Oystercatcher	Yes		NS
Upland Sandpiper			NS
Common Tern	Yes		NS
Forster's Tern		Yes	NS
Least Tern (US-E, *Red WatchList*)	Yes	Yes	NS
Black Skimmer (*Yellow WatchList*)	Yes	Yes	NS
Short-eared Owl (*Yellow WatchList*)			NS
Red-headed Woodpecker (*Yellow WatchList*)	Yes		NS
Loggerhead Shrike			NS
Brown Creeper			NS
Sedge Wren			NS
Northern Parula	Yes	Yes	NS
Cerulean Warbler (*Yellow WatchList*)			NS
Swainson's Warbler (*Yellow WatchList*)			NS
Hooded Warbler		Yes	NS
Henslow's Sparrow (*Red WatchList*)			NS

[1] From Delaware Wildlife Action Plan, 2007-2017 (Allen et al. 2006); *WatchList* species from Butcher et al. 2007; see Section 4.1 discussion.

[2] S = Suitable habitat for nesting occurs at site for this species, MS = Marginally Suitable, NS = Not Suitable, ? = uncertainty in evaluation.

In the following sections, two data sources will be examined to determine the likely breeding bird community in and around the Project site. One is the Delaware Breeding Bird Atlas (BBA, 1983-1987), because it covered the Project site and surrounding region. It will be checked for the occurrence of special-status species (endangered, SGCN, and ***WatchList***). The other source is the last ten years of data from a nearby route of the Breeding Bird Survey (BBS) of the U.S. Geological Survey (USGS). That route will be analyzed in detail in order to profile the breeding bird community.

4.1.1 Breeding Bird Atlas (BBA) Analysis

A Breeding Bird Atlas (BBA) is a survey that reveals the distribution of breeding birds in a country, state, or region. Delaware's first BBA was conducted in 1983-1987, with the results reported in ***Birds of Delaware*** (Hess et al. 2000). A second BBA was initiated in 2008, with completion scheduled for 2011[2].

As explained by Hess et al. (2000), atlas organizers used the 7.5-minute quadrangle series of the U.S. Geological Survey (USGS) topographic maps to section the state into sampling units. Each quadrangle was divided into six equal blocks, each 25 km^2 (9.6 mi^2). Mainly volunteer participants relied on topographic maps to orient themselves and survey as much of their assigned blocks as possible to record evidence of breeding for the birds they saw. Evidence of breeding was assessed as ***Possible*** (i.e., a species is simply observed in possible nesting habitat), ***Probable*** (i.e., a species exhibits certain behaviors that indicate breeding, such as territoriality, courtship and display, or nest building), or ***Confirmed*** (i.e., a species is observed nesting or engaged in behaviors associated with nesting, such as distraction display, carrying a fecal sac, carrying food for young, feeding young, etc.).

The Project site is situated in the Lewes SE block, which is surrounded by six blocks. Table 4.1.1-1 has been prepared to summarize the occurrence of endangered, SGCN, and ***WatchList*** species in the one overlapping and six surrounding blocks. Data are from the 1983-1987 BBA (Hess et al. 2000), because results of the 2008-2011 BBA are still preliminary. For example, in 1983-1987, 76 species were recorded in the Lewes SE block, while so far in the 2008-2011 BBA only 46 species have been recorded.

As may be seen in Table 4.1.1-1, twelve Delaware-endangered species were recorded in surrounding blocks, but none was recorded in the overlapping block. The lack of endangered species records in the overlapping block has continued so far in the 2008-2011 BBA (data accessed 7 January 2010).

Confirmed breeding for Piping Plover, Common Tern, Least Tern, and Black Skimmer and possible breeding for Northern Harrier and American Oystercatcher were from the block that covers Cape Henlopen, which is located 4 miles (6.4 km) east of the Project site. In a block to the northwest of the Project site, Piping Plover was also recorded as a possible breeder (probably from the beaches on Beach Plum Island), Northern Harrier was recorded as a probable breeder (likely in saltmarsh), and Black Rail was recorded as a probable breeder (likely from salt hay marsh). Possible breeding for Pied-billed Grebe was recorded from the three surrounding blocks to the west of the Project site.

Confirmed breeding for Bald Eagle and possible breeding for Cooper's Hawk were recorded in the block to the southwest of the Project site, where Red-headed Woodpecker was also recorded as a probable breeder. The woodpecker was confirmed as a breeder in the adjacent block to the

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[2] For preliminary results, visit http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=DE2008.

north (i.e., the block west of the Project site). A possible breeding record for Northern Parula was from the block to the south of the Project site.

Table 4.1.1-1. Special-status species recorded in overlapping and surrounding BBA blocks, 1983-1987[1]

	Status in Overlapping Block	# of 6 Surrounding Blocks in Which Recorded	Highest Status in Surrounding Blocks
Delaware Endangered[2]			
Pied-billed Grebe		3	Possible
Bald Eagle		1	Confirmed
Northern Harrier		2	Probable
Cooper's Hawk		1	Possible
Black Rail (*Red WatchList*)		1	Probable
Piping Plover (US-T, *Red WatchList*)		2	Confirmed
American Oystercatcher		1	Possible
Common Tern		1	Confirmed
Least Tern (US-E, *Red WatchList*)		1	Confirmed
Black Skimmer (*Yellow WatchList*)		1	Confirmed
Red-headed Woodpecker (*Yellow WatchList*)		2	Confirmed
Northern Parula		1	Possible
SGCN (Tier 1)[2]			
American Black Duck	Confirmed	4	Confirmed
Osprey	Confirmed	3	Confirmed
Spotted Sandpiper		2	Possible
American Woodcock	Probable	5	Confirmed
Common Nighthawk	Confirmed	3	Confirmed
Wood Thrush (*Yellow WatchList*)	Probable	6	Confirmed
Prairie Warbler (*Yellow WatchList*)	Possible	5	Probable
Saltmarsh Sparrow (*Red WatchList*)	Possible	1	Confirmed
Seaside Sparrow (*Red WatchList*)	Probable	3	Confirmed
Swamp Sparrow (coastal plain race)	Probable	2	Confirmed
SGCN (Tier 2)[2]			
Mallard	Possible	6	Confirmed
Northern Bobwhite	Confirmed	6	Confirmed
American Bittern	Possible	1	Possible
Least Bittern		1	Confirmed
Red-shouldered Hawk		1	Possible
Peregrine Falcon		1	Probable
King Rail (*Yellow WatchList*)		2	Probable
Willet	Confirmed	4	Confirmed
Barn Owl		1	Confirmed
Barred Owl		1	Possible
Whip-poor-will	Possible	6	Probable
Chimney Swift	Confirmed	6	Probable
Northern Flicker	Confirmed	6	Confirmed
Willow Flycatcher (*Yellow WatchList*)		1	Confirmed

Delaware Endangered[2]	**Status in Overlapping Block**	**# of 6 Surrounding Blocks in Which Recorded**	**Highest Status in Surrounding Blocks**
Great Crested Flycatcher	Confirmed	6	Confirmed
Eastern Kingbird	Probable	6	Confirmed
Yellow-throated Vireo		1	Probable
Brown-headed Nuthatch		1	Confirmed
Marsh Wren	Probable	4	Confirmed
Brown Thrasher	Confirmed	6	Confirmed
Yellow-throated Warbler		1	Possible
Prothonotary Warbler (*Yellow WatchList*)		3	Confirmed
Worm-eating Warbler		1	Probable
Louisiana Waterthrush		3	Probable
Kentucky Warbler (*Yellow WatchList*)		3	Probable
Yellow-breasted Chat	Possible	5	Probable
Scarlet Tanager	Confirmed	4	Confirmed
Eastern Towhee	Possible	6	Confirmed
Field Sparrow	Confirmed	5	Confirmed
Grasshopper Sparrow		1	Probable
Baltimore Oriole		2	Confirmed
***WatchList* not listed in Delaware**[2]			
Clapper Rail (*Yellow WatchList*)	Confirmed	3	Confirmed

[1] Data from Hess et al. 2000.

[2] Special-status species are discussed in Section 4.1.

Regarding SGCN and other special-status species, we look at birds of saltmarsh and shrubland/edge habitats, as they are most likely to occur in the vicinity of the proposed wind turbine. Saltmarsh-related species were American Black Duck, Clapper Rail, Willet, Marsh Wren, Saltmarsh Sparrow, Seaside Sparrow, and the coastal race of Swamp Sparrow. Shrubland/edge birds included Willow Flycatcher, Eastern Kingbird, Brown Thrasher, Prairie Warbler, Yellow-breasted Chat, Eastern Towhee, Field Sparrow, and Baltimore Oriole.

SGCN raptors recorded were Osprey, Red-shouldered Hawk, Peregrine Falcon, Barn Owl, and Barred Owl; they could conceivably occur in the vicinity of the proposed turbine. Indeed, a Red-shouldered Hawk was recorded at the site during the site visit. Aerial-foraging birds that could fly over the Project site were Common Nighthawk and Chimney Swift.

4.1.2 Breeding Bird Survey (BBS) Analysis

Now overseen by the Patuxent Wildlife Research Center of the U.S. Geological Survey (USGS), the North American Breeding Bird Survey (BBS) is an avian monitoring program that tracks the status and trends of North American bird populations. Each year during the height of the breeding season (normally June), mainly volunteer participants skilled in bird identification collect bird population data along roadside survey routes. Each survey route is 24.5 miles (39.4 km) long with stops at 0.5 mile (0.8 km) intervals, for a total of 50 stops. At each stop, a three-minute point count is conducted. The total survey time over the entire route, therefore, is 2.5 hours. At each point count, every bird seen within a 0.25 mile (0.4 km) radius or heard is recorded. Surveys start one-half hour before local sunrise and take about five hours to complete.

We have chosen to analyze the Harrington BBS route (21003) because it accesses coastal habitats similar to those in the vicinity of the Project site. It approaches within 7 miles (11.3 km) of the Project site. Appendix E lists in taxonomic and abundance orders the birds recorded on that route during the last ten years (2000-2009). Average abundance was calculated by dividing the average number of individuals per year by the survey time of 2.5 hours. This measure indicates which birds are likeliest to be found in habitats at the Project site.

A total of 125 species was recorded on the Harrington route over the last ten years. Of them, 74 were recorded above 1.00 bird/hr and may be considered common to abundant. They are listed in abundance order in Table 4.1.2-1. Together, individuals of these 74 species made up 98% of all individuals recorded on the BBS route. The other 51 species recorded (see Appendix E) were uncommon to rare.

Of the species included in Table 4.1.2-1, 18 averaged above 10 birds/hour and may be considered abundant. Most would be expected to occur in the Project vicinity. Horned Lark, however, is unlikely; Hess et al. (2000) describe its habitat as open fields in agricultural areas.

Of the common species (1-10 birds/hour), saltmarsh and shrubland/edge species may be expected in the Project vicinity, but woodland birds (e.g., Wood Thrush, Ovenbird, etc.) would not. Of the obligate grassland birds, Grasshopper Sparrow is not described as nesting in higher parts of tidal marshes, but Eastern Meadowlark is (Hess et al. 2000).

Table 4.1.2-2 highlights the special-status species recorded in the last ten years on the Harrington route. In addition to average abundance, it shows the percent of years in which a species was recorded and the range in individuals recorded.

Among endangered species, only Forster's Tern was recorded as common (i.e., >1.00 birds/hour), with small numbers found nearly every year. All others were uncommon to rare.

Of the SGCN species, the same suite of saltmarsh and shrubland/edge species was encountered as in the BBA. Common to abundant saltmarsh specialists were Willet (9.92 birds/hour) and Seaside Sparrow (5.64). Both were found all years in relatively large numbers.

Table 4.1.2-1. Most abundant birds on 2000-2009 Harrington BBS route (21003)[1]

Abundance Sort[1]	Avg. birds/hr
Common Grackle	109.08
European Starling	58.08
Red-winged Blackbird	45.72
American Robin	40.04
Laughing Gull	34.96
House Sparrow	30.12
Purple Martin	29.04
Mourning Dove	28.52
Barn Swallow	24.68
Turkey Vulture	19.52
Northern Cardinal	17.56
Northern Mockingbird	16.40
Indigo Bunting	15.24
Ring-billed Gull	15.04
American Crow	15.00
Carolina Wren	14.48
Song Sparrow	14.44
Horned Lark	10.12
Willet (SGCN-2)	9.92
House Finch	9.88
American Goldfinch	9.88
Blue Grosbeak	9.60
Canada Goose	9.20
Rock Pigeon	8.68
Common Yellowthroat	8.48
Red-eyed Vireo	8.04
Chimney Swift (SGCN-2)	7.76
Tufted Titmouse	7.44
Chipping Sparrow	7.28
Brown-headed Cowbird	7.17
Red-bellied Woodpecker	5.80
Seaside Sparrow (SGCN-1, *Red WatchList*)	5.64
Fish Crow	5.44
Cedar Waxwing	5.44
Great Crested Flycatcher (SGCN-2)	5.24
Wood Thrush (SGCN-1, *Yellow WatchList*)	4.76
Boat-tailed Grackle	3.96
Blue Jay	3.76
Eastern Wood-Pewee	3.72
Double-crested Cormorant (SGCN-2)	3.60
Orchard Oriole	3.60
Herring Gull	3.40
Tree Swallow	3.32
Gray Catbird	3.16
Great Blue Heron (SGCN-2)	3.00
Acadian Flycatcher	2.76

Abundance Sort[1]	**Avg. birds/hr**
Northern Bobwhite (SGCN-2)	2.60
Killdeer	2.36
Black Vulture (SGCN-2)	2.12
Mallard (SGCN-2)	2.04
Eastern Bluebird	2.00
Swamp Sparrow (SGCN-1)	2.00
Carolina Chickadee	1.92
Eastern Kingbird (SGCN-2)	1.88
Marsh Wren (SGCN-2)	1.88
Ovenbird	1.80
Scarlet Tanager (SGCN-2)	1.76
Eastern Meadowlark	1.76
White-eyed Vireo	1.60
Snowy Egret (SGCN-2)	1.48
Yellow Warbler	1.40
Green Heron	1.36
Blue-gray Gnatcatcher	1.32
Prothonotary Warbler (SGCN-2, *Yellow WatchList*)	1.32
Bank Swallow (SGCN-2)	1.28
Downy Woodpecker	1.24
Field Sparrow (SGCN-2)	1.20
Clapper Rail (*Yellow WatchList)*	1.16
Northern Flicker (SGCN-2)	1.12
Brown Thrasher (SGCN-2)	1.12
Red-tailed Hawk	1.08
unid. Crow	1.08
Grasshopper Sparrow (SGCN-2)	1.08
Forster's Tern (DE-E)	**1.04**
House Wren	1.04

[1] Recorded at 1.00 birds/hour or greater.

[2] Delaware-endagered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Need (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

Table 4.1.2-2. Special-status species recorded on 2000-2009 Harrington BBS route (21003)[1]

Conservation Priority and Taxonomic Sort[1]	Avg. birds/hr	% years recorded	Range # individuals
Pied-billed Grebe (DE-E)	**0.04**	10%	1
Black-crowned Night-Heron (DE-E)	**0.08**	10%	2
Bald Eagle (DE-E)	**0.16**	40%	1
Northern Harrier (DE-E)	**0.08**	20%	1
Cooper's Hawk (DE-E)	**0.12**	30%	1
Forster's Tern (DE-E)	**1.04**	80%	2-4
Least Tern (DE-E, Red WatchList)	**0.12**	10%	3
Black Skimmer (DE-E, Yellow WatchList)	**0.24**	20%	2-4
Northern Parula (DE-E)	**0.04**	10%	1
Hooded Warbler (DE-E)	**0.04**	10%	1
American Black Duck (SGCN-1)	0.40	90%	3-11
Osprey (SGCN-1)	0.92	90%	1-5
Common Nighthawk (SGCN-1)	0.08	20%	1
Wood Thrush (SGCN-1, *Yellow WatchList*)	4.76	100%	7-19
American Redstart (SGCN-1)	0.20	50%	1
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.04	10%	1
Seaside Sparrow (SGCN-1, *Red WatchList*)	5.64	100%	7-22
Swamp Sparrow (SGCN-1)	2.00	100%	1-10
Mallard (SGCN-2)	2.04	90%	4-11
Northern Bobwhite (SGCN-2)	2.60	100%	1-29
Double-crested Cormorant (SGCN-2)	3.60	100%	1-53
Least Bittern (SGCN-2)	0.04	10%	1
Great Blue Heron (SGCN-2)	3.00	100%	3-15
Great Egret (SGCN-2)	0.08	20%	1
Snowy Egret (SGCN-2)	1.48	100%	1-9
Tricolored Heron (SGCN-2)	0.04	10%	1
Cattle Egret (SGCN-2)	0.04	10%	1
Glossy Ibis (SGCN-2)	0.40	20%	3-7
Black Vulture (SGCN-2)	2.12	100%	1-13
Red-shouldered Hawk (SGCN-2)	0.04	10%	1
Black-necked Stilt (SGCN-2)	0.32	50%	1-3
Willet (SGCN-2)	9.92	100%	18-32
Barred Owl (SGCN-2)	0.04	10%	1
Whip-poor-will (SGCN-2)	0.04	10%	1
Chimney Swift (SGCN-2)	7.76	100%	11-35
Northern Flicker (SGCN-2)	1.12	100%	1-4
Willow Flycatcher (SGCN-2, *Yellow WatchList*)	0.56	60%	1-5
Great Crested Flycatcher (SGCN-2)	5.24	100%	8-28
Eastern Kingbird (SGCN-2)	1.88	90%	2-8
Yellow-throated Vireo (SGCN-2)	0.08	20%	1
Bank Swallow (SGCN-2)	1.28	100%	1-7
Marsh Wren (SGCN-2)	1.88	100%	3-8
Brown Thrasher (SGCN-2)	1.12	100%	1-7

Conservation Priority and Taxonomic Sort[1]	**Avg. birds/hr**	**% years recorded**	**Range # individuals**
Yellow-throated Warbler (SGCN-2)	0.40	80%	1-2
Prothonotary Warbler (SGCN-2, *Yellow WatchList*)	1.32	90%	2-6
Worm-eating Warbler (SGCN-2)	0.08	20%	1
Louisiana Waterthrush (SGCN-2)	0.12	30%	1
Kentucky Warbler (SGCN-2, *Yellow WatchList*)	0.40	70%	1-3
Yellow-breasted Chat (SGCN-2)	0.72	100%	1-4
Scarlet Tanager (SGCN-2)	1.76	100%	2-9
Eastern Towhee (SGCN-2)	0.72	80%	1-4
Field Sparrow (SGCN-2)	1.20	100%	1-4
Grasshopper Sparrow (SGCN-2)	1.08	100%	1-7
Baltimore Oriole (SGCN-2)	0.20	50%	1
Clapper Rail (*Yellow WatchList)*	1.16	90%	1-6

[1] Delaware-endangered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Concern (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

4.1.3 Breeding Birds, Conclusions

Based on the site visit's assessment of habitat and on analyses of Breeding Bird Atlas (BBA) and Breeding Bird Survey (BBS) data, no Delaware-endangered species is expected to nest in the vicinity of the proposed turbine, but a number of endangered species may occasionally forage near or fly in the vicinity of the turbine. These would include Black-crowned Night-Heron, Yellow-crowned Night-Heron, Bald Eagle, Northern Harrier, American Oystercatcher (also ***Yellow WatchList***), Common Tern, Forster's Tern, Least Tern (also federally endangered and ***Red WatchList***), and possibly Black Skimmer (also ***Yellow WatchList***). Species of Greatest Conservation Need (SGCN) foraging or flying near the proposed turbine would be limited to raptors, saltmarsh specialists, and shrubland/edge species. These may include Black Vulture, Osprey, Red-shouldered Hawk, Peregrine Falcon, and Barn Owl among raptors; American Black Duck, Clapper Rail (***Yellow WatchList***), Willet, Marsh Wren, Saltmarsh Sparrow (also ***Red WatchList***), Seaside Sparrow (also ***Red WatchList***), and the coastal race of Swamp Sparrow among saltmarsh specialists; and Willow Flycatcher (also ***Yellow WatchList***), Eastern Kingbird, Brown Thrasher, Prairie Warbler (also ***Yellow WatchList***), Yellow-breasted Chat, Eastern Towhee, Field Sparrow, and Baltimore Oriole among shrubland/edge species.

4.2 Migratory Birds

This section sheds light on how migratory birds are likely to use the Project site's airspace and habitats. Bird migration is a complex phenomenon; therefore, this report examines the major migratory bird groups separately: night-migrating songbirds, raptors, and waterbirds (waterfowl, shorebirds, and others).

4.2.1 Nocturnal Songbird Migration

Most songbirds and allies migrate at night. In North America, they include cuckoos, woodpeckers, flycatchers, vireos, nuthatches, wrens, kinglets, gnatcatchers, thrushes, catbirds, thrashers, warblers, tanagers, and sparrows (Kerlinger 1995). Based on population estimates provided by Rich et al. (2004), hundreds of millions of birds are aloft at night over North America during the fall and spring migration seasons. Studies with radar, ceilometer, and direct observation have shown that nocturnal migration begins thirty minutes to an hour after sunset and peaks soon thereafter until after midnight. Most birds land by sunrise (Kerlinger 1995).

Nocturnal migration generally fits a broad-front pattern. To paraphrase Berthold (2001), individual birds originating from geographically broad breeding or wintering ranges migrate roughly parallel to each other (on broad fronts, like weather systems), crossing major landforms with little deviation in direction. This has been graphically demonstrated in the Appalachians, where radar studies (Cooper et al. 2004, Kerlinger 2005) found that fall migrants cross ridges at oblique angles and at high altitudes, thus refuting a ridge-following hypothesis. Nocturnal migration has also been found to occur in waves associated with meteorological phenomena. For example, fall migration is concentrated after the passage of cold fronts, which provide tail winds (Kerlinger 1995).

Along the Atlantic coast, radar studies demonstrate broad-front migration over the ocean. In Nova Scotia, Richardson (1978) documented migrants moving offshore at right and acute angles to the coast irrespective of wind direction. From Cape Cod, Drury and Nisbet (1964) and Nisbet and Drury (1967) found that migrants maintained constant headings over the water by apparently making corrections for displacement by crosswinds.

Broad-front nocturnal migration may occasionally concentrate at ecological barriers, such as coasts or lakeshores. In coastal Louisiana, inclement weather during spring migration was found to precipitate spectacular fallout events involving trans-Gulf of Mexico migrants in coastal woodland patches, but in fair weather, songbirds continued their flight hundreds of miles inland (Gauthreaux 1971). Away from ecological barriers, nocturnal migrants disperse themselves across the landscape to rest and feed in appropriate habitats.

Night migrants aloft at dawn over coastal Delaware or the adjacent Atlantic Ocean within sight of land will direct themselves to the nearest landfall, particularly if winds and weather conditions are unfavorable. For example, at dawn in Nova Scotia, Richardson (1978) found that landbirds over the ocean in unfavorable winds reoriented themselves toward the coast to make landfall. At a bird banding station at Island Beach, New Jersey, Murray (1976) found that, on heavy flight nights, fall migrants made landfall in peak numbers up until 9:00 a.m., after which time arrivals dropped off sharply. Murray’s observation indicates that offshore birds that can see land at dawn reorient themselves to fly toward land. This phenomenon has also been recorded by birdwatchers at Cape May, New Jersey (Sutton and Sutton 2006, Wiedner et al. 1992).

With regard to the Project site, it is likely that some night-migrating songbirds will use the shrubby thickets near the wind turbine to rest and feed. That habitat will be used most after peak migration nights, which normally occur after the passage of cold fronts in fall.

The traffic rate, altitude, and direction of nocturnal migration have been studied at several dozen wind-energy sites in the Eastern and Midwestern U.S. Reviewed by Kerlinger (in preparation), these studies report similar results, as would be expected from broad-front migration. Seasonal migration rates ranged from 135 to 661 targets/km/hr in fall and from 42 to 473 targets/km/hr in spring, with significant variation from night to night. Nonetheless, these rates are a fraction of those at heavy migration areas, such as the Gulf Coast, where seasonal rates on the order of 10,000 targets/km/hr have been recorded (Gauthreaux 1971, 1972, 1980).

Mean migration altitude ranged from 365 m to 583 m (1,197-1,912 feet) agl (above ground level) in the fall, and from 401 m to 528 m (1,315-1,732 feet) agl in the spring. Only between 4% and about 13% of night migrants in both seasons were found to fly below 125 m (~410 feet) agl, the height of a wind turbine. In other words, most migration occurs well above the rotor-swept area of wind turbines. Flight direction also did not vary greatly among sites. In the fall, it averaged 190° (south-southwesterly), in spring 38° (northeasterly).

Young and Erickson (2006) have also reviewed radar studies at proposed and existing wind-energy projects in the Eastern U.S. (see National Research Council 2007). Based on 21 studies, they found similar mean passage rates in spring and fall (258 versus 247 targets/km/hr, respectively). Mean height of flight was 409 m (1,342 feet) agl in spring and 470 m (1,542 feet) agl in fall, with 14% of targets below 125 m (410 feet) in spring and 6.5% below that height in fall. Mean flight directions were SSW (193 degrees) in fall and NNE (31 degrees) in spring. These averages are in line with Kerlinger's analysis.

4.2.2 Hawk Migration

In their global directory of raptor migration sites, Zalles and Bildstein (2000) do not list a globally significant migration site in Delaware, but the Hawk Migration Association of North America (HMANA; see http://www.hmana.org) does report data from the Cape Henlopen Hawk Watch, which is located 4 miles (6.4 km) east of the Project site. This hawk watch is active in both spring and fall migration. Table 4.2.2-1 reports average raptor counts during these two seasons over the last five years (2005-2009; data from hawkcount.org). During this time span, an average of 111.6 hours of observation were conducted in spring from March 15 to May 10; in fall, an average of 343.1 hours of observation were conducted from September 1 to November 30.

In terms of number of raptors counted, fall migration at Cape Henlopen is an order of magnitude greater than spring passage (9,302 versus 801 raptors). When the number of observation hours is considered, fall passage averages 27.1 raptors/hour, while spring passage averages 7.2 raptors/hour. The fall passage rate is relatively large compared with other hawk watches reported by HMANA (at hawkcount.org).

Table 4.2.2-1 2005-2009 average raptor count at Cape Henlopen Hawk Watch[1]

Species[2]	# of individuals Spring	Fall
Black Vulture (SGCN-2)	7.2	117.2
Turkey Vulture	15.4	421.4
Swallow-tailed Kite (*Yellow WatchList*)	0.4	-
Osprey (SGCN-1)	68.8	2,898.8
Bald Eagle (DE-E)	9.8	200.0
Northern Harrier (DE-E)	36.6	273.2
Sharp-shinned Hawk (SGCN-1)	216.2	2,928.4
Cooper's Hawk (DE-E)	38.0	611.6
Northern Goshawk	0.2	1.8
Red-shouldered Hawk (SGCN-2)	0.8	25.6
Broad-winged Hawk (SGCN-1)	1.6	79.0
Swainson's Hawk (*Yellow WatchList*)	-	0.4
Red-tailed Hawk	14.2	198.0
Rough-legged Hawk	-	-
Golden Eagle	0.2	3.8
American Kestrel	172.2	650.6
Merlin	170.0	402.0
Peregrine Falcon (SGCN-2)	4.6	312.6
Unidentified Raptor	44.6	178.0
Average count	**800.8**	**9,302.4**

[1] Data from HawkCount.org.

[2] Delaware-endangered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Concern (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

Sharp-shinned Hawk and Osprey are by a wide margin the most numerous fall migrants at Cape Henlopen. It is interesting to note, however, that the average number of Sharp-shinned Hawks at Cape Henlopen is an order of magnitude less than that recorded at the Cape May Hawk Watch in New Jersey, while Osprey numbers are about the same (hawkcount.org). This pattern relates to the tendency to attempt water crossings. Kerlinger (1985) studied water crossing by hawks at Cape May Point and at Whitefish Point, Michigan. He found that all species made water crossings on some occasions, but the tendency varied greatly. Turkey Vultures, Broad-winged Hawks, and Red-tailed Hawks crossed infrequently, whereas Sharp-shinned Hawks, Rough-legged Hawks, American Kestrels, and Merlins crossed more often. Ospreys, Northern Harriers, and Peregrine Falcons usually made crossings. His results suggest that the tendency for hawks to undertake water crossings is related to wing shape, with longer-winged species, often with pointed wings, having high aspect ratios that decrease induced drag and therefore the energetic cost of powered flight.

Among spring migrants, Sharp-shinned Hawk again was most numerous, but its average was less than a tenth of that in fall. Spring numbers of American Kestrels and Merlins were one-quarter and two-fifths that of fall numbers, but their passage rates in both seasons were fairly similar when observation hours are factored in; this was not the case, however, for Peregrine Falcon, the spring numbers of which were proportionally much lower than fall numbers.

Located 4 miles (6.4 km) west of Cape Henlopen and 0.5 miles (0.8 km) south of the barrier beach along Delaware Bay, the Project site is not on the main migration path of raptors. Nonetheless, migrating Osprey, Sharp-shinned Hawks, and falcons may be expected to hunt occasionally in the vicinity of the proposed turbine.

4.2.3 Waterbird Migration

Shorebird migration in Delaware Bay is significant. The Western Hemisphere Shorebird Reserve Network (WHSRN; see http://www.mnomet.org/WHSRN/) ranks Delaware Bay as a ***Site of Hemispheric Importance***, WHSRN's highest priority category. Sites of Hemispheric Importance have at least 500,000 shorebirds annually, or at least 30% of the biogeographic population for a species. The Project site is located at the mouth of this bay.

Found at http://www.manomet.org/WHSRN/viewsite-new.php?id=6, WHSRN's habitat description for Delaware Bay reads as follows:

> Land included in reserve is coastal, from hightide line down. Mostly narrow, sandy beaches, some mud flats; area made up of shorefront and lowtide flats, including dunes, sandy beaches and sandy/muddy mouths of rivers, adjacent tidal salt marshes, and salt water impoundments. There are extensive freshwater and saltwater wetlands throughout the Delaware River and Bay estuary.
>
> The extensive wetlands in the Delaware River Estuary provide excellent resting habitat and nesting sites for many species of migratory waterfowl, bald eagles, ospreys, northern harrier, waders (including yellow and black crowned night herons) and migrating raptors. The area functions as a major staging area for 80 percent of the Atlantic flyway population of Snow Geese (up to 200,000). Several federal and state endangered and threatened species are supported including: Bald Eagle, Peregrine Falcon, Piping Plover, Pied-billed Grebe, Short-eared Owl, Delmarva Fox Squirrel, and Shortnose Sturgeon. Delaware Bay is also the site of the largest spawning concentration of horseshoe crabs along the Atlantic coast.
>
> The northbound migration of shorebirds coincides with horseshoe crab spawning in the bay. Shorebirds have been found to feed mostly on horseshoe crab eggs on the bay beaches, but some species, such as the Semipalmated Sandpiper, Dunlin, and Short-billed Dowitcher, rely more heavily on marsh habitats. All shorebirds move between the beaches and marshes for feeding, resting and roosting. NJ Division of Fish, Game and Wildlife, in conjunction with the Delaware Department of Fish and Wildlife - Nongame and Endangered Species Program, conducts annual surveys of shorebird abundance on beaches. Total birds counted on beaches in aerial surveys over the 6-week migration period range from 250,000 to over 600,000 (May through mid-June). Birds observed in tidal marsh habitats are estimated at 700,000, approximately two times that on bay beaches, but species that associate more with marshes than beaches are underestimated by aerial surveys.

Four species accounted for 99% of birds observed on Delaware Bay beaches:

- Semipalmated Sandpipers 30-70%
- Ruddy Turnstones 20-35 %
- Red Knots 15-20 %
- Sanderling 4-6 %

Dunlin and Short-billed Dowitchers account for another 2-8 % (numbers fluctuate yearly).

Red Knot, Sanderling, and Semipalmated Sandpiper are all ***Yellow WatchList*** species, while Ruddy Turnstone, Red Knot, and Sanderling are on the SGCN-1 list in Delaware. Red Knot is also a candidate for federal listing as an endangered species. According to Sutton and Sutton (2006), researchers in the 1980s estimated that at least 80% of the East Coast race (subspecies ***rufa***) of the Red Knot staged on Delaware Bay to refuel in spring on their 10,000-mile migration from southern South America to the Arctic. The Red Knot population on Delaware Bay has apparently declined from a high of 100,000 birds in the 1980s to about 15,000 in 2005. This decline has been attributed to over-harvesting of the horseshoe crab, whose eggs are the principal food source for the knot and other shorebirds.

Located about 35 miles (56 km) northeast of the Project site, the Avalon Seawatch has documented that large numbers of seabirds migrate along the Atlantic coast in fall (visit http://www.njaudubon.org/Research/SeaWatch.html). Operating from September 22 to December 22, this count averages over 750,000 seabirds annually. Nearly 80 species are regularly recorded. The most abundant migrants are Double-crested Cormorant (average of 188,245), Surf Scoter (144,921), Black Scoter (126,294), dark-winged scoters (either Surf or Black, 80,088), Red-throated Loon (57,508), Northern Gannet (47,696), Laughing Gull (16,906), and Ring-billed Gull (12,902).

Where seabirds migrate along the coast depends on the wind (Sutton and Sutton 2006). In northwest winds, seabirds are often far at sea, but in northeast winds, the migration may come ashore, including over the marshes behind the barrier island of Avalon. Many of the seabirds, however, migrate along the nearshore zone, where they can easily access the shallow water where they feed.

Given that the Project site is located 4 miles (6.4 km) from the Atlantic coast, it is unlikely that seabird migration will extend over the site, even in strong onshore winds.

In his treatise on North American waterfowl, Bellrose (1980) shows significant waterfowl migration terminating along the Atlantic coast near Delaware. His map for duck migration shows a broad migration corridor used by between 3.0 and 5.3 million ducks that links what the Prairie Breeding Grounds of south-central Canada, the Dakotas, and Minnesota with wintering areas along the Mid-Atlantic coast. His map for goose migration shows a corridor between Hudson Bay and the Mid-Atlantic coast used by between 150,000 and 500,000 geese.

Most migration of waterfowl and other waterbird species takes place at night, but some extends to daylight hours, depending on the distance traveled. Radar studies show altitudes of 500 to

1,000 feet (152 to 304 m) or more at many locations for ducks, geese, loons, and other birds (Kerlinger 1982, reviewed by Kerlinger and Moore 1989). According to Bellrose (1980), aviation reports indicate that most Canada Geese in the Midwest fly at about 2,000 feet above the ground in fall, with 52% of flocks between 1,000 and 3,000 feet and some flocks as low as 500 feet and others as high as 11,000 feet; spring aviation records show the average altitude even higher, at 2,500 feet.

4.2.4 Migratory Birds, Conclusions

Nocturnal songbird migration is expected to occur on a broad front above the Project site, with most birds flying well above the sweep of wind-turbine rotors. In fall migration, however, fallout events may occasionally concentrate night-migrating songbirds in coastal woodland habitats, including the shrubland near the proposed turbine. Given that coastal woodlands and shrublands are well distributed along the Delaware coast, the limited shrubland at the Project site is not expected to attract particularly large numbers of songbird migrants.

Concentrated raptor migration has been documented in fall at Cape Henlopen, with Sharp-shinned Hawk and Osprey (both SGCN-1) most abundant. The Project site is sufficiently inland from Cape Henlopen and barrier beaches to be off the main raptor migration path, but migrating Osprey, Sharp-shinned Hawks, falcons, and other species may occasionally hunt in the vicinity of the proposed turbine.

Delaware Bay is of hemispheric importance as a staging site for Ruddy Turnstone (SGCN-1), Red Knot (SGCN-1 and ***Yellow WatchList***), Sanderling (SGCN-1 and ***Yellow WatchList***), and Semipalmated Sandpiper (***Yellow WatchList***) in spring migration. They mostly forage for horseshoe crab eggs in Delaware Bay, but they also forage and roost in saltmarshes. Nonetheless, give the location of the proposed turbine above the saltmarsh zone and away from Delaware Bay and the Atlantic Ocean, it is likely that few of these shorebirds, or other coastally migrating waterbirds, will fly in the vicinity of the turbine.

4.3 Wintering Birds

Audubon's Christmas Bird Count (CBC) provides an excellent overview of the birds that inhabit an area or region during early winter. Counts take place on a single day during a three-week period around Christmas, when dozens of birdwatchers comb a 15-mile (24 km) diameter circle (area of 177 square miles [453 km^2]) in order to tally the bird species and individuals they encounter. While most of these birdwatchers are unpaid amateurs, they are usually proficient or highly skilled observers.

Available at http://audubon2.org/birds/cbc/hr/count_table.html, CBC data are used by scientists, wildlife agencies, and environmental groups to monitor bird populations. To evaluate winter bird abundance at the Project site, we have examined the last ten years of data for the Cape Henlopen-Prime Hook CBC (coded DECH), the coverage of which includes the Project site. It was active in each of the last ten years (2000-2009), recruited between 19 and 38 observers per year, and recorded between 123 and 161 species.

To profile the winter bird community in the region including the Project site, Appendix E has been prepared. Sorted in taxonomic and abundance orders, this table displays the average abundance of birds, measured in birds/hour. In each year, abundances were determined by dividing the number of individuals tallied by the total number of party hours (i.e., the cumulative hours that parties of observers were in the field). These values were then averaged using the last ten years of data (2000 to 2009).

A total of 190 species were recorded at least once on the Cape Henlopen-Prime Hook CBC over the last ten years. Of them, 46 were recorded above 1.00 bird/hr and may be considered common to abundant. Listed in Table 4.3-1, individuals of these species made up over 98% of all individuals recorded on the count. The other 144 species were uncommon to rare (see Appendix E).

Recorded at 1,143.31 birds/hour, the abundance of Snow Goose on this CBC is highly noteworthy. 73% of all individual birds recorded on this CBC were Snow Geese. No other bird remotely approached Snow Goose in abundance. Hess et al. (2000) describe its habitat as saltwater cordgrass marshes, impoundments, bays, and upland fields. Thus, Snow Geese are expected to forage in saltmarshes adjacent to the turbine location. Other abundant to common waterfowl likely to feed in saltmarshes adjacent to the Project site are Canada Goose (SGCN-1 for the migratory population; 63.81 birds/hour) and American Black Duck (SGCN-1; 9.13).

Raptor diversity on the CBC was high, with 14 diurnal species recorded. Most abundant were Turkey Vulture (2.41 birds/hour), Northern Harrier (DE endangered as a breeder; 0.52), Black Vulture (0.49), Red-tailed Hawk (0.28), Bald Eagle (DE endangered, 0.19), Sharp-shinned Hawk (SGCN-1; 0.11), and American Kestrel (0.10). All other raptors were relatively scarce.

Table 4.3-2 highlights the special-status species recorded in the last ten years on this CBC. In addition to average abundance, it shows the percent of years in which a species was recorded and the range in individuals recorded.

Among endangered species, Forster's Tern was most abundant, recorded every year, occasionally exceeding 100 individuals. Hess et al. (2000) describe its habitat as saltmarsh and adjacent coastal waters. Thus, it may occur in the vicinity of the proposed turbine in winter. Northern Harrier was also relatively abundant, but most of the birds recorded were likely not endangered Delaware breeders. It is likely to hunt regularly over saltmarshes adjacent to the site. Bald Eagle was also relatively abundant, recorded every year, sometimes in the dozens of birds. According to Buehler (2000), Bald Eagle is an opportunistic feeder that prefers fish, but it will take waterfowl and gulls. Thus, it may be expected to hunt Snow Geese and other large waterbirds in the saltmarshes adjacent to the Project. All other endangered species were relatively scarce.

Of the SGCN species, few saltmarsh and shrubland/edge species were common enough (>0.10 birds/hour) to be expected to frequent areas near the proposed turbine.

Table 4.3-1. Most abundant birds on 2000-2009 Cape Henlopen-Prime Hook CBC (DECH)[1]

Abundance Sort[1]	Avg. birds/hr
Snow Goose	1,143.31
Common Grackle	67.73
Canada Goose (SGCN-1 in part)	63.81
Red-winged Blackbird	57.53
European Starling	24.14
Ring-billed Gull	23.64
Herring Gull	18.70
American Robin	14.71
Northern Pintail	12.56
Dunlin (SGCN-2)	9.59
American Black Duck (SGCN-1)	9.13
Mallard (SGCN-2)	7.17
Surf Scoter (SGCN-2)	6.13
American Green-winged Teal	5.88
Yellow-rumped Warbler	5.30
White-throated Sparrow	5.04
Dark-eyed Junco	4.31
Great Black-backed Gull (SGCN-2)	3.92
Mourning Dove	3.89
House Finch	3.36
Bonaparte's Gull	3.31
Song Sparrow	3.29
Sanderling (SGCN-1, *Yellow WatchList*)	3.10
Rock Pigeon	3.09
Ring-necked Duck	2.89
Brown-headed Cowbird	2.81
Northern Shoveler (SGCN-2)	2.51
Turkey Vulture	2.41
Bufflehead (SGCN-2)	2.02
American Goldfinch	1.97
Brant (SGCN-2)	1.96
Black Scoter (SGCN-2)	1.77
Cedar Waxwing	1.77
American Pipit	1.68
Gadwall	1.57
Carolina Chickadee	1.56
Northern Cardinal	1.52
American Crow	1.42
Carolina Wren	1.41

Abundance Sort[1]	**Avg. birds/hr**
Tundra Swan (SGCN-2)	1.40
Savannah Sparrow	1.39
Swamp Sparrow (SGCN-1 in oart)	1.36
Lesser Scaup (SGCN-2)	1.23
House Sparrow	1.21
Red-breasted Merganser	1.07
Greater Scaup (SGCN-2)	1.04

[1] Recorded at 1.00 birds/hour or greater.

[2] Delaware-endagered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Need (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

In conclusion, Christmas Bird Count (CBC) data indicate that Snow Geese will be abundant winter visitors in the Cape Henlopen-Prime Hook region. As they feed in saltmarshes, they will frequent the vicinity of the proposed wind turbine and probably attract the endangered Bald Eagle to prey on them. Northern Harrier (Delaware endangered as a breeder) will also frequent adjacent marshes, and the endangered Forster's Tern may occasionally forage there too.

Table 4.3-2. Special-status species recorded on 2000-2009 Cape Henlopen-Prime Hook CBC (DECH)[1]

Conservation Priority and Taxonomic Sort[1]	Avg. birds/hr	% years recorded	Range # individuals
Pied-billed Grebe (DE-E)	**0.07**	100%	1-19
Black-crowned Night-Heron (DE-E)	**0.03**	70%	1-10
Bald Eagle (DE-E)	**0.19**	100%	5-32
Northern Harrier (DE-E)	**0.52**	100%	12-63
Cooper's Hawk (DE-E)	**0.06**	100%	2-8
Forster's Tern (DE-E)	**0.76**	100%	9-132
Black Skimmer (DE-E, *Yellow Watchlist*)	**0.00**	10%	1
Short-eared Owl (DE-E, *Yellow WatchList*)	**0.01**	70%	1-3
Red-headed Woodpecker (DE-E, *Yellow WatchList*)	**0.00**	20%	1
Loggerhead Shrike (DE-E)	**0.00**	20%	1
Brown Creeper (DE-E)	**0.10**	90%	3-18
Sedge Wren (DE-E)	**0.01**	70%	1-4
Canada Goose (SGCN-1 in oart)	63.81	100%	2444-8067
American Black Duck (SGCN-1)	9.13	100%	440-1100
Common Eider (SGCN-1)	0.08	60%	2-32
Sharp-shinned Hawk (SGCN-1)	0.11	100%	6-12
Ruddy Turnstone (SGCN-1)	0.44	100%	10-54
Sanderling (SGCN-1, *Yellow WatchList*)	3.10	100%	110-389
American Woodcock (SGCN-1)	0.13	100%	2-41
Long-eared Owl (SGCN-1)	0.02	70%	1-4
Prairie Warbler (SGCN-1, *Yellow WatchList*)	0.00	10%	1
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.02	70%	1-11
Seaside Sparrow (SGCN-1, *Red WatchList*)	0.02	60%	1-3
Swamp Sparrow (SGCN-1 in oart)	1.36	100%	30-214
Brant (SGCN-2)	1.96	100%	53-585
Tundra Swan (SGCN-2)	1.40	100%	15-255
Mallard (SGCN-2)	7.17	100%	175-910
Northern Shoveler (SGCN-2)	2.51	100%	56-529
Canvasback (SGCN-2)	0.02	30%	1-11
Redhead (SGCN-2)	0.01	20%	3-4
Greater Scaup (SGCN-2)	1.04	90%	15-184
Lesser Scaup (SGCN-2)	1.23	80%	72-358
scaup sp. (SGCN-2)	0.65	10%	639
Surf Scoter (SGCN-2)	6.13	100%	8-2208
White-winged Scoter (SGCN-2)	0.09	100%	2-19
Black Scoter (SGCN-2)	1.77	100%	1-979
scoter sp. (SGCN-2)	0.81	10%	800
Long-tailed Duck (SGCN-2)	0.20	100%	3-35
Bufflehead (SGCN-2)	2.02	100%	39-243
Hooded Merganser (SGCN-2)	0.38	100%	3-60
Northern Bobwhite (SGCN-2)	0.16	90%	9-28
Brown Pelican (SGCN-2)	0.00	10%	1
Double-crested Cormorant (SGCN-2)	0.51	100%	21-78
Great Cormorant (SGCN-2)	0.58	100%	1-135

Conservation Priority and Taxonomic Sort[1]	**Avg. birds/hr**	**% years recorded**	**Range # individuals**
American Bittern (SGCN-2)	0.02	70%	1-5
Great Blue Heron (SGCN-2)	0.99	100%	17-122
Great Egret (SGCN-2)	0.02	40%	1-5
Snowy Egret (SGCN-2)	0.00	10%	1
Tricolored Heron (SGCN-2)	0.00	10%	1
Black Vulture (SGCN-2)	0.49	100%	14-89
Red-shouldered Hawk (SGCN-2)	0.02	80%	1-4
Peregrine Falcon (SGCN-2)	0.02	70%	1-4
King Rail (SGCN-2, *Yellow WatchList*)	0.02	60%	1-7
Sora (SGCN-2)	0.00	10%	2
American Coot (SGCN-2)	0.11	50%	1-61
Black-bellied Plover (SGCN-2)	0.04	60%	1-14
Greater Yellowlegs (SGCN-2)	0.26	100%	2-45
Purple Sandpiper (SGCN-2)	0.72	100%	3-153
Dunlin (SGCN-2)	9.59	100%	235-1356
Little Gull (SGCN-2)	0.00	20%	1
Great Black-backed Gull (SGCN-2)	3.92	100%	172-361
Barn Owl (SGCN-2)	0.02	70%	1-5
Barred Owl (SGCN-2)	0.04	100%	1-6
Northern Flicker (SGCN-2)	0.60	100%	15-83
Brown-headed Nuthatch (SGCN-2)	0.43	100%	7-66
Marsh Wren (SGCN-2)	0.02	60%	1-3
Brown Thrasher (SGCN-2)	0.12	100%	2-32
Yellow-breasted Chat (SGCN-2)	0.00	20%	1
Eastern Towhee (SGCN-2)	0.31	100%	4-64
Field Sparrow (SGCN-2)	0.65	100%	4-116
Vesper Sparrow (SGCN-2)	0.00	10%	1
Baltimore Oriole (SGCN-2)	0.00	10%	1
Clapper Rail (*Yellow WatchList*)	0.07	90%	1-22
Iceland Gull (*Yellow WatchList*)	0.00	30%	1
Razorbill (*Yellow WatchList*)	0.01	20%	1-4
Le Conte's Sparrow (*Yellow WatchList*)	0.00	20%	1
Nelson's Sparrow (*Yellow WatchList*)	0.01	50%	1-3
Painted Bunting (*Yellow WatchList*)	0.00	10%	1
Rusty Blackbird (*Yellow WatchList*)	0.19	90%	1-116

[1] Delaware-endangered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Concern (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

5.0 Analysis of Sensitive Avian Habitats

The presence of Important Bird Areas (IBAs), reserves, and designated sensitive habitats at or near the Project site may indicate increased avian risk. We check for their presence here.

5.1 Important Bird Areas (IBAs)

The Important Bird Area (IBA) Program is sponsored by BirdLife International and Audubon. Described at http://www.audubon.org/bird/iba/, it seeks to identify and protect essential habitats for one or more species of breeding or non-breeding birds. The sites vary in size, but usually they are discrete and distinguishable in character, habitat, or ornithological importance from surrounding areas. In general, an IBA should exist as an actual or potential protected area, with or without buffer zones, or should have the potential to be managed in some way for birds and general nature conservation. An IBA, whenever possible, should be large enough to supply all or most of the requirements of the target birds during the season for which it is important.

According to information at http://www.delawareaudubon.org/birding/globaliba.html, Delaware Audubon has designated five IBAs, one of which is the Delaware Coastal Zone, which includes the Project site. It is described as follows:

> Delaware's Coastal Zone, including the C&D Canal, and the Inland Bays, contains approximately 270,000 acres. Excluding open water within this area, approximately 232,000 acres are wetlands and uplands. Breeding distribution maps indicate that the Delaware Coastal Zone contains breeding grounds for several WatchListed and endangered/threatened birds. These include the following species: Piping Plover; American Black Duck; Black Rail; Least Tern; Chuck-will's-widow; Wood Thrush; Prairie, Prothonotary, Worm-eating and Kentucky Warblers; Salt-marsh, Sharp-tailed and Seaside Sparrows; and Brown-headed Nuthatch. The importance of the Delaware Coastal Zone for birds cannot be overstated. More horseshoe crabs spawn here than anywhere else on earth. During their spring migration from South America to the Arctic, tens of thousands of the WatchListed Red Knot, Semipalmated Sandpipers, Ruddy Turnstones, Sanderlings, Dunlin, and Short-billed Dowitchers stop in Delaware to consume huge quantities of eggs laid by horseshoe crabs. This has made Delaware one of the most crucial sites for migrating shorebirds on the entire Atlantic Coast of North America. The high percentage of public and conservation lands in the Zone, plus its restrictions on heavy industry, make it a truly outstanding area for the protection of birds.

The American Bird Conservancy (ABC) has compiled a list of the 500 most important bird areas in the United States (ABC 2003). This list includes 35 IBAs in the New England/Mid-Atlantic Coast Bird Conservation Region (BCR 30; see Section 4.0), of which nine are on Delaware Bay. Two of these nine IBAs are located within 4 miles (6.4 km) of the Project site: Cape Henlopen State Park and Prime Hook Wildlife Area and National Wildlife Refuge. ABC highlights Delaware Bay for the over one million shorebirds that stage there in spring migration to feed on horseshoe crab eggs. The importance of the Delaware Bay estuary to shorebirds was discussed in Section 4.2.3.

5.2 Federal, State, and Private Protected Areas

As noted above, the Prime Hook National Wildlife Refuge is located as close as 2 miles (3.2 km) west of the Project site. Cape Henlopen State Park is located about 4 miles (6.4 km) east. American Bird Conservancy (ABC) classifies both as Important Bird Areas (IBAs). Cape Henlopen is the site of a spring and fall hawk watch (see Section 4.2.2).

Regarding private protected areas, The Nature Conservancy (TNC) manages the 17,000 Great Marsh and 149-acre Burton Farm outside of Lewes[3]. The website account does not specify the locations of these preserves, but appear to be within 2 miles (3.2 km) of the Project site. The Great Marsh preserve may abut the Project site.

In conclusion, the Project site is located in the Delaware Coastal Zone, which Delaware Audubon has classified as an Important Bird Area (IBA). The Project site is also located between Prime Hook National Wildlife Refuge and Cape Henlopen State Park, which the American Bird Conservancy (ABC) has classified as IBAs. The IBA descriptions emphasize the importance of Delaware Bay to a suite of special-status shorebirds that stage there in spring migration, and to a number of special-status breeders. Nonetheless, the Project site is not located on Delaware Bay where the shorebirds concentrate, and it appears to lack habitats that would attract special-status breeding birds.

[3] Visit http://www.nature.org/wherewework/northamerica/states/delaware/preserves/art10707.html.

6.0 Literature Review of Documented Avian Risk at Wind Farms

An increasing number of post-construction studies at U.S. wind farms has greatly improved understanding of avian impacts. We summarize this research below. Then, in the next section, we compare the Project site's avian profile (see Sections 3.0 through 5.0) with the principal research findings. In this way, we arrive at probabilistic assessments of avian risk.

Two general types of avian impacts have been documented: 1) displacement as a result of the construction and operation of wind turbines and related infrastructure, and 2) fatalities resulting from collisions with turbines and other infrastructure. They are detailed below.

This review focuses on U.S. research, as the bird species involved are the same as, or similar to, those found at the Project site. When applicable, we report on the extensive research that is being conducted in Europe.

6.1 Displacement Impacts

The footprint of turbine pads, roads, and other infrastructure required for a wind farm is generally a small percentage of a site, often estimated at two to four percent. Therefore, in general, overall land use is changed minimally by wind-power development, and actual habitat lost is generally small. This is particularly true in agricultural landscapes. But, in forested landscapes, the construction of a wind farm and its connection to the electricity grid may fragment habitat in a significant way, affecting wildlife populations (National Research Council 2007).

Despite the relatively small footprint of a wind farm, the amount of wildlife habitat altered by a wind-power project sometimes extends beyond the limits of disturbed ground. This results from the presence and operation of the wind turbines, which are large new structures in the landscape, and increased human activity to construct and maintain them. Various studies have examined wind-turbine presence to determine whether birds avoid or are displaced from an area as a result of these new features.

We discuss these studies in the following order, given the habitat composition of the Project site: 1) Grassland and Open Habitats, 2) Forest, Woodland, and Shrubland, and 3) Raptor Use.

6.1.1 Displacement in Grassland and Open Habitats

In the U.S., studies documenting disturbance, avoidance, and displacement have focused mainly on birds living in grassland and other open-country habitats, including farm fields. The most cited study took place at the **Buffalo Ridge Wind Resource Area** in southwestern Minnesota (Leddy et al. 1999). There, Conservation Reserve Program (CRP) grasslands without turbines and CRP areas located at least 180 m (590 feet) from turbines were found to support greater densities of grassland birds than CRP areas within 80 m (260 feet) of turbines. At the turbine bases, mean bird density was measured at 58.2 males/100 ha; at 40 m, 66.0 males/100 ha; and at 80 m, 128.0 males/100 ha. At 180 m, mean bird density rose to 261.0 males/100 ha. In CRP control plots, mean bird density was calculated at 312.5 males/100 ha. Bobolinks, Red-winged

Blackbirds, and Savannah Sparrows were the commonest species in CRP grasslands with turbines, whereas Bobolinks, Sedge Wrens, and Savannah Sparrows were commonest in CRP grasslands without turbines. Other birds recorded were Common Yellowthroat, Clay-colored Sparrow, Grasshopper Sparrow, Le Conte's Sparrow, Dickcissel, Western Meadowlark, and Brown-headed Cowbird.

The Buffalo Ridge study appears to demonstrate that displacement was greatest close to turbines and decreased with distance from turbines. In other words, after turbine construction, some birds either did not nest or forage near the turbines or did so at lower densities. It should be noted, however, that the Buffalo Ridge turbines were shorter (hub height of 37 m, rotor diameter of 33 m) than the turbine proposed for the Project. The Buffalo Ridge turbines were also spaced closely (separated by 91-183 m). Furthermore, the Buffalo Ridge study appears to have been conducted in the first year after construction, when vegetation at turbine construction sites may not have fully recovered and birds may not have had time to habituate to the project.

At the **Foote Creek Rim Wind Plant** in Wyoming (Johnson et al. 2000), the number of Mountain Plovers (***Red WatchList***) nesting in shortgrass prairie declined after turbine construction. Plover productivity also declined, but successful nesting was noted within 200 m (660 feet) of operating turbines.

The Buffalo Ridge and Foote Creek Rim studies show impacts extending beyond project footprints, but other studies demonstrate no differences in breeding densities.

At the **Oklahoma Wind Energy Center** (O'Connell and Piorkowski 2006, reviewed in Mabey and Paul 2007) breeding bird densities were measured at three distances: adjacent to turbines, intermediate (1 to 5 km away), and distant (5 to 10 km away). Northern Bobwhite, Scissor-tailed Flycatcher, Horned Lark, Bewick's Wren, Cassin's Sparrow, Grasshopper Sparrow, Painted Bunting, Dickcissel, and Eastern Meadowlark showed no differences in breeding density in relation to proximity to wind turbines. The same was true of an analysis of all breeding birds combined. Curiously, Killdeer was found to be most abundant at intermediate distances from turbines, and Greater Roadrunner and Western Meadowlark were found to be most abundant at distant sites. The authors concluded that most breeding grassland birds experienced no negative effects from wind turbines that would translate into a reduction of breeding density.

At the **Maple Ridge Wind Power Project** in Lewis County, New York, an impact gradient study (Kerlinger and Dowdell 2008) was conducted to determine whether birds nesting in hay fields were displaced by wind turbines erected the previous year. Mean bird densities were found to be 15.2/ha in turbine plots and 18.5/ha in reference plots, with Savannah Sparrows and Bobolinks accounting for nearly all individuals. Bobolink density was significantly lower within 75 m of turbines, but this may have been because vegetation had not yet been fully restored. Savannah Sparrow density did not reveal a displacement gradient, possibly because dirt piles near the turbines served as singing perches, attracting males. Killdeer density was greater within 75 m of turbines, undoubtedly because they nested on the bare earth and gravel pads beneath the turbines.

If displacement was occurring at Maple Ridge, it was only evident within about 75-100 m of the turbines. But, as indicated above, the displacement effect noted may have been related to impacts on vegetation rather than resulting from wind-turbine presence. It should be noted that turbine and reference plots were mowed for hay after the study, eliminating all nests. This led the authors to the conclusion that impacts from hay mowing were orders of magnitude greater than displacement by turbines, which they judged to be minimal.

At the **Erie Shores Wind Farm** in Port Burwell, Ontario, along the shore of Lake Erie (James 2008), Killdeer nested at distances of 3 to 40 m (10 nests) from the bases of turbines, Horned Larks at 15, 21, 37 and 40 m, Vesper Sparrow at 30 m, and Savannah Sparrow at 16 and 20 m. The author concluded that these species were more affected by the farming practices, including hay mowing and tilling, than by turbines.

At two wind farms in **East Anglia, England** (Devereux et al. 2008), wintering farmland birds were found not to avoid areas close to wind turbines. This study looked at the distributions of four bird groups (seed-eaters, corvids, gamebirds and skylarks) at distances ranging from 0–150 m to 600–750 m from wind turbines. Only in Ring-necked Pheasant did abundance increase with distance from wind turbines, but turbine proximity had no effect on Red-legged Partridge.

In **Europe**, a review (Hötker et al. 2006) looked at population effects, avoidance distances, and habituation at wind farms mainly in farmland and open habitats. It found that no negative population effects could be verified for any breeding birds, including Mallard, Common Buzzard, two gamebirds, four shorebirds (including Black-tailed Godwit, Redshank, Oystercatcher, and Lapwing), and various songbirds (20 species). However, breeding shorebirds and gamebirds displayed reduced numbers in connection with wind farms. Outside the breeding season, reduced densities were apparent in various geese, European Wigeon, Lapwing, and Golden Plover. For European Starling, impacts were generally positive. For most species, however, effects could not be statistically verified.

For avoidance distances, the review found a wide range of values, with some studies recording a species within 50 m of turbines, while others found the same species not approaching within hundreds of meters. Avoidance distances during the breeding season were smaller than outside the breeding season. Birds of open habitats, such as geese, ducks, and shorebirds, generally avoided turbines by several hundred meters, but there were some notable exceptions, namely, Grey Heron, raptors, Oystercatcher, gulls, European Starling, and crows.

For habituation (i.e., avoidance reactions decreasing over time), the review analyzed 122 data sets that included waterfowl, raptors, shorebirds, gulls, and songbirds. For breeding birds, 38 of 84 data sets (45%) indicated habituation. For non-breeding birds, 25 of 38 data sets (66%) indicated habituation. In other words, about half of the species analyzed demonstrated habituation. The observed degree of habituation in most cases was small, leading to the conclusion that habituation could not be ruled out, but it appeared not to be a widespread or strong phenomenon. Long-term studies should answer this question.

In North America, two studies have looked at displacement of waterbirds in agricultural habitats. Two years of post-construction studies at the **Top of Iowa Wind Plant** (Jain 2005, Koford et al. 2005) revealed that Canada Geese were not significantly displaced by the construction of 89 turbines. At the **Erie Shores Wind Farm** (James 2008), Canada Geese appeared not to be inhibited from flying through the wind farm or from using fields and ponds within 200 m of operating turbines. Goose tracks were found within 25 m (80 feet) of turbines on five occasions, with some of the tracks within 10 m (33 feet) of a tower. Tundra Swans appeared to differentiate between operating and non-operating turbines. Of 280 swans seen flying less than 300 m (990 feet) from operating turbines at rotor height, only three flew within 100 m (330 feet). But, of 240 swans seen flying past non-operating turbines, just over 20% flew less than 50 m (165 feet) from those turbines.

6.1.2 Displacement in Forest, Woodland, and Shrubland Habitats

In a recent literature review on the ecological effects of wind-energy development (National Research Council 2007), the following was concluded regarding effects on forest ecosystems:

1. Forest clearing resulting from road construction, transmission lines leading to the grid, and turbine placements represents perhaps the most significant potential change through habitat loss and fragmentation for forest-dependent species.
2. Changes in forest structure and the creation of openings may alter microclimate and increase the amount of forest edge.
3. Plants and animals throughout the ecosystem respond differently to these changes, and particular attention should be paid to species of concern that are known to have narrow habitat requirements and whose niches are disproportionately altered.

Research indicates that shrubland and forest-interior birds are likely to respond to wind farm development in different ways. The removal of forest canopy and subsequent release of the understory can benefit shrub-nesting species, such as Eastern Towhee, as has been demonstrated in timber-managed tracts (Duguay 1997, Duguay et al. 2000, 2001, cited in National Research Council 2007). On the other hand, habitat for Ovenbirds and Blackburnian Warblers is negatively correlated with understory density and positively correlated with the size and density of hardwood trees (Hagan and Meeham 2002, cited in National Research Council 2007). Territory densities of Ovenbirds were 40% less within edge areas (0 to 150 m from unpaved roads through forest) than within interior areas (150 to 300 m from roads) (Ortega and Capen 1999).

In other words, populations of shrubland species may be expected to respond positively to wind farm construction in forested areas, at least until the forest canopy fills in. Populations of forest-interior species, however, may be expected to respond negatively in the vicinity of cleared areas, with a reduction in density of territories. In heavily logged or significantly fragmented forests, effects would be less than in undisturbed forests.

Pre and post-construction studies in high-elevation forest at **Searsburg, Vermont** (Kerlinger 2000a, 2002) demonstrated a reduction in some forest-interior species, and increases in edge species, following construction of a wind farm. But, a number of common forest breeders – in order of abundance, Yellow-rumped Warbler, Dark-eyed Junco, White-throated Sparrow, Blackpoll Warbler, and Magnolia Warbler – appeared to habituate to the turbines within a year of construction. Swainson's Thrush was heard deep in the forest following construction, but during a site visit six years after construction (P. Kerlinger, personal communication), it was found singing (and likely nesting) within the forest adjacent to turbines. The management recommendation to allow forest to grow up to turbines and roadways appeared to have reduced fragmentation impacts at that site, but it was also possible that habituation had occurred.

At **Erie Shores Wind Farm** (James 2008; John Guarnaccia, personal observation), some turbines are situated at the edge of woodlots, but resident woodland and woodland-edge birds appeared to habituate readily to their presence, including forest-interior species, such as Wood Thrush (***Yellow WatchList***). Forest-edge birds lived as close as habitat allowed, including below the rotating turbine blades.

6.1.3 Displacement of Nesting and Migrating Raptors

Resident raptors appear to habituate readily to wind turbines. When Red-tailed Hawks trained for falconry were exposed at 100 feet (30 m) to the turbines at the **Altamont Pass Wind Resource Area** (APWRA) of California, at first they would not fly. Within weeks, however, they had habituated to turbines in a manner comparable to resident Red-tailed Hawks (R. Curry, personal communication). Anecdotal evidence suggests that raptor use at the APWRA may have increased since installation of the wind turbines (Orloff and Flannery 1992).

At **Erie Shores** (James 2008), construction activity displaced a pair of Bald Eagles nesting 400 m (1,310 feet) of a proposed turbine location, but the pair established a new nest about 900 m (2,950 feet) away and successfully raised two young. This pair returned to the new nest the following year, but the nest failed for unknown reasons. These adults and juveniles were seen perched within 200 m (660 feet) of active turbines, and on a few occasions they were observed flying closer than 100 m (330 feet) of rotating blades. Over the course of two years, Bald Eagles were noted flying past active turbines within 300 m (985 feet) of the towers on about 170 occasions. Most of these were along the Lake Erie shore, where they routinely soared past at less than 200 m (660 feet) away (137 times noted), but only 5 or 6 occasions were they seen less than 50 m (165 feet) of turning blades.

Also at Erie Shores (James 2008), a pair of Red-tailed Hawks nested within 135 m (215 feet) of a turbine under construction. The turbine was in operation about a month before the young had fledged, during which time the adults made hundreds of trips to the nest. They were observed on numerous occasions negotiating the airspace around the operating rotors. In 2007, possibly the same pair returned to nest, but they moved to 265 m (870 feet) from the same turbine. This location was within a quadrangle of turbines instead of on the edge of the wind farm. Cooper's Hawk nests were found at 112 m (367 feet) and 175 m (574 feet) away from the closest turbines.

At **Montezuma Hills** in California, similar numbers of raptor nests were found before and after construction of the project’s first phase (Howell and Noone 1992). At **Stateline** on the border of Oregon and Washington, two years of raptor nest monitoring showed no measurable change in density (Erickson et al. 2004). A survey of breeding Golden Eagle territories at the APWRA found that, within a sample of 58 territories, all territories occupied by eagle pairs in 2000 were also occupied in 2005 (Hunt and Hunt 2006).

Regarding migrating raptors and other birds, a study at **Tarifa** in Spain (Janss 2000, de Lucas et al. 2004) appeared to indicate that birds were aware of, and possibly avoided, wind turbines. On one ridge with turbines and two ridges without turbines, over 72,000 migrating birds (principally Black Kites, White Storks, House Martins, and Swallows) were recorded during nearly 1,000 hours of observation from fixed observation points. Changes in flight direction were recorded more often over the wind farm than over the other two areas, with migrants tending to fly higher over the wind farm. Abundance also did not appear affected by the presence of wind turbines. In contrast, resident Griffon Vultures were not observed to fly higher over the wind farm.

At **Searsburg** in Vermont (Kerlinger 2000a, 2002), a pre-construction study observed about 50% of migrating hawks over the mountaintop where wind turbines would be constructed. The other half migrated over the mountain flanks. After construction, only 10% were observed over the turbine sector. This appears to indicate avoidance by migrating hawks.

The **Erie Shores Wind Farm** is located within two miles of Lake Erie in a well-documented, fall raptor migration corridor. Twenty miles (32 km) west of Erie Shores is Hawk Cliff Hawk Watch, which averages 37,000 raptors per fall season (Zalles and Bildstein 2000). James (2008) logged more than 2,300 observations of Sharp-shinned Hawks passing through the wind farm area, with 1,534 passing within 300 m (990 feet) of the turbines. Few birds, if any, hesitated to fly near an operating wind turbine, and there were only seven instances in which single birds got close enough to spinning rotors to be judged at risk. Indeed, just over 21% of birds made course changes that brought them closer to turbines. Most of these involved birds moving along a woodland edge or a “fencerow” of trees. Had birds not changed their headings, they would have passed turbine towers at distances greater than 100 m (330 feet), but shifting course to continue to follow tree lines brought them within 50 m (160 feet) of a turbine tower. Overall, there was nothing to indicate that the turbines were an impediment to the migration of Sharp-shinned Hawks. A concurrent mortality study found one Sharp-shinned Hawk carcass in two years of study.

Other autumn migrant raptors observed at Erie Shores flying within 300 m of wind turbines were Turkey Vulture (about 1,000 observations), Osprey (12), Bald Eagle (170), Northern Harrier (115), Cooper’s Hawk (60), Northern Goshawk (6), Red-shouldered Hawk (4), Broad-winged Hawk (3), Red-tailed Hawk (300), Golden Eagle (4), American Kestrel (463), Merlin (21), and Peregrine Falcon (8). In all cases, the wind farm appeared to pose no impediment to migration, and birds appeared to negotiate the wind farm without hesitation or difficulty.

6.1.4 Displacement of Seabirds

Waterbird interactions with coastal wind farms have been well studied in Europe, where coastal and offshore wind farms have been in operation since the early 1990s. A German review of the impacts to seabirds from offshore wind farms (Dierschke and Garthe 2006) has summarized studies at five coastal wind farms.

At **Bythe Harbor** in northeastern England, nine, fairly short turbines (rotor diameter 25 m, total height 38 m) were constructed on a pier at 200 m intervals. Dierschke and Garthe (2006) report that, during a seven-year study (Still et al. 1996, Painter et al. 1999), large numbers of Great

Cormorants, Common Eiders, Black-headed Gulls, Herring Gulls, and Great Black-backed Gulls were present for several months of the year. Great Cormorants were found to cross the turbine string regularly, with 10% flying at rotor height and the rest below. In the first years, eiders flew between the turbines to enter the harbor, but later, they entered the harbor only by swimming. Large gulls made 80% of the flights between turbines, but many more flew along the turbine row (20-300 flights per ten minutes) than between them (0.7-1.5 flights per ten minutes). Great Black-backed Gulls and Herring Gulls crossed the turbines at rotor height 16% and 13% of the time respectively, with most crossing below rotor height and very few above. There were also anecdotal reports of Northern Fulmars, Black-headed Gulls, Black-legged Kittiwakes, and Sandwich Terns passing through the wind farm.

At **Maasvlakte** wind farm in the Netherlands two rows of nine and 13 turbines were built on a seawall near a breeding colony of gulls and Common Terns. The turbines are at 130-m intervals with heights of 56.5 m and rotor diameters of 35 m. According to Dierschke and Garthe (2006), van den Bergh at al. (2002) observed flight behavior of breeding birds in July of 2001. They found that 92% of seabirds at one turbine row and 62% at the other crossed below rotor height. Of those birds, 3.1% of gull flocks and 5.3% of Common Tern flocks exhibited a behavioral reaction, but only one gull turned back. Among gulls, this was about the same reaction rate as gulls flying above the turbines (3.0%). The authors concluded that the turbine rows posed no apparent barrier to foraging flights. They saw their results as showing a rapid habituation (or reduced sensitivity) to the presence of the turbines.

At **Zeebrugge** in Belgium, Everaert et al. (2002) studied flight behavior at 23 turbines of different dimensions (but all small in comparison with modern turbines) constructed on a pier. Thirteen turbines were located on the shoreline at close distance to a tern colony. The terns as well as gulls breeding elsewhere in the harbor regularly crossed the wind farm to forage at sea. According to Dierschke and Garthe's summary of the study, the majority of birds (54-82%) crossed the turbines below rotor height; only a small fraction (1-14%) crossed above. Depending on species and flight altitude, the percentage of avoidance reactions varied. We highlight the results for Common Tern, an endangered species in Delaware. At 50-m tall turbines, 498 Common Terns were recorded passing. Of the 408 birds (81.9% of total) passing at 0-15 m, 15 (3.7%) showed an avoidance reaction. Of the 35 birds (7.0%) passing at 16-50 m (rotor height), 11 (31.4%) exhibited avoidance behavior. Of the 55 birds (11.0%) passing at 51-65 m, 6 (10.9%) exhibited avoidance behavior. Interestingly, very few Least Terns exhibited avoidance behavior at any height class (5 of 1860 birds [0.2%], including 4 of 828 birds [0.5%] at rotor height; none of the 1,010 flying below rotor height demonstrated avoidance).

At **Den Oever** in the Netherlands, a single turbine was situated in the morning and evening flight paths of Black Terns and Common Terns. Dierschke and Garthe (2006) report a study during the 1997 breeding season (Dirksen et al. 1998a) in which visual and radar observation were employed to record the flight behaviors of up to 15,000 Black Terns and up to 6,500 Common Terns. These birds deviated their flight courses on both sides of the turbine, keeping a distance of 50-100 m from the turbine. Therefore, the direct vicinity of the turbine was used less than adjacent areas.

At **Lely** wind farm in the Netherlands, four turbines have been constructed 800 m (0.5 miles) offshore. These turbines had a total height of 60 m, rotor diameters of 41 m, and spacing of 200 m. Dierschke and Garthe (2006) report that Dirksen et al. (1998b) used radar to study the flight paths of two diving ducks (Pochard and Tufted Duck) whose flight paths between diurnal roosts and nocturnal feeding grounds intersected the wind farm. On moonlit nights, the ducks could apparently perceive the wind farm, because a higher proportion of ducks flew close to the wind farm and included a low rate of flights between turbines. No birds turned back, but detour reactions were common. On moonless nights, these ducks avoided approaching the wind farm; instead, they flew parallel to it. The authors also found that resident birds, in contrast to migrants stopping over, habituated to the presence of turbines, even if they constituted a barrier to their regular movements. A second study (Dirksen et al. 2000, van der Winden et al. 2000) demonstrated the same results for Greater Scaup.

6.1.4 Displacement Impacts, Conclusions

In summary, avian displacement has not been consistently demonstrated at wind farms, but they have been documented in some grassland and prairie birds and in some waterfowl and shorebirds. Forest birds, on the other hand, do not generally appear to be disturbed or displaced in a significant way by wind turbine operation; but, forest fragmentation, as a result of cutting trees and brush for wind farm construction, may impact forest-interior birds that are sensitive to edge effects and removal of forest canopy. Resident raptors may be displaced by construction activities during nesting season, but they appear to habituate to the turbines after the construction phase. Migrating raptors, however, have been shown to detect the presence of turbines and divert their course around them, but their abundance appeared not to be affected. Gulls, terns, and other waterbirds have been found to habituate to the presence of wind turbines in coastal environments and adjust their flight paths to avoid them.

6.2 Collision Mortality

6.2.1 Collision Mortality in Context

Collision mortality is well documented at wind-power sites in the United States. It is studied by systematically searching below turbines to record bird and bat carcasses found. This number is then adjusted to take into account searcher efficiency (because searchers do not find all the carcasses) and carcass removal (because scavengers may remove some carcasses before searchers look for them). According to best practices (Anderson et al. 1999, National Research Council 2007), searcher efficiency and carcass removal tests should be regularly conducted to account for different habitats, seasonal changes in ground cover, and fluctuations in scavenger populations.

A recent review of the environmental impacts of wind-energy development (National Research Council 2007) analyzed fourteen studies that measured collision mortality for an annual period and incorporated searcher-efficiency and scavenging biases into estimates. Although the protocols used in these studies varied, they generally followed the guidance in Anderson et al. (1999).

Table 6.2.1-1. Mortality Reported at U.S. Wind-Energy Projects (from National Research Council 2007)

Wind Project	# Turbines	Turbine MW	Project MW	All Bird Mortality: Turbine per year	All Bird Mortality: MW per year	Reference
Pacific Northwest						
Stateline, OR/WA[1]	454	0.66	300	1.93	2.92	Erickson et al. 2004
Vansycle, OR[1]	38	0.66	25	0.63	0.95	Erickson et al. 2004
Combine Hills, OR[1]	41	1.00	41	2.56	2.56	Young et al. 2005
Klondike, OR[1]	16	1.50	24	1.42	0.95	Johnson et al. 2003
Nine Canyon, WA[1]	37	1.30	62	3.59	2.76	Erickson et al. 2003
Rocky Mountain						
Foote Creek Rim, WY, Phase I[2]	72	0.60	43	1.50	2.50	Young et al. 2001
Foote Creek Rim, WY, Phase II[2]	33	0.75	25	1.49	1.99	Young et al. 2003
Upper Midwest						
Wisconsin[3]	31	0.66	20	1.30	1.97	Howe et al. 2002
Buffalo Ridge, MN, Phase I[3]	73	0.30	33	0.98	3.27	Johnson et al. 2002
Buffalo Ridge, MN, Phase I[3]	143	0.75	107	2.27	3.03	Johnson et al. 2002
Buffalo Ridge, MN, Phase II[3]	139	0.75	104	4.45	5.93	Johnson et al. 2002
Top of Iowa[3]	89	0.90	80	1.29	1.44	Koford et al. 2004
East						
Buffalo Mountain, TN[4]	3	0.66	2	7.70	11.67	Nicholson 2003
Mountaineer, WV[4]	44	1.50	66	4.04	2.69	Kerns and Kerlinger 2004

[1] Agricultural/grassland/Conservation Reserve Program (CRP) lands
[2] Shortgrass prairie
[3] Agricultural
[4] Forest

As can be seen in Table 6.2.1-1, mortality estimates were similar among these fourteen studies, despite differences in methodology, geography, and habitat. This suggests that these results are quantitatively robust. When the studies are averaged, they yield fatality rates of 2.51 birds/turbine/year and 3.19 birds/MW/year. The values at the Tennessee site were greater than other sites, but they do not suggest a biologically significant impact. It should be noted that a recent study at the Tennessee site (Fiedler et al. 2007) found mortality levels more in line with the other studies (see below).

Erickson et al. (2005) attempted to put this mortality in context. Based on various studies, they estimated that annual bird mortality from human-caused sources easily approaches one billion birds in the U.S. alone. The principal mortality sources they listed were:

- Collisions with windows (550 million birds, 58.2%; Klem 1990)
- Collisions and electrocutions with electric transmission lines (130 million, 13.7%; Koops 1987)
- Predation by cats (100+ million, 10.6%; Coleman and Temple 1996)
- Collisions with cars and trucks (80 million, 8.5%; Hodson and Snow 1965, Banks 1979)
- Poisoning by pesticides (67 million, 7.1%; Pimental et al. 1991)
- Collisions with communications towers (4.5 million, 0.5%; Manville 2005)

Erickson et al. (2005) did not include hunting among their mortality sources. Richkus et al. (2008) estimate that hunters harvest 100 million waterfowl and other game birds each year.

While the uncertainties in these mortality estimates are large, the numbers are so large that they cannot be obscured even by the uncertainties (National Research Council 2007). Erickson et al. did not include the impacts of hunting, oil spills, by-catch in the fishing industry, hay mowing, and several other sources of avian mortality, which together would add another 100+ million birds to their total.

In contrast, Erickson et al. found that, collisions from wind turbines amounted to <0.01% of human-caused mortality for the sources he included. Using a likely range in mortality rates averaging 2.11 birds/turbine/year and 3.04 birds/MW/year, they estimated that 20,000 to 37,000 birds were killed at about 17,500 wind turbines of 6,374 MW of total U.S. capacity in 2003. Today, with more than 30,000 wind turbines operating in the U.S., it is likely that the total numbers of fatalities at wind plants has grown to more than 75,000 per year (assuming <3 birds per turbine per year).

Based on best available estimates, Erickson et al. (2005) figured that human-caused mortality takes approximately 5% to 10% of the U.S. landbird population each year. The biological significance of this take may be uncertain, but best wildlife management practices routinely allow harvests at or above these levels for waterfowl and gamebird populations, including some species of conservation concern. Using a common species as an example, in 2007, about 1.1 million hunters harvested 20.5 million Mourning Doves (Richkus et al. 2008). This is slightly more than 15% of the total population of about 130 million individuals (Rich et al. 2004) and additive to the other human-caused Mourning Dove mortality discussed above.

For context in Delaware, we have prepared a list (Table 6.2.1-2) of SGCN species that are hunted in the state, along with their Tier status (http://www.dnrec.state.de.us/nhp/information/dewaptoc.shtml), daily bag limits, possession limits, and approximate annual harvest during the 2007 and 2008 hunting seasons (Richkus et al. 2008). Note that a total of 19 or more SGCN species are also hunted in Delaware. What is significant about this list is that it shows that even rarer species may be harvested without significant impacts to the species' populations. A comparison with wind turbine harvests is most interesting because the impacts to these species at most wind turbine sites may be counted on one hand, if not with one or two fingers. Also of note is the fact that the margin of error (confidence intervals) provided by the agencies that keep track of hunting harvests are on the order of thousands of individuals for species like waterfowl and for rails there appears to be orders of magnitude differences between high and low estimates of hunting harvest for a particular year.

Table 6.2.1-2. Summary of selected SGCN species that are hunted in Delaware and may be present at the Project site (King Rail, American Black Duck, Northern Bobwhite, and American Woodcock have all been shown to be declining in the U.S. Margin of error for Canada Geese and ducks ranges from 20-35%+ and for woodcock it was 100%.)

Species	Tier Status	Daily Bag Limit/Possession Limit Per Hunter	Average Harvest 2007 and 2008
Canada Goose	Tier 1 - Migratory	2/4	~25,000
	No Tier - Resident	15/30	
Mallard	Tier 2	4/8	~19,000
American Black Duck	Tier 1	1/2	~6,000
King (or Clapper Rail)*	Tier 2	10	<50 ± 170%
Northern Bobwhite	Tier 2	6/12	Not Available
American Woodcock	Tier 2	3/6	±1,000

*Virtually indistinguishable between species, especially when hunting.

In other words, collisions with wind turbines are a small fraction of incidental bird mortality. When added to other mortality sources, wind-turbine collisions appear unlikely to affect bird populations in a biologically significant way. This is particularly true because studies (discussed in Section 6.2.4) show that fatalities are spread among dozens of species. Nonetheless, there are taxonomic differences in collision susceptibility (see discussion of night-migrating songbirds and raptors below) and population sensitivity.

We estimate that more than 50,000 carcass searches at individual wind turbines at more than 30 sites have been conducted to date in the United States. Many more have been conducted in studies in Europe, Canada, and Australia. This research far exceeds post-construction wildlife-impact studies for all other types of electricity generation (coal, natural gas, nuclear, hydro, etc.), which account for the other 99% of electricity generation in the U.S. Permitting agencies are not requesting or requiring post-construction studies for traditional forms of electricity generation, so it is not possible to make comparisons with wind power. Granted, the wildlife effects of traditional electricity generation are generally indirect and difficult to quantify (e.g., effects of acid rain, mercury bioaccumulation, habitat fragmentation, strip mining, oil spills, and climate change), sometimes extending hundreds or thousands of miles from the point sources. But, indications are that these effects are probably immense.

For example, the Wood Thrush (***Yellow WatchList***) is a forest-interior species that breeds in the eastern North America, downwind of Midwest power-plant emissions. A Cornell University study (Hames et al. 2002) has demonstrated a strong correlation between acid rain occurrence and decreases in Wood Thrush numbers (estimated at 1.7% per year). The suspected reason is the leaching of calcium in the environment by acid rain, which results in eggshell thinning or scarcity of calcium in the diets of developing birds. While it is difficult to make a per megawatt comparison of Wood Thrush mortality between electricity sources, it is not hard to see that a decrease in fecundity over a species' range has a population effect, whereas the removal of a small number of individuals through turbine collisions does not.

This conclusion is supported by a recent review (Environmental Bioindicators Foundation and Pandion Systems 2009) that found that, overall, non-renewable electricity generation sources, such as coal and oil, pose higher risks to wildlife than renewable electricity generation sources, such as hydro and wind. Based on the comparable amounts of SO_2, NO_X, CO_2, and mercury emissions generated from coal, oil, natural gas, and hydro and the associated effects of acidic deposition, climate change, and mercury bioaccumulation, the authors found that coal as an electricity generation source is by far the largest contributor to risks to wildlife in the New York/New England region. They also detailed impacts caused by the extraction (mining and drilling) of fossil fuels, which do not occur as part of the wind-energy generation lifecycle.

6.2.2 Collision Risk Factors: Night-Migrating Songbirds

At the fourteen projects summarized in Table 6.2.2.1-1, the percentage of night-migrating songbirds among all bird fatalities was found to increase from west to east – from 24% at Stateline in the West and 48% at Foote Creek Rim in the Rocky Mountains, to 70% at Buffalo Ridge in Minnesota and 71% at Mountaineer in West Virginia (National Research Council 2007). At Buffalo Mountain in Tennessee, all birds killed were night migrants (Nicholson 2002, as well as the more recent Fiedler et al. 2007). A recent study at Maple Ridge in northern New York State (Jain et al. 2007) found that 80% of casualties were night migrants. This pattern is likely the result of the more dense nocturnal migration over eastern North American than over the western part of the continent (see Gauthreaux et al. 2003, Lowrey and Newman 1966).

These percentages translate to about one night-migrating songbird killed per turbine per year in the west, while rates in the east are, about three-five/six birds or more. What is notable, however, is that most night-migrant fatalities at wind turbines are of single birds. This is very different from the large-scale, episodic mortality events that have been documented over the past sixty years at communication towers, where some fatality events have been recorded in the hundreds or thousands of birds (Kerlinger 2000b).

Not all communication towers are responsible for large-scale, episodic mortality events. Those that do are almost all taller than 500-600 feet (152-183 m) (Kerlinger 2000b). This is likely due to the increasing volume of nocturnal migration with altitude, which was discussed above in

Section 3.2.1. Presently, the rotor-swept area of most wind turbines extends upward to about 400 feet (122 m). However, engineering advances have increased the height of wind turbines to harvest stronger winds aloft. Already, 500-foot (152-m) turbines are being proposed at some sites.

Where large mortality events have been recorded at communication towers less than 500 feet, those towers were almost without exception adjacent to sources of bright lights, such as steady-burning sodium-vapor lights (Kerlinger 2004). Very attractive to birds, sodium-vapor and other very bright lights are different from the lights the Federal Aviation Administration (FAA) stipulates for wind turbines. Sodium-vapor lights were implicated in the collisions of 30 night-migrating songbirds on a foggy night in May 2003 at the Mountaineer Wind Energy Facility in West Virginia (Kerns and Kerlinger 2004). Sodium-vapor lamps at the ridgeline substation attracted the birds, which collided with the three closest turbines (mostly the closest turbine) and the substation infrastructure. Almost no birds were found at the 41 other turbines at that project, despite 11 of them being lit with L-864 flashing red lights.

Gehring et al. (2009) have demonstrated that lighting affects the frequency of avian collisions at communication towers. In Michigan, they found a mean of 3.7 songbird fatalities per migration season under 116-146 m above ground level (agl) towers equipped with only red or white flashing obstruction lights, whereas towers with non-flashing/steady burning lights in addition to flashing lights were responsible for 13.0 fatalities per season. They also found no significant differences in fatality rates among towers lit with only red strobes, white strobes, and red, incandescent flashing lights. Their results suggest that avian fatalities can be reduced, perhaps by as much as 50-71% (about 2 million birds), at guyed communication towers simply by removing non-flashing/steady burning red lights.

Wind turbines almost never have steady-burning red L-810 obstruction lights. Rather, they are equipped with L-864 flashing red lights (preferred by FAA) and sometimes L-865 flashing white lights. Moreover, the FAA does not require that all wind turbines be lit. Instead, gaps between lights may not exceed one-half mile (0.8 km) (see FAA Advisory Circular, available at http://www.windaction.org/documents/7912). In this regard, a recent review (Kerlinger et al., unpublished manuscript) of studies at 31 wind farms showed no detectable difference in fatality rates between wind turbines deployed with L-864 flashing red lights and turbines without lights. The Kerlinger et al. study summarized the results of 25,000+ individual turbine fatality searches and revealed fatality rates at turbines across North America at between about one and five/six birds per turbine per year.

Where L-810 steady-burning red lights have been used on wind turbines, higher bird fatalities have sometimes been recorded. At Buffalo Ridge in Minnesota, a small fatality event involving 14 migrants at two adjacent turbines (seven under each turbine) was probably the result of the steady-burning red light on one of the turbines combined with weather conditions. At Erie Shores in Ontario, Canada, turbines with lighting (in all cases steady-red) averaged more night-migrant fatalities than unlit turbines. For this reason, Environment Canada requested that the lighting be changed to flashing red. This suggests that L-810 steady-burning red lights can attract birds.

It should be noted that, in its guidance document (USFWS 2003), the USFWS recommends only white strobes to avoid attracting night migrants. But as noted above, the color of the lighting appears not to matter, so long as it is not steady burning.

Finally, guy wires on tall communication towers (at many heights arrayed in three directions) probably account for almost all of the collisions, as birds attracted by lights circle the towers in a disoriented way (Gauthreaux and Besler 2006). It is noteworthy that the literature reveals few fatalities (between zero and two birds/tower/year) at freestanding (i.e., unguyed) communication towers, some of which are as tall as 475 feet (145 m) (Gehring and Kerlinger 2007a and 2007b).

In summary, wind turbines essentially lack the major risk factors implicated in large-scale mortality events involving nocturnal migrants at communication towers. These risk factors are: 1) height above 500-600 feet (152-183 m), 2) attractive lighting, and 3) guy wires. In contrast, wind turbines: 1) are relatively short in height when compared with tall communication towers, 2) have flashing lights that appear not to attract nocturnal migrants, and 3) lack guy wires.

6.2.3 Collision Risk Factors: Raptors

Raptor mortality has been generally low at most U.S. wind farms. When averaged, the raptor mortality reported in fourteen U.S. studies analyzed by the National Research Council (2007; see Table 6.2.1-1) was 0.03 birds/turbine/year and 0.04 birds/MW/year. In its review, the National Research Council saw no evidence that fatalities caused by wind turbines had resulted in measurable demographic changes to U.S. bird populations, including raptors, but it did single out the Altamont Pass Wind Resource Area (APWRA) as a possible exception with respect to raptors. We examined the Altamont to shed light on factors that increase raptor collision risk.

Located east of San Francisco, the APWRA is one of three early wind farms constructed in California in the 1980s, the other two being Tehachapi and San Gorgonio (Palm Springs). Unlike present day wind farms, these early plants crowded thousands of small turbines into the landscape. Today, the APWRA still has between 5,000 and 5,400 turbines of various types and sizes (ranging from 40 kW to 300 kW, with 100 kW the most common) that total approximately 550 MW (102 kW/turbine) (National Research Council 2007). Sited in treeless grassland on rolling hills, the APWRA contains abundant perching sites for raptors on the lattice towers of the older turbines and on aboveground transmission lines (National Research Council 2007). Already in progress, repowering will substantially decrease the number of turbines, as older models are replaced with new ones, but the APWRA’s total rotor-swept area will likely not decrease (Thelander and Smallwood 2007).

Raptors are remarkably abundant in the APWRA. In one study (Thelander et al. 2003), the five most commonly observed species among all birds were Red-tailed Hawk (30% of observations), Turkey Vulture (14%), Common Raven (13%), Golden Eagle (7%), and American Kestrel (7%). Mortality searches found that Golden Eagle, Red-tailed Hawk, and American Kestrel were killed more often than expected based on abundance, while Turkey Vulture and Common Raven were rarely killed (Orloff and Flannery 1992, 1996).

Golden Eagle mortality was particularly high, estimated at 1,500-2,300 individuals over the past two decades (Thelander and Smallwood 2007), but these estimates have been questioned. According to the National Research Council (2007), a four-year radio telemetry study conducted by Hunt (2002), concluded that the APWRA's Golden Eagle population was self-sustaining, but fatalities resulting from wind-energy development were concerning because the population apparently depended on immigration of eagles from other subpopulations to fill vacant territories. A follow-up survey in 2005 (Hunt and Hunt 2006) found that, within a sample of 58 territories, all territories occupied by eagle pairs in 2000 were also occupied in 2005.

Several factors are believed to contribute to raptor risk in the APWRA (Howell and DiDonato 1991, Orloff and Flannery 1992, 1996), namely:

- **High raptor abundance,** related to a high density of California ground squirrels and other prey
- **High turbine density creating many obstacles to flight,** with thousands of closely spaced turbines (less than 10 m [30 feet] between rotors)
- **Some turbines sited in high risk situations,** such as in canyons, where mortality was found to be greater
- **Rotor-swept area close to ground** (within 10 m [30 feet]) in airspace where raptors forage extensively
- **Lattice towers that encourage perching on turbines**, drawing birds to the turbines
- **Rotors that are difficult to see,** because they revolve at high rates (40-72 rpm)

Fortunately, new turbine designs avoid or minimize most of these risk factors. For example, raptors cannot perch on the tubular towers of late-model turbines, and they can better see the rotors, which spin slowly (at 12-18 rpm). Raptors have more room to maneuver among late-model turbines, because they are spaced more than 250 m (800 feet) apart, and their rotors do not sweep lower than 30 m (100 feet).

Of particular importance, however, is improved understanding, gained through mortality studies, of what siting and habitat conditions increase risk. Thelander and Smallwood (2007) found that fatality rates at the APWRA were weakly related to most landscape elements, such as slope conditions, but turbines in canyons killed more raptors, especially Golden Eagles. Red-tailed Hawk fatalities appear to be strongly linked to pocket gopher distribution, whereas turbine strings where Golden Eagles are killed appear to be associated with rock piles, which provide cover for cottontail rabbits.

These findings suggest a number of actions to minimize fatalities, such as not placing turbines in canyons, not piling rocks cleared from lay-down areas near turbines, and not grazing cattle intensively near turbines (because short grass attracts rodent colonies and the raptors that prey on them). High raptor abundance at the APWRA is expected to continue, but with repowering, avoiding turbine placements in canyons, and managing habitat to draw raptors away from turbines, raptor mortality should decrease significantly.

No other wind-power site in North America has a raptor abundance approaching that of the APWRA. But, with modern turbine designs, attention to avoiding risky turbine placements, and, when necessary, habitat management to draw raptors away from turbines, wind farms may minimize raptor mortality and avoid regional population effects.

6.2.4 Review of Avian Mortality Studies

Based on the reports to which we have access, more than 40 avian mortality studies have been conducted at wind farms in the United States and Canada. They are listed with a summary of mortality data in Appendix F. In this section, we review the results by region and discuss noteworthy findings.

In the **Eastern United States**, wind farms are mostly located in farmland and on forested ridges, but coastal projects are beginning to be built. The empirically estimated fatality rate at a mountaintop site in Tennessee (Nicholson 2003) was greater (7.7 birds/turbine/year) than at other U.S. sites (see Table 6.2.2.1-1), but a more recent study (Fiedler et al. 2007) has shown much reduced mortality (1.8 birds/turbine/year) at that site. In general, fatality rates in the East (above 4 birds/turbine/year) are greater than in the far west, likely because of greater densities of night-migrating songbirds (see Gauthreaux et al. 2003, Lowrey and Newman 1966). Raptor mortality has been low, consisting mainly of resident Turkey Vultures and Red-tailed Hawks (various studies). This is despite intensive wind-farm development on Appalachian ridges, where a heavy fall raptor migration occurs (Zalles and Bildstein 2000). On those ridges, a raptor species of special concern is Golden Eagle, because a large, but unknown, fraction of its relatively small eastern North American population migrates along central Appalachian ridges in both late fall and early spring (Brandes 2005). To date, Golden Eagle mortality has not been recorded. One Peregrine Falcon and two Osprey (both state-listed) were recorded among 29 carcasses found at a small coastal wind farm bordering saltmarsh in New Jersey (New Jersey Audubon 2008). Very few waterbirds have been recorded at inland sites, but mainly gulls made up 11 of 29 carcasses discovered at the coastal New Jersey site.

In the **Central United States**, wind farms are sited mainly in farmland. Measured fatality rates (correcting for searcher efficiency and scavenging) have been low, between 0.98 and 4.45 birds/turbine/year (see Table 6.2.1-1). As already noted, night-migrating songbirds made up about 70% of fatalities at one site. Raptor fatalities have generally been low, but recent studies from Texas (Tierney 2007) and Oklahoma (Schnell et al. 2007) show surprising mortality among Turkey Vultures. This species frequents many U.S. wind farms, but it is infrequently recorded in mortality studies (see APWRA discussion above). In the Texas study, most of the Turkey Vultures that could be aged were juveniles, suggesting that younger birds may be more collision prone. Regarding waterbirds, at the Top of Iowa wind farm, a study (Jain 2005, Koford et al. 2005) of 89 turbines located within one to two miles of three waterfowl management areas reporting >1.5 million duck and goose-use-days per year revealed no fatalities of Canada Geese or other waterfowl, despite intense use of the turbine fields. Waterfowl use of the wind-farm area did not diminish after construction. At Buffalo Ridge in Minnesota (Johnson et al. 2002), few waterbirds were recorded among victims, despite their regular presence and the wind farm's location on a major migration route (Bellrose 1980). Similarly, no waterfowl fatalities were found during a study at the Crescent Ridge wind plant in north-central Illinois (Kerlinger et al. 2007).

In the **Rocky Mountains**, wind turbines have mostly been constructed in rangeland and shortgrass prairie. Fatality rates have been recorded at less than 2 birds/turbine/year (see Table 6.2.1-1). At a site in Wyoming (Young et al. 2003), about half of the fatalities were migrating songbirds. Most of the recorded fatalities at a Colorado site (Kerlinger et al., unpublished manuscript) were resident Horned Larks, which were likely struck on their aerial courtship flights. At that site, raptor fatalities have been infrequent, involving mostly resident American Kestrels. Very few waterbird casualties have been recorded.

In **California and the Pacific Northwest**, wind farms are mostly situated in farmland and grassland. Outside the Altamont (APWRA, see Section 6.2.3), reported fatality numbers have been small. At facilities in Oregon and Washington, fatality rates have ranged from 0.63 to 3.59 birds/turbine/year (see Table 6.2.1-1), with night-migrant casualties calculated at 24% at Stateline on the Washington/Oregon border (Erickson et al. 2004). It is important to note that the large number of raptor fatalities recorded at the APWRA has not been recorded at other California wind farms (Tehachapi and San Gorgonio) that also have thousands of older turbine models (Anderson et al. 2000). This strongly suggests that raptor abundance at the APWRA was the principal risk factor, along with topography and dense spacing of turbines. Elsewhere, raptor mortality has been low, including studies with no raptors recorded among victims. Waterbird mortality has been very low.

In **Canada**, mortality at the Erie Shores Wind Farm in Ontario (James 2008) was estimated at between 2.0 and 2.5 birds/turbine/year, including a rate of 0.04 birds/turbine/year for raptors. Mortality was slightly greater at wind turbines within 200 m (660 feet) of the Lake Erie shore bluffs, at turbines with steady red aviation-warning lights, and within 50 m (165 feet) of woodlands. In future installation of wind farms in the Great Lakes area, James (2008) recommends that all turbines be kept at least 250 m (820 feet) away from shore bluffs or shores, aviation-warning lights should be flashing, and turbine bases should be kept at least 50 m (165 feet) from trees. Two other studies in Ontario revealed mortality levels similar to those at Erie Shores.

In **Europe**, bird collisions with wind farms have been less comprehensively investigated than in the U.S. (Hötker et al. 2006). Data compiled by Dürr (2001, 2004; reviewed by Hötker et al.) show notably high raptor mortality at mountain sites (especially Griffon Vulture) and among gulls and raptors (especially White-tailed Eagle) at wetland and coastal sites. High Red Kite mortality has occurred in Germany where wind turbines were placed in pastures and fallow fields, where birds hunt for rodents, but converting fields to cropland appears to be an effective method for drawing birds away from turbines and reducing mortality (Jan Blew, personal communication). Hötker et al. (2006) have found that species or species groups that show little avoidance reaction to wind farms (e.g., birds of prey, gulls, and starlings) are more likely to be collision victims than species that tend to avoid wind farms (e.g., geese and shorebirds). Crows are a notable exception in that they do not avoid wind farms, yet they are rarely killed.

Migrant fatalities have been relatively rare at European sites, notably so at migration bottlenecks, such as Tarifa, Spain, where several hundred thousand soaring birds, including more than 100,000 raptors, and millions of other birds, converge on the Straits of Gibraltar to cross between Europe and Africa (Marti Montes and Barrios Jaque 1995, Janss 2000, Barrios and Rodriguez

2004, and de Lucas et al. 2004). Moreover, as discussed above, migrants were found not to exhibit behaviors that put them at risk of collision, such as flying within 5 m (16 feet) of wind turbines (Barrios and Rodriguez 2004). Nonetheless, mortality at Tarifa was relatively high in resident Griffon Vultures and Kestrels, the former in winter wind conditions that limited their maneuverability, the latter during the breeding season at turbine locations in preferred hunting habitats (Barrios and Rodriguez 2004). Elsewhere in Spain, significant Griffon Vulture mortality has been recorded at wind farms in the Pyrenees Mountains of Navarre, where high mortality was found at closely spaced turbines on ridges habitually used for soaring by nearby colonies, with higher rates in wind conditions that limited maneuverability (Lekuona 2001). There is also a recent report from Valencia of 250 Griffon Vultures killed in one month at a wind farm (Bowyer et al. 2009).

6.2.5 Collision Mortality, Conclusions

Post-construction fatality studies have demonstrated that fatalities are relatively infrequent events at wind farms. In a recent literature review, calculated mortality rates at U.S. wind farms were similar, averaging 2.51 birds per turbine per year and 3.19 birds per MW per year. Rates were greater in the eastern U.S. (up to about 7 birds/turbine/year) than in the west, presumably because of the denser nocturnal migration of songbirds in eastern North America. To date, no federally listed endangered or threatened species have been killed, and only occasional waterfowl or shorebird fatalities have been documented. For raptors, only at the Altamont Pass Wind Resource Area (APWRA) and at some European sites have fatality levels been suggestive of biologically significant impacts. However, research indicates that raptor fatalities can be minimized by avoiding high-risk turbine placements and by managing habitat so that raptors hunt away from turbines.

7.0 Avian Risk Assessment for the University of Delaware Wind Turbine Project

7.1 Displacement Risk

The wind turbine at the University of Delaware site will be constructed on what appears to be barren fill bordering a 10-acre (4-ha) patch of disturbed shrubby woodland. An extensive saltmarsh of many hundreds of acres begins at about 200 feet (60 m) from the turbine base. Thus, a small number of individuals of an assortment of mainly common shrubland/edge species are expected to inhabit the shrubland, while larger numbers of a few saltmarsh-specialty species are expected to inhabit the adjacent marsh.

We define displacement risk as the probability that bird densities around wind turbines decrease to the point of having a population effect. Using this measure, it is likely that bird species inhabiting the Project site and vicinity will not be at significant risk of displacement, because they have large populations that have withstood environmental disturbance (e.g., agriculture, residential development, draining of saltmarshes, etc.). Possible exceptions would be endangered species, because they have small populations and generally require less disturbed habitats, but data sources indicate that endangered species are not likely to nest close enough to the proposed turbine to be displaced by it.

It is uncertain whether saltmarsh breeding birds, such as Saltmarsh Sparrow and Seaside Sparrow (both SGCN-1 and ***Red WatchList***), will be reduced in the vicinity of the turbine. Nonetheless, a small reduction in density, if it occurs, is unlikely to have a population effect, given that the populations of these species are reasonably large and abundant habitat occurs in the Project vicinity. Furthermore, it will probably be impossible to test for reduced densities given that sample sizes will be too small around a single turbine.

7.2 Collision Risk

To begin this section, we summarize a fatality study conducted at a coastal wind farm in New Jersey. The results of that study are particularly applicable to the Project because of habitat and geographic similarities. New Jersey Audubon (2008) studied collision mortality at the Atlantic County Utility Authority (ACUA) Wind Energy Facility (see Figure 1), a 5-turbine wind farm located 57 miles (92 km) northeast of the Project site. It is situated on a tidal creek in saltmarsh 2 miles (3.2 km) from the Atlantic Ocean. New Jersey Audubon searched each turbine about 100 times from August 2007 to September 2008 (roughly three migration, one winter, and one nesting season) and found 23 avian carcasses:

- **9 gulls (39%),** 7 Laughing Gulls, one Herring Gull, and one Great Black-backed Gull
- **6 night-migrating songbirds (26%),** one each of Red-eyed Vireo, Ruby-crowned Kinglet, Blue-gray Gnatcatcher, Gray Catbird, Swamp Sparrow, and Baltimore Oriole.
- **3 raptors (13%),** two Osprey (NJ threatened and Delaware SGCN-1) and one Peregrine Falcon (NJ endangered and Delaware SGCN-2)
- **2 shorebirds (9%),** one Short-billed Dowitcher and one American Woodcock
- **2 unknown species (9%)**
- **1 Red-winged Blackbird (4%),** a diurnal migrant

Note that among the fatalities during three migration seasons, as well as one winter and one nesting season, there were no waterfowl and only two shorebirds reported, despite the site being located in one of the most dense concentration areas of shorebirds and waterfowl along the East Coast. Preconstruction studies (Kerlinger 2003) revealed that more than 3,600 waterfowl and 1,100+ shorebirds were present within the boundaries of the ACUA turbine areas during fall 2002. The ACUA site is also adjacent to a designated Western Hemisphere Shorebird Reserve Network site (Forsythe National Wildlife Refuge) and a New Jersey Wildlife Management Area. Thus, although these birds were present in large numbers, they were not highly susceptible to colliding with the five wind turbines. The relative scarcity of waterfowl and shorebird fatalities has also been demonstrated in more than 30 studies at wind farms across North America (see Section 7.2.3 discussion). Many of those wind farms are situated adjacent to waterfowl management areas or migration stopover areas where tens of thousands to millions of these birds occur during fall and spring migration.

Given that New Jersey Audubon has not reported searcher efficiency and carcass removal rates, mortality rates of some species at the ACUA facility cannot be directly compared with other wind farms. Nonetheless, waterbird mortality, excluding gulls, was minimal and not that much different from what has been recorded at inland wind farms in the U.S. Ducks and geese were absent, as were herons, egrets, ibis, rails, terns, and other waterbirds. Higher gull fatality rates are to be expected, given the ACUA wind farm's coastal situation, and given that gulls were attracted by the thousands to sewage treatment tanks and settling ponds adjacent to turbines. The number of discovered carcasses of night-migrating songbirds (even when the two unknown species are added) does not appear to indicate that much greater mortality than that documented at inland wind farms in the Eastern U.S., but we await New Jersey Audubon's final report.

Given that collision risk varies with bird type, we will discuss the various bird groups separately: night-migrating songbirds, raptors, waterbirds, and listed species.

7.2.1 Night-migrating Songbirds

As discussed in Section 6.2.2, wind turbines essentially lack the risk factors demonstrated for large-scale mortality events involving nocturnal migrants at tall communication towers. In contrast, wind turbines: 1) are shorter than tall communication towers, 2) have flashing lights that do not attract nocturnal migrants (Gehring et al. 2009, Kerlinger et al. in prep.), and 3) lack guy wires, which are responsible for a vast majority of collisions.

Regarding collision risk to night-migrating songbirds at the Project site, the studies discussed in Section 4.2.1 strongly suggest that nocturnal migration occurs across a broad front at altitudes mostly above the sweep of wind-turbine rotors. A small percentage of migrants is likely to fly below 125 m (410 feet, the height of the proposed wind turbine) and to be at risk of collision. If L-864 red-flashing lights (likely to be recommended by the FAA) are installed on the Project's turbine, evidence suggests that these birds will not be attracted to collide. Therefore, significant fatality events at the University of Delaware site are not an issue, and the number of fatalities on a per turbine per year basis will likely be similar to that found at Eastern U.S. wind farms, which generally have reported fewer than five night migrants per turbine per year. This is further supported by the small number of observed fatalities of night migrants (N = 6) at the coastal ACUA wind farm.

The Atlantic Ocean is a migration barrier that can precipitate fallout events in coastal woodlands after heavy flight nights. It is unlikely, however, that extraordinary numbers of songbirds will use the shrubland patch at the Project site, given the patch's small size and distance from the coast, and given that similar habitat is abundant in the Delaware coastal zone.

7.2.2 Raptors

In Section 6.2.3, the discussion of raptor risk factors focused on the Altamont Pass Wind Resource Area (APWRA), the only U.S. wind farm where potentially significant raptor mortality has been reported. Because modern turbines will be used at the Project site, raptor risk factors involving older turbines at the APWRA do not apply (e.g., high turbine density creating many obstacles to flight, rotor-swept area close to the ground, lattice towers that encourage perching on turbines, rotors that are difficult to see). Therefore, we examine the other risk factors that could conceivably apply: high raptor abundance and high-risk situations.

Data from the Breeding Bird Survey (BBS; see Section 4.1.2) and Christmas Bird Counts (CBC; see Section 4.3) indicate that raptor abundance is relatively low in the breeding and winter seasons. Data from Cape Henlopen (see Section 4.2.2) indicate a significant coastal raptor migration in fall, with Osprey and Sharp-shinned Hawk (both SGCN-1) particularly abundant. Raptor numbers are an order of magnitude less in spring migration, when no species is particularly abundant.

The Project site is sufficiently inland from Cape Henlopen and barrier beaches to be off the main raptor migration path, but migrating Osprey, Sharp-shinned Hawks, falcons, and other species may occasionally hunt in the vicinity of the proposed turbine. As explained in Section 6.1.3, studies from Tarifa, Spain, and Erie Shores, Canada, indicate that migrating raptors tend to avoid wind turbines and are not particularly collision prone. Nonetheless, two Osprey (SGCN-2) and one Peregrine Falcon (SGCN-2) were recorded among fatalities in 18 months of research at the ACUA wind farm (see above).

Topography at the site does not present a risk to soaring raptors. The site lacks canyons and steep hills (where raptor mortality was particularly high at the APWRA), as well as traditional soaring ridges (where Griffon Vulture mortality was high at sites in Spain).

7.2.3 Waterbirds

Waterbird mortality at U.S. wind farms has been demonstrated to be relatively low (but see the ACUA example above) and in many cases, nonexistent. In a review of bird collisions reported in 31 studies at wind-energy facilities, Erickson et al. (2001, cited in National Research Council 2007) reported that 5.3% of fatalities were waterfowl, 3.3% waterbirds (mainly rails and coot), and 0.7% shorebirds. It is interesting that waterfowl and shorebirds are mostly nocturnal migrants, but they do not appear to be attracted to lights (FAA or other types). Hüppop et al. (2006) demonstrated this in their carcass searches at the illuminated FINO 1 platform in the

North Sea, where they found no waterfowl and only one shorebird (a Dunlin) among 442 carcasses.

Given that the Project site is located on a saltmarsh, waterbird mortality may be similar to that reported at the ACUA wind farm (see above), which was mainly gulls and no waterfowl. Nonetheless, the Project would consist of only one turbine and the site lacks the sewage settling ponds that attracted gulls to the ACUA site. Thus, even gull mortality is likely to be low. Gull mortality, if it occurs, is unlikely to result in a population effect. Wildlife managers kill thousands of gulls each year at New York City-area airports to minimize risk of bird collisions with aircraft, but this program has not curbed regional gull populations in a significant way (Dolbeer et al 1993).

7.2.4 Listed Species

Any listed species that habituates to the Project's turbine and regularly flies at or near rotor height may be at greater risk of collision. In this regard, the Delaware-endangered Bald Eagle may qualify because wintering eagles are likely to hunt Snow Geese and other waterbirds in the saltmarsh adjacent to the turbine. It is important to point out, however, that Bald Eagle has not been reported in collision studies at any U.S. wind farms. Note, however, that closely related White-tailed Eagle in Europe has been killed at coastal wind farms in Germany (Dürr 2001, 2004) and Norway (reported by BirdLife International).

Other listed species are likely to fly over the saltmarsh adjacent to the turbine, but they would do so mostly at altitudes lower than the rotor-swept zone. Thus, collision risk would be low. Possibilities include Black-crowned Night-Heron, Yellow-crowned Night-Heron, Northern Harrier, American Oystercatcher (also ***Yellow WatchList***), Common Tern, Forster's Tern, Least Tern (also federally endangered and ***Red WatchList***), and Black Skimmer (also ***Yellow WatchList***). All of these species were observed near the ACUA turbines, yet none were found dead by New Jersey Audubon despite intensive search effort.

7.2.5 Collision Risk, Conclusions

In most respects, fatality numbers and species impacted are likely to be similar, on a per turbine per year basis, to those found at Eastern U.S. wind farms. Those fatalities are not likely to be biologically significant because there will be only one turbine at the Project site and because the small number of fatalities likely to result will be distributed among several species. Collision risk to night-migrating songbirds is likely to be similar to other sites examined because migration occurs on broad fronts at altitudes mostly above the rotor-swept zone; in addition, habitat at the Project site is unlikely to attract large numbers of songbirds in coastal fallout events. Collision risk factors for raptors also will likely be minimal, given that raptor abundance is generally low, the Project is removed from coastal migration paths, and the proposed turbine placement does not appear to be problematic. The Project may register slightly greater waterbird mortality, particularly among gulls, than inland wind farms because of its coastal location. Among listed species, the Delaware-endangered Bald Eagle may be at slightly elevated collision risk because some eagles are likely to hunt Snow Geese and other waterbirds in the saltmarsh adjacent to the turbine.

8.0 Recommendations

Pre-construction Studies

- A seasonal flight-use study may be considered, although the project is so small as to make impacts minimal and, therefore, preconstruction studies cannot predict risk precisely or reliably. Such a study would measure flight use of the site (particularly at altitudes equivalent to the rotor-swept zone) by raptors, waterbirds, and landbirds, paying particular attention to the endangered Bald Eagle and other special-status species.

Construction Guidelines

- Electrical lines within the Project site should be underground. Any new above-ground lines from the site to a substation or transmission line should follow Avian Power Line Interaction Committee (APLIC) guidelines for insulation, spacing, and obstruction marking.
- Permanent meteorology towers, if any are proposed, should be freestanding (i.e., without guy wires) to prevent the potential for avian collisions.
- Size of roads and turbine pads should be minimized to disturb as little habitat as possible. After construction, the area around the turbine should be maintained as mowed lawn to facilitate a mortality study.
- Lighting of turbines and other infrastructure should be minimal to reduce potential for attracting night-migrating songbirds and other species. Federal Aviation Administration (FAA) night-obstruction lighting should only be flashing beacons (L-864 red or white strobe [or LED], or red-flashing L-810) with the longest permissible off cycle. Steady-burning (L-810) red FAA lights should not be used. Sodium vapor lamps and spotlights should not be used at any facility (e.g., lay-down area or substation) at night except when emergency maintenance is needed.

Post-construction Studies

- A mortality study following best practices should be conducted over a two-year period, with the second year contingent on what is found during the first year. In other words, if fatalities in the first year are construed as biologically significant, a second year of study would be conducted.
- Results of the mortality study should be compared with cradle-to-grave (life-cycle) cumulative impacts to birds from other types of power generation now supplying electricity in Delaware. This comparison would facilitate long-term planning with respect to electrical generation and wildlife impacts. The study should seek information from USFWS, DDFW, and environmental organizations regarding existing energy-generation impacts to wildlife in Delaware. If information is not available, these agencies and organizations should consider funding such studies.

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<u>Appendix A.</u> Photographs of representative habitats

<u>Appendix A.</u> Photographs of representative habitats (continued)

Appendix B. Birds observed during 4 December 2009 site visit

Species listed in the Delaware Wildlife Action Plan (Allen et al. 2006) are indicated. Delaware-endangered (DE-E) species are shown in boldface, and Species of Greatest Conservation Need (SGCN) are noted; see Section 4.1 discussion.

Snow Goose
Canada Goose (SGCN-2)
American Black Duck (SGCN-1)
Mallard (SGCN-2)
Bufflehead (SGCN-2)
Northern Gannet
Double-crested Cormorant (SGCN-2)
Great Blue Heron (SGCN-2)
Black Vulture (SGCN-2)
Turkey Vulture
Bald Eagle (DE-E)
Northern Harrier (DE-E when breeding)
Cooper's Hawk (DE-E when breeding)
Red-shouldered Hawk (SGCN-2)
Red-tailed Hawk
Merlin
Killdeer
Ring-billed Gull
Herring Gull
Great Black-backed Gull
Rock Pigeon
Mourning Dove
Belted Kingfisher
Red-bellied Woodpecker
Downy Woodpecker
Northern Flicker
Blue Jay
American Crow
Fish Crow
Horned Lark
Carolina Chickadee
Tufted Titmouse
Carolina Wren
Winter Wren
Golden-crowned Kinglet
Hermit Thrush
American Robin
Gray Catbird
Northern Mockingbird
Brown Thrasher (SGCN-2)
European Starling
American Pipit
Cedar Waxwing
Yellow-rumped Warbler
Eastern Towhee (SGCN-2)
Field Sparrow (SGCN-2)
Fox Sparrow
Song Sparrow
Swamp Sparrow (SGCN-1)
White-throated Sparrow
Dark-eyed Junco
Northern Cardinal
Red-winged Blackbird
Common Grackle
Brown-headed Cowbird
House Finch
American Goldfinch
House Sparrow

58 species

Appendix C. Correspondence from USFWS and DDFW.

Letters could not be scanned because of poor quality of pdf file. Letters to be inserted in final version of report.

Appendix D. Average breeding bird abundance on 2000-200 Harrington BBS route (21003)

Taxonomic Sort[1]	Avg. birds/hr	Abundance Sort[1]	Avg. birds/hr
Canada Goose (SGCN-2)	9.20	Common Grackle	109.08
Wood Duck	0.36	European Starling	58.08
Gadwall	0.04	Red-winged Blackbird	45.72
American Black Duck (SGCN-1)	0.40	American Robin	40.04
Mallard (SGCN-2)	2.04	Laughing Gull	34.96
Ring-necked Pheasant	0.04	House Sparrow	30.12
Wild Turkey	0.08	Purple Martin	29.04
Northern Bobwhite (SGCN-2)	2.60	Mourning Dove	28.52
Pied-billed Grebe (DE-E)	**0.04**	Barn Swallow	24.68
Double-crested Cormorant (SGCN-2)	3.60	Turkey Vulture	19.52
Least Bittern (SGCN-2)	0.04	Northern Cardinal	17.56
Great Blue Heron (SGCN-2)	3.00	Northern Mockingbird	16.40
Great Egret (SGCN-2)	0.08	Indigo Bunting	15.24
Snowy Egret (SGCN-2)	1.48	Ring-billed Gull	15.04
Tricolored Heron (SGCN-2)	0.04	American Crow	15.00
Cattle Egret (SGCN-2)	0.04	Carolina Wren	14.48
Green Heron	1.36	Song Sparrow	14.44
Black-crowned Night-Heron (DE-E)	**0.08**	Horned Lark	10.12
Glossy Ibis (SGCN-2)	0.40	Willet (SGCN-2)	9.92
Black Vulture (SGCN-2)	2.12	House Finch	9.88
Turkey Vulture	19.52	American Goldfinch	9.88
Osprey (SGCN-1)	0.92	Blue Grosbeak	9.60
Mississippi Kite	0.04	Canada Goose	9.20
Bald Eagle (DE-E)	**0.16**	Rock Pigeon	8.68
Northern Harrier (DE-E)	**0.08**	Common Yellowthroat	8.48
Cooper's Hawk (DE-E)	**0.12**	Red-eyed Vireo	8.04
Red-shouldered Hawk (SGCN-2)	0.04	Chimney Swift (SGCN-2)	7.76
Red-tailed Hawk	1.08	Tufted Titmouse	7.44
American Kestrel	0.12	Chipping Sparrow	7.28
Clapper Rail (*Yellow WatchList)*	1.16	Brown-headed Cowbird	7.17
Killdeer	2.36	Red-bellied Woodpecker	5.80
Black-necked Stilt (SGCN-2)	0.32	Seaside Sparrow (SGCN-1, *Red WatchList*)	5.64
Willet (SGCN-2)	9.92	Fish Crow	5.44
Laughing Gull	34.96	Cedar Waxwing	5.44
Ring-billed Gull	15.04	Great Crested Flycatcher (SGCN-2)	5.24
Herring Gull	3.40	Wood Thrush (SGCN-1, *Yellow WatchList*)	4.76
Great Black-backed Gull	0.36	Boat-tailed Grackle	3.96
Forster's Tern (DE-E)	**1.04**	Blue Jay	3.76
Least Tern (DE-E, *Red WatchList*)	**0.12**	Eastern Wood-Pewee	3.72
Black Skimmer (DE-E, *Yellow WatchList*)	**0.24**	Double-crested Cormorant (SGCN-2)	3.60
Rock Pigeon	8.68	Orchard Oriole	3.60

Mourning Dove	28.52
Yellow-billed Cuckoo	0.36
Great Horned Owl	0.12
Barred Owl (SGCN-2)	0.04
Common Nighthawk (SGCN-1)	0.08
Chuck-will's-widow	0.20
Whip-poor-will (SGCN-2)	0.04
Chimney Swift (SGCN-2)	7.76
Ruby-throated Hummingbird	0.44
Belted Kingfisher	0.12
Red-bellied Woodpecker	5.80
Downy Woodpecker	1.24
Hairy Woodpecker	0.68
Northern Flicker (SGCN-2)	1.12
Pileated Woodpecker	0.32
Eastern Wood-Pewee	3.72
Acadian Flycatcher	2.76
Willow Flycatcher (SGCN-2, *Yellow WatchList*)	0.56
Eastern Phoebe	0.44
Great Crested Flycatcher (SGCN-2)	5.24
Eastern Kingbird (SGCN-2)	1.88
White-eyed Vireo	1.60
Yellow-throated Vireo (SGCN-2)	0.08
Red-eyed Vireo	8.04
Blue Jay	3.76
American Crow	15.00
Fish Crow	5.44
unid. Crow	1.08
Horned Lark	10.12
Purple Martin	29.04
Tree Swallow	3.32
Northern Rough-winged Swallow	0.60
Bank Swallow (SGCN-2)	1.28
Barn Swallow	24.68
Carolina Chickadee	1.92
Tufted Titmouse	7.44
Carolina Wren	14.48
House Wren	1.04
Marsh Wren (SGCN-2)	1.88
Blue-gray Gnatcatcher	1.32
Eastern Bluebird	2.00
Wood Thrush (SGCN-1, *Yellow WatchList*)	4.76
American Robin	40.04
Gray Catbird	3.16
Northern Mockingbird	16.40
Brown Thrasher (SGCN-2)	1.12
European Starling	58.08

Herring Gull	3.40
Tree Swallow	3.32
Gray Catbird	3.16
Great Blue Heron (SGCN-2)	3.00
Acadian Flycatcher	2.76
Northern Bobwhite (SGCN-2)	2.60
Killdeer	2.36
Black Vulture (SGCN-2)	2.12
Mallard (SGCN-2)	2.04
Eastern Bluebird	2.00
Swamp Sparrow (SGCN-1)	2.00
Carolina Chickadee	1.92
Eastern Kingbird (SGCN-2)	1.88
Marsh Wren (SGCN-2)	1.88
Ovenbird	1.80
Scarlet Tanager (SGCN-2)	1.76
Eastern Meadowlark	1.76
White-eyed Vireo	1.60
Snowy Egret (SGCN-2)	1.48
Yellow Warbler	1.40
Green Heron	1.36
Blue-gray Gnatcatcher	1.32
Prothonotary Warbler (SGCN-2, *Yellow WatchList*)	1.32
Bank Swallow (SGCN-2)	1.28
Downy Woodpecker	1.24
Field Sparrow (SGCN-2)	1.20
Clapper Rail (*Yellow WatchList)*	1.16
Northern Flicker (SGCN-2)	1.12
Brown Thrasher (SGCN-2)	1.12
Red-tailed Hawk	1.08
unid. Crow	1.08
Grasshopper Sparrow (SGCN-2)	1.08
Forster's Tern (DE-E)	**1.04**
House Wren	1.04
Osprey (SGCN-1)	0.92
Yellow-breasted Chat (SGCN-2)	0.72
Eastern Towhee (SGCN-2)	0.72
Hairy Woodpecker	0.68
Northern Rough-winged Swallow	0.60
Willow Flycatcher (SGCN-2, *Yellow WatchList*)	0.56
Pine Warbler	0.52
Ruby-throated Hummingbird	0.44
Eastern Phoebe	0.44
American Black Duck (SGCN-1)	0.40
Glossy Ibis (SGCN-2)	0.40
Yellow-throated Warbler (SGCN-2)	0.40
Kentucky Warbler (SGCN-2, *Yellow WatchList*)	0.40

Cedar Waxwing	5.44
Northern Parula (DE-E)	**0.04**
Yellow Warbler	1.40
Yellow-throated Warbler (SGCN-2)	0.40
Pine Warbler	0.52
American Redstart (SGCN-1)	0.20
Prothonotary Warbler (SGCN-2, *Yellow WatchList*)	1.32
Worm-eating Warbler (SGCN-2)	0.08
Ovenbird	1.80
Louisiana Waterthrush (SGCN-2)	0.12
Kentucky Warbler (SGCN-2, *Yellow WatchList*)	0.40
Common Yellowthroat	8.48
Hooded Warbler (DE-E)	**0.04**
Yellow-breasted Chat (SGCN-2)	0.72
Summer Tanager	0.12
Scarlet Tanager (SGCN-2)	1.76
Eastern Towhee (SGCN-2)	0.72
Chipping Sparrow	7.28
Field Sparrow (SGCN-2)	1.20
Grasshopper Sparrow (SGCN-2)	1.08
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.04
Seaside Sparrow (SGCN-1, *Red WatchList*)	5.64
Song Sparrow	14.44
Swamp Sparrow (SGCN-1)	2.00
Northern Cardinal	17.56
Blue Grosbeak	9.60
Indigo Bunting	15.24
Dickcissel	0.12
Red-winged Blackbird	45.72
Eastern Meadowlark	1.76
Boat-tailed Grackle	3.96
Common Grackle	109.08
Brown-headed Cowbird	7.17
Orchard Oriole	3.60
Baltimore Oriole (SGCN-2)	0.20
House Finch	9.88
American Goldfinch	9.88
House Sparrow	30.12
125 species	

Wood Duck	0.36
Great Black-backed Gull	0.36
Yellow-billed Cuckoo	0.36
Black-necked Stilt (SGCN-2)	0.32
Pileated Woodpecker	0.32
Black Skimmer (DE-E, *Yellow WatchList*)	**0.24**
Chuck-will's-widow	0.20
American Redstart (SGCN-1)	0.20
Baltimore Oriole (SGCN-2)	0.20
Bald Eagle (DE-E)	**0.16**
Cooper's Hawk (DE-E)	**0.12**
American Kestrel	0.12
Least Tern (DE-E, *Red WatchList*)	**0.12**
Great Horned Owl	0.12
Belted Kingfisher	0.12
Louisiana Waterthrush (SGCN-2)	0.12
Summer Tanager	0.12
Dickcissel	0.12
Wild Turkey	0.08
Great Egret (SGCN-2)	0.08
Black-crowned Night-Heron (DE-E)	**0.08**
Northern Harrier (DE-E)	**0.08**
Common Nighthawk (SGCN-1)	0.08
Yellow-throated Vireo (SGCN-2)	0.08
Worm-eating Warbler (SGCN-2)	0.08
Gadwall	0.04
Ring-necked Pheasant	0.04
Pied-billed Grebe (DE-E)	**0.04**
Least Bittern (SGCN-2)	0.04
Tricolored Heron (SGCN-2)	0.04
Cattle Egret (SGCN-2)	0.04
Mississippi Kite	0.04
Red-shouldered Hawk (SGCN-2)	0.04
Barred Owl (SGCN-2)	0.04
Whip-poor-will (SGCN-2)	0.04
Northern Parula (DE-E)	**0.04**
Hooded Warbler (DE-E)	**0.04**
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.04
Cumulative Abundance	**764.97**

[1] Delaware-endangered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Concern (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

Appendix E. Average abundance of wintering birds on 2000-2009 Cape Henlopen-Prime Hook CBC (DECH)

Taxonomic Sort[1]	Avg. birds/hr	Abundance Sort[1]	Avg. birds/hr
Greater White-fronted Goose	0.00	Snow Goose	1,143.31
Snow Goose	1,143.31	Common Grackle	67.73
Ross's Goose	0.03	Canada Goose (SGCN-1 in oart)	63.81
Brant (SGCN-2)	1.96	Red-winged Blackbird	57.53
Cackling Goose	0.01	European Starling	24.14
Canada Goose (SGCN-1 in oart)	63.81	Ring-billed Gull	23.64
Mute Swan	0.07	Herring Gull	18.70
Tundra Swan (SGCN-2)	1.40	American Robin	14.71
Wood Duck	0.08	Northern Pintail	12.56
Gadwall	1.57	Dunlin (SGCN-2)	9.59
Eurasian Wigeon	0.00	American Black Duck (SGCN-1)	9.13
American Wigeon	0.59	Mallard (SGCN-2)	7.17
American Black Duck (SGCN-1)	9.13	Surf Scoter (SGCN-2)	6.13
Mallard (SGCN-2)	7.17	American Green-winged Teal	5.88
Blue-winged Teal	0.00	Yellow-rumped Warbler	5.30
Northern Shoveler (SGCN-2)	2.51	White-throated Sparrow	5.04
Northern Pintail	12.56	Dark-eyed Junco	4.31
American Green-winged Teal	5.88	Great Black-backed Gull (SGCN-2)	3.92
Canvasback (SGCN-2)	0.02	Mourning Dove	3.89
Redhead (SGCN-2)	0.01	House Finch	3.36
Ring-necked Duck	2.89	Bonaparte's Gull	3.31
Greater Scaup (SGCN-2)	1.04	Song Sparrow	3.29
Lesser Scaup (SGCN-2)	1.23	Sanderling (SGCN-1, *Yellow WatchList*)	3.10
scaup sp. (SGCN-2)	0.65	Rock Pigeon	3.09
Common Eider (SGCN-1)	0.08	Ring-necked Duck	2.89
Harlequin Duck	0.00	Brown-headed Cowbird	2.81
Surf Scoter (SGCN-2)	6.13	Northern Shoveler (SGCN-2)	2.51
White-winged Scoter (SGCN-2)	0.09	Turkey Vulture	2.41
Black Scoter (SGCN-2)	1.77	Bufflehead (SGCN-2)	2.02
scoter sp. (SGCN-2)	0.81	American Goldfinch	1.97
Long-tailed Duck (SGCN-2)	0.20	Brant (SGCN-2)	1.96
Bufflehead (SGCN-2)	2.02	Black Scoter (SGCN-2)	1.77
Common Goldeneye	0.05	Cedar Waxwing	1.77
Hooded Merganser (SGCN-2)	0.38	American Pipit	1.68
Common Merganser	0.08	Gadwall	1.57
Red-breasted Merganser	1.07	Carolina Chickadee	1.56
Ruddy Duck	0.79	Northern Cardinal	1.52
Wild Turkey	0.01	American Crow	1.42
Northern Bobwhite)SGCN-2)	0.16	Carolina Wren	1.41
Red-throated Loon	0.95	Tundra Swan (SGCN-2)	1.40
Common Loon	0.15	Savannah Sparrow	1.39
Pied-billed Grebe (DE-E)	**0.07**	Swamp Sparrow (SGCN-1 in oart)	1.36
Horned Grebe	0.07	Lesser Scaup (SGCN-2)	1.23
Northern Gannet	0.37	House Sparrow	1.21

Brown Pelican (SGCN-2)	0.00
Double-crested Cormorant (SGCN-2)	0.51
Great Cormorant (SGCN-2)	0.58
American Bittern (SGCN-2)	0.02
Great Blue Heron (SGCN-2)	0.99
Great Egret (SGCN-2)	0.02
Snowy Egret (SGCN-2)	0.00
Tricolored Heron (SGCN-2)	0.00
Black-crowned Night-Heron (DE-E)	**0.03**
Black Vulture (SGCN-2)	0.49
Turkey Vulture	2.41
Bald Eagle (DE-E)	**0.19**
Northern Harrier (DE-E)	**0.52**
Sharp-shinned Hawk (SGCN-1)	0.11
Cooper's Hawk (DE-E)	**0.06**
Northern Goshawk	0.00
Red-shouldered Hawk (SGCN-2)	0.02
Red-tailed Hawk	0.28
Rough-legged Hawk	0.01
Golden Eagle	0.00
American Kestrel	0.10
Merlin	0.03
Peregrine Falcon (SGCN-2)	0.02
Clapper Rail (*Yellow WatchList*)	0.07
King Rail (SGCN-2, *Yellow WatchList*)	0.02
Virginia Rail	0.04
Sora (SGCN-2)	0.00
American Coot (SGCN-2)	0.11
Black-bellied Plover (SGCN-2)	0.04
Semipalmated Plover	0.01
Killdeer	0.37
Greater Yellowlegs (SGCN-2)	0.26
Lesser Yellowlegs	0.15
Ruddy Turnstone (SGCN-1)	0.44
Sanderling (SGCN-1, *Yellow WatchList*)	3.10
Western Sandpiper	0.05
Least Sandpiper	0.05
Pectoral Sandpiper	0.00
Purple Sandpiper (SGCN-2)	0.72
Dunlin (SGCN-2)	9.59
Long-billed Dowitcher	0.05
Common Snipe	0.08
American Woodcock (SGCN-1)	0.13
Laughing Gull	0.10
Little Gull (SGCN-2)	0.00
Black-headed Gull	0.01
Bonaparte's Gull	3.31

Red-breasted Merganser	1.07
Greater Scaup (SGCN-2)	1.04
Great Blue Heron (SGCN-2)	0.99
Snow Bunting	0.98
Red-throated Loon	0.95
Northern Mockingbird	0.90
Eastern Meadowlark	0.88
Eastern Bluebird	0.86
Blue Jay	0.84
scoter sp. (SGCN-2)	0.81
Ruddy Duck	0.79
Forster's Tern (DE-E)	**0.76**
Tufted Titmouse	0.76
Purple Sandpiper (SGCN-2)	0.72
Golden-crowned Kinglet	0.71
Boat-tailed Grackle	0.70
scaup sp. (SGCN-2)	0.65
Field Sparrow (SGCN-2)	0.65
Northern Flicker (SGCN-2)	0.60
American Wigeon	0.59
Great Cormorant (SGCN-2)	0.58
Northern Harrier (DE-E)	**0.52**
Double-crested Cormorant (SGCN-2)	0.51
Black Vulture (SGCN-2)	0.49
Horned Lark	0.49
Downy Woodpecker	0.48
Ruddy Turnstone (SGCN-1)	0.44
Brown-headed Nuthatch (SGCN-2)	0.43
Hooded Merganser (SGCN-2)	0.38
Red-bellied Woodpecker	0.38
Northern Gannet	0.37
Killdeer	0.37
Tree Swallow	0.31
Eastern Towhee (SGCN-2)	0.31
Red-breasted Nuthatch	0.29
Red-tailed Hawk	0.28
Great Horned Owl	0.28
Greater Yellowlegs (SGCN-2)	0.26
Hermit Thrush	0.23
Ruby-crowned Kinglet	0.22
Long-tailed Duck (SGCN-2)	0.20
Bald Eagle (DE-E)	**0.19**
Rusty Blackbird (*Yellow WatchList*)	0.19
White-crowned Sparrow	0.17
Northern Bobwhite)SGCN-2)	0.16
Winter Wren	0.16
Fox Sparrow	0.16

Ring-billed Gull	23.64
Herring Gull	18.70
Iceland Gull (*Yellow WatchList*)	0.00
Lesser Black-backed Gull	0.05
Glaucous Gull	0.00
Great Black-backed Gull (SGCN-2)	3.92
Caspian Tern	0.00
Forster's Tern (DE-E)	**0.76**
Black Skimmer (DE-E, *Yellow Watchlist*)	**0.00**
Razorbill (*Yellow WatchList*)	0.01
Rock Pigeon	3.09
Mourning Dove	3.89
Barn Owl (SGCN-2)	0.02
Eastern Screech-Owl	0.14
Great Horned Owl	0.28
Barred Owl (SGCN-2)	0.04
Long-eared Owl (SGCN-1)	0.02
Short-eared Owl (DE-E, *Yellow WatchList*)	**0.01**
Northern Saw-whet Owl	0.02
Rufous Hummingbird	0.00
Belted Kingfisher	0.13
Red-headed Woodpecker (DE-E, *Yellow WatchList*)	**0.00**
Red-bellied Woodpecker	0.38
Yellow-bellied Sapsucker	0.04
Downy Woodpecker	0.48
Hairy Woodpecker	0.14
Northern Flicker (SGCN-2)	0.60
Pileated Woodpecker	0.03
Eastern Phoebe	0.02
Loggerhead Shrike (DE-E)	**0.00**
Northern Shrike	0.00
Blue Jay	0.84
American Crow	1.42
Fish Crow	0.02
Horned Lark	0.49
Tree Swallow	0.31
Carolina Chickadee	1.56
Tufted Titmouse	0.76
Red-breasted Nuthatch	0.29
White-breasted Nuthatch	0.02
Brown-headed Nuthatch (SGCN-2)	0.43
Brown Creeper (DE-E)	**0.10**
Carolina Wren	1.41
House Wren	0.01
Winter Wren	0.16
Sedge Wren (DE-E)	**0.01**
Marsh Wren (SGCN-2)	0.02

Common Loon	0.15
Lesser Yellowlegs	0.15
Eastern Screech-Owl	0.14
Hairy Woodpecker	0.14
American Woodcock (SGCN-1)	0.13
Belted Kingfisher	0.13
Brown Thrasher (SGCN-2)	0.12
Sharp-shinned Hawk (SGCN-1)	0.11
American Coot (SGCN-2)	0.11
American Kestrel	0.10
Laughing Gull	0.10
Brown Creeper (DE-E)	**0.10**
White-winged Scoter (SGCN-2)	0.09
Gray Catbird	0.09
Wood Duck	0.08
Common Eider (SGCN-1)	0.08
Common Merganser	0.08
Common Snipe	0.08
Mute Swan	0.07
Pied-billed Grebe (DE-E)	**0.07**
Horned Grebe	0.07
Clapper Rail (*Yellow WatchList*)	0.07
Cooper's Hawk (DE-E)	**0.06**
Common Goldeneye	0.05
Western Sandpiper	0.05
Least Sandpiper	0.05
Long-billed Dowitcher	0.05
Lesser Black-backed Gull	0.05
Virginia Rail	0.04
Black-bellied Plover (SGCN-2)	0.04
Barred Owl (SGCN-2)	0.04
Yellow-bellied Sapsucker	0.04
American Tree Sparrow	0.04
Chipping Sparrow	0.04
Purple Finch	0.04
Ross's Goose	0.03
Black-crowned Night-Heron (DE-E)	**0.03**
Merlin	0.03
Pileated Woodpecker	0.03
Pine Siskin	0.03
Canvasback (SGCN-2)	0.02
American Bittern (SGCN-2)	0.02
Great Egret (SGCN-2)	0.02
Red-shouldered Hawk (SGCN-2)	0.02
Peregrine Falcon (SGCN-2)	0.02
King Rail (SGCN-2, *Yellow WatchList*)	0.02
Barn Owl (SGCN-2)	0.02

Golden-crowned Kinglet	0.71
Ruby-crowned Kinglet	0.22
Eastern Bluebird	0.86
Hermit Thrush	0.23
American Robin	14.71
Gray Catbird	0.09
Northern Mockingbird	0.90
Brown Thrasher (SGCN-2)	0.12
European Starling	24.14
American Pipit	1.68
Cedar Waxwing	1.77
Orange-crowned Warbler	0.01
Yellow-rumped Warbler	5.30
Pine Warbler	0.02
Prairie Warbler (SGCN-1, *Yellow WatchList*)	0.00
Palm Warbler	0.02
Northern Waterthrush	0.00
Common Yellowthroat	0.02
Yellow-breasted Chat (SGCN-2)	0.00
Eastern Towhee (SGCN-2)	0.31
American Tree Sparrow	0.04
Chipping Sparrow	0.04
Clay-colored Sparrow	0.00
Field Sparrow (SGCN-2)	0.65
Vesper Sparrow (SGCN-2)	0.00
Savannah Sparrow	1.39
Le Conte's Sparrow (*Yellow WatchList*)	0.00
Nelson's Sparrow (*Yellow WatchList*)	0.01
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.02
Seaside Sparrow (SGCN-1, *Red WatchList*)	0.02
Fox Sparrow	0.16
Song Sparrow	3.29
Lincoln's Sparrow	0.00
Swamp Sparrow (SGCN-1 in oart)	1.36
White-throated Sparrow	5.04
White-crowned Sparrow	0.17
Dark-eyed Junco	4.31
Snow Bunting	0.98
Northern Cardinal	1.52
Painted Bunting (*Yellow WatchList*)	0.00
Red-winged Blackbird	57.53
Eastern Meadowlark	0.88
Rusty Blackbird (*Yellow WatchList*)	0.19

Long-eared Owl (SGCN-1)	0.02
Northern Saw-whet Owl	0.02
Eastern Phoebe	0.02
Fish Crow	0.02
White-breasted Nuthatch	0.02
Marsh Wren (SGCN-2)	0.02
Pine Warbler	0.02
Palm Warbler	0.02
Common Yellowthroat	0.02
Saltmarsh Sparrow (SGCN-1, *Red WatchList*)	0.02
Seaside Sparrow (SGCN-1, *Red WatchList*)	0.02
Cackling Goose	0.01
Redhead (SGCN-2)	0.01
Wild Turkey	0.01
Rough-legged Hawk	0.01
Semipalmated Plover	0.01
Black-headed Gull	0.01
Razorbill (*Yellow WatchList*)	0.01
Short-eared Owl (DE-E, *Yellow WatchList*)	**0.01**
House Wren	0.01
Sedge Wren (DE-E)	**0.01**
Orange-crowned Warbler	0.01
Nelson's Sparrow (*Yellow WatchList*)	0.01
Red Crossbill	0.01
Greater White-fronted Goose	0.00
Eurasian Wigeon	0.00
Blue-winged Teal	0.00
Harlequin Duck	0.00
Brown Pelican (SGCN-2)	0.00
Snowy Egret (SGCN-2)	0.00
Tricolored Heron (SGCN-2)	0.00
Northern Goshawk	0.00
Golden Eagle	0.00
Sora (SGCN-2)	0.00
Pectoral Sandpiper	0.00
Little Gull (SGCN-2)	0.00
Iceland Gull (*Yellow WatchList*)	0.00
Glaucous Gull	0.00
Caspian Tern	0.00
Black Skimmer (DE-E, *Yellow Watchlist*)	**0.00**
Rufous Hummingbird	0.00
Red-headed Woodpecker (DE-E, *Yellow WatchList*)	**0.00**
Loggerhead Shrike (DE-E)	**0.00**

Common Grackle	67.73	Northern Shrike	0.00
Boat-tailed Grackle	0.70	Prairie Warbler (SGCN-1, *Yellow WatchList*)	0.00
Brown-headed Cowbird	2.81	Northern Waterthrush	0.00
Baltimore Oriole (SGCN-2)	0.00	Yellow-breasted Chat (SGCN-2)	0.00
Purple Finch	0.04	Clay-colored Sparrow	0.00
House Finch	3.36	Vesper Sparrow (SGCN-2)	0.00
Red Crossbill	0.01	Le Conte's Sparrow (*Yellow WatchList*)	0.00
Common Redpoll	0.00	Lincoln's Sparrow	0.00
Pine Siskin	0.03	Painted Bunting (*Yellow WatchList*)	0.00
American Goldfinch	1.97	Baltimore Oriole (SGCN-2)	0.00
House Sparrow	1.21	Common Redpoll	0.00
190 species		**Cumulative Abundance**	**1,567.12**

[1] Delaware-endangered species are indicated in boldface; see Table 4.1-1. Species of Greatest Conservation Concern (SGCN) and *WatchList* species are noted; see discussion in Section 4.1.

Appendix F. Annotated review of avian fatality studies at North American wind farms

Recorded fatalities are the number of carcasses found. Fatality estimates (/turbine/yr, except where indicated) factor in searcher efficiency and carcass removal (see Section 6.2.1). Modern turbines have a height range of about 58.5 m (192 feet) to above 122.0 m (400 feet), older turbines below 50 m (164 feet). No turbine had guy wires. Citations may be found at end of appendix.

Eastern U.S. – Farmland, Forest, and Saltmarsh

Mars Hill, ME: 28 modern turbines on forested ridge, two years of study using daily (first year only) and weekly searches, plus seasonal dog-assisted searches: 36 recorded fatalities, mostly night-migrating songbirds except for one Ruffed Grouse and one Barred Owl; fatality estimated at 0.44-2.65/turbine/year (Stantec 2008, 2009)

Hull, MA: 1 modern turbine adjacent to high school on island in Boston Harbor, dozens of informal searches by high school students for at least one year: 0 recorded fatalities (Malcolm Brown, personal communication in 2002)

Atlantic County Utility Authority, NJ: 5 modern turbines in filled saltmarsh along waterway, searches from August 2007 to September 2008: 23 observed fatalities, including 3 raptors (2 Osprey and 1 Peregrine Falcon), 9 gulls, 2 shorebirds, and 6 night-migrating songbirds (New Jersey Audubon Society 2008)

Clinton, NY: 67 modern turbines in farmland with woodlots, with 23 turbines searched at daily, 3-day, or weekly intervals over six months spanning migration seasons: 14 recorded fatalities, including 9 night migrants, 1 raptor (Broad-winged Hawk), 2 Killdeers, and 1 Rock Pigeon; fatality estimated at 1.4-3.3/turbine/year (Jain et al. 2009a)

Eagle, NY: 67 modern turbines in farmland with woodlots, with 23 turbines searched at daily, 3-day, or weekly intervals from April 21 to November 14: 20 recorded fatalities, including 14 night migrants, 4 raptors (Sharp-shinned and Red-tailed hawks), and 2 gamebirds (Ruffed Grouse and American Woodcock); fatality estimated at 0.7-4.3/turbine/year (Jain et al. 2009b)

Ellenburg, NY: 54 modern turbines in farmland with woodlots, with 18 turbines searched at daily, 3-day, or weekly intervals from April 28 to October 13: 12 recorded fatalities, including 8 night migrants, 1 raptor (Broad-winged Hawk), 1 woodpecker (Northern Flicker), 1 Tree Swallow, and 1 European Starling; fatality estimated at 1.2-2.1/turbine/year (Jain et al. 2009c)

Madison, NY: 7 modern turbines in farmland, one year of study: 4 recorded fatalities, including 2 night-migrating songbirds, 1 owl, and 1 woodpecker, no diurnal raptors or waterbirds (Kerlinger 2002a)

Maple Ridge, NY: 195 modern turbines in farmland adjacent to fragmented forest on Tug Hill Plateau, with 50-64 turbines searched mostly at weekly intervals (daily and 3-day intervals in first year), three years of study: ~90 recorded fatalities per year in searches, most of which were night migrants, few raptors (range of 1 to 3); fatality estimated at 3.1-4.6/turbine/year based on weekly search interval (Jain et al. 2007, 2009d, 2009e)

Tug Hill Plateau, NY: 2 older turbines in farmland, 2 migration seasons: 0 recorded fatalities (Cooper et al. 1995)

Garrett, PA: 8 modern turbines in farm fields in Somerset County, one year of study: 0 recorded fatalities (Kerlinger 2001)

Meyersdale, PA: 20 modern turbines on forested ridge in Somerset County, all turbines searched more than 20 times from July 30 to September 13, 2004: 13 recorded fatalities, mostly night-migrating songbirds, no raptors or waterbirds (Arnett et al. 2005)

Buffalo Mountain, TN: Two studies on forested, strip-mined mountain: 1) 3 modern turbines searched for three years: fatalities estimated at ~7/turbine/year (Nicholson 2003); 2) searched again after 15 taller turbines added: fatality estimated at 1.8/turbine/year (Fiedler et al. 2007)

Searsburg, VT: 11 modern turbines on forested mountain near Green Mountain National Forest, studied during nesting and fall migration seasons: 0 recorded fatalities (Kerlinger 2002b)

Mountaineer, WV: Two studies of 44 modern turbines on forested ridge: 1) 22 searches throughout year of all turbines in 2003: 69 recorded fatalities, ~75% night-migrating songbirds, 2 Turkey Vultures, 1 Red-tailed Hawk; fatalities estimated at 4.04/turbine/year (Kerns and Kerlinger 2004); 2) 20+ searches from July 31 to September 11, 2004: 15 recorded fatalities (Arnett et al. 2005)

Mount Storm, WV: 82 modern turbines on wooded ridge, of which 27 turbines searched (two-thirds weekly and one-third daily; 978 total searches) in July-October 2008: 29 recorded fatalities, over 80% night-migrating songbirds, 1 Turkey Vulture; fatality estimates for study period were 3.81/turbine for daily search interval and 2.41/turbine for weekly search interval (Young et al. 2009)

Central U.S. – Farmland

Algona, IA: 3 modern turbines in farmland, 3 migration seasons: 0 recorded fatalities (Demastes and Trainer 2000)

Top of Iowa, IA: 89 modern turbines, of which 26 studied over two years, in tilled farmland: 7 recorded fatalities, mostly songbirds, 2 Red-tailed Hawks, no waterfowl despite high use of nearby wildlife management areas; fatality estimated at 0.38-0.90/turbine/year (Jain 2005, Koford et al. 2005)

Crescent Ridge, IL: 33 modern turbines in farmland, 1,363 turbine searches in fall and spring migration: 10 recorded fatalities, mostly night migrants, 1 Red-tailed Hawk; fatality estimated at ~1/turbine/year (Kerlinger et al. 2007)

Jeffrey Energy Center, KS: 2 modern turbines in grassland/prairie adjacent to a coal-fired power plant, 66 turbine searches in two migration seasons: 0 recorded fatalities (Young et al. 2000)

Buffalo Ridge, MN: Over 400 mostly modern turbines in farmland and grassland, four years of study (1996-1999): 55 recorded fatalities among 31 species, of which 42 (76.4%) were songbirds, one raptor (Red-tailed Hawk); depending on the section of the wind farm studied, estimated fatality ranged from 2.27 to 4.45/turbine/year (Johnson et al. 2002)

Ainsworth, NE: 36 wind turbines in sandhills/grazing land studied during one year: 27 recorded fatalities, including 9 Horned Larks, 2 American Kestrels, 1 Sharp-tailed Grouse, 1 Upland Sandpiper, 1 Short-eared Owl, and songbirds; fatality rate of 2.7/turbine per year with 2.5/turbine/year for small birds (Derby et al. 2007)

Blue Canyon II, OK: 84 turbines, of which 50 studied over one year: 15 recorded fatalities, including 11 Turkey Vultures, 2 Red-tailed Hawks, and 2 songbirds; fatality estimated at 0.25/turbine/year for raptors and 0.27/turbine/year for songbirds (Schnell et al. 2007)

Buffalo Gap I, TX: 67 turbines, of which 21 studied over one year: 21 recorded fatalities, including 15 Turkey Vultures, 1 Red-tailed Hawk, and 3 passerines; fatality estimated at 2.37/turbine/year, including 0.43/turbine/year for raptors (Tierney 2007)

Kewaunee, WI: 31 modern turbines in farmland, two years of study (four migration seasons): 25 recorded fatalities, including three waterfowl, 14 songbirds (some night migrants), no raptors; fatality estimated at 1.3/turbine/year (Howe et al. 2002)

Shirley, WI: 2 modern turbines in farmland, 54 surveys over spring and fall migration in one year: 1 recorded fatality, a night-migrating songbird (Howe and Atwater 1999)

<u>Western U.S. – Prairie and Farmland</u>

Altamont Pass, CA: 5,400 older turbines mostly on lattice towers in grazing and tilled land, over 20 years of study: recorded fatalities number in the thousands, of which over 40% are raptors, with Red-tailed Hawk, Burrowing Owl, American Kestrel, and Golden Eagle most often found; fatality estimated recently (Smallwood and Thelander 2008) at 4.67/MW/year for all birds, 1.94/MW/year for raptors (Howell and DiDonato1991, Howell 1997, Orloff and Flannery 1992, 1996, Kerlinger and Curry 1997, Thelander and Rugge 2000, Smallwood and Thelander 2005, Smallwood and Thelander 2008, Altamont Pass Avian Monitoring Team 2008)

High Winds, CA: 90 modern turbines in tilled farmland, 4,220 turbine searches over two years: 163 recorded fatalities, including 71 raptors of 7 species (45 American Kestrels, 18 Red-tailed Hawks), 60 songbirds of 17 species, and 5 waterbirds; fatality estimated at 2.0-2.9/turbine/year (Kerlinger et al. 2006)

Montezuma Hills, CA: 237 older turbines, 11 modern turbines in tilled farmland, with 59 turbines searched twice weekly for 18 months: 13 recorded fatalities, including 5 Red-tailed

Hawks, 4 American Kestrels, 1 Mallard, 1 Rock Dove, and 2 Red-winged Blackbirds (Howell 1997)

San Gorgonio, CA: About 3,000 older turbines in desert, 423 turbines sampled every 90 days in two one-year periods: 61 recorded fatalities among 19 species, including two Red-tailed Hawks; raptor fatality unadjusted for searcher efficiency and scavenging estimated at 0.006/turbine/yr or 0.03/MW/year (Anderson et al. 2005)

Tehachapi Pass, CA: About 3,300 turbines in grazing land and scrub in mountains of Mojave Desert, 637 turbines sampled over 17 months: 127 recorded fatalities among 27 species, including 54 raptors (of most numerous, 14 Red-tailed Hawks, 13 Great Horned Owls, and 9 American Kestrels); raptor fatality estimated at 0.04/turbine/year, or 0.20/MW/year (Anderson et al. 2004)

Ponnequin, CO: 29 modern turbines in rangeland, increased to 41 in 2001, five years of study (1999-2003): ~24 recorded fatalities each year; Horned Lark most abundant, 1 teal, 1 American Kestrel, other songbirds (Kerlinger and Curry 2000, Kerlinger, unpublished data)

Judith Gap, MT: 90 turbines in cropland and grassland, of which 20 searched monthly: 26 recorded fatalities, including 10 songbirds, 1 Merlin, 1 Short-eared Owl, 1 Sharp-tailed Grouse, and 13 waterbirds (7 grebes, 2 ducks, 4 coots); fatality estimate for study period was 4.52/turbine (TRC Environmental Corporation 2008)

Klondike, OR: 16 modern turbines in rangeland and shrub-steppe, one year of study: 8 recorded fatalities, mostly songbirds, of which half night migrants, 2 Canada Geese, no raptors; fatality estimated at 1.3/turbine/year (Johnson et al. 2003)

Vansycle, OR: 38 modern turbines in farm and rangeland, one year of study: 12 recorded fatalities among 6 species, including 6 songbirds, of which at least 4 were night migrants, 4 game birds, 1 woodpecker, and 1 swift, no raptors or waterbirds; fatality estimated at 0.63/turbine/year (Erickson et al. 2000)

Stateline, OR/WA: 454 modern turbines in farmland, of which 399 searched over two years: 232 recorded fatalities among 35 species, of which nearly 40% were resident Horned Larks and nearly 25% night-migrating songbirds, most of 13 raptor fatalities were Red-tailed Hawks and American Kestrels; fatality estimated at 1.65/turbine/year for all birds, 0.06/turbine/year for raptors (Erickson et al. 2004)

Nine Canyon, WA: 37 modern turbines in prairie and farmland searched over one year: 36 recorded fatalities, with 47% Horned Larks, 14% Ring-necked Pheasant, and 6% Western Meadowlarks, two raptors (a kestrel and Short-eared Owl); fatality estimated at 3.59/turbine/year (Erickson 2003)

Foote Creek Rim, WY: 69 modern turbines in prairie/rangeland, two years of study: 122 recorded fatalities, of which 83 at turbines and 36 at guyed meteorology towers, with 92% songbirds (Horned Lark most common victim; nearly half of songbirds were night migrants), 3

American Kestrels, 1 Northern Harrier, 1 Short-eared Owl, 1 grebe; fatality estimated at 1.45-2.04/turbine/year (Young et al. 2003)

Canada

Erie Shores, ON: 66 modern turbines in farmland with woodlots, two migration seasons: fatalities estimated at 2.0-2.5/turbine/year, including 0.04/turbine/year for raptors (James 2008)

Exhibition Place, ON: 1 modern turbine on Toronto lakefront, 2 migration seasons: 2 recorded fatalities, European Starling and American Robin; fatalities estimated at 3/turbine/year (James and Coady 2003)

Pickering, ON: 1 modern turbine near a marsh, 2 migration seasons: 2 recorded fatalities, both night-migrating songbirds; fatalities estimated at ~4-5/turbine/year (James 2004)

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Appendix E
Acoustic Study of the UD / Gamesa Wind Turbine Project, Lewes, Delaware

ACOUSTIC STUDY OF THE UD / GAMESA WIND TURBINE PROJECT

LEWES, DELAWARE

January 2009

DOE NOTE: The report completion date shown here is in error. It was completed in January 2010. Field work described in the report was performed in November 2009 and the Delaware Noise Regulations that are included as Appendix A of the report were downloaded on November 11, 2009. It is believed this was no more than an error caused by the habit of using "2009" after the transition into the new year.

SUSTAINABLE ENERGY DEVELOPMENTS INC.

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ACOUSTIC STUDY OF THE UNIVERSITY OF DELAWARE / GAMESA WIND TURBINE PROJECT LEWES, DELAWARE

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1.0 EXECUTIVE SUMMARY

The University of Delaware (UD), Lewes proposes to locate a Gamesa G90 2.0MW wind turbine on a parcel of land south of the UD College of Marine Studies. A study of the wind turbine sounds at nearby residential areas, at the Virden Conference Center, and at nearby UD campus buildings was performed. The Gamesa G90 will be on a tower with a hub height of 80 meters. The guaranteed sound power levels for this wind turbine are as follows: 94.8 dBA for the cut-in wind speed condition (hub heights winds at or above 4.2 m/s) and 108.4 dBA for the design wind condition (hub height winds at or above 9.7 m/s). Maximum sound power is first produced by the wind turbine at the design wind speed. The study's conclusions are as follows:

- When winds are sufficient to support turbine operation, existing L_{90}[1] ambient sound levels in the nearby residential and campus areas are in the range of 31 to 55 dBA. Existing L_{eq} average sound levels are in the range of 34 to 56 dBA.
- The maximum wind turbine sound level under design wind conditions at the closest residential receivers (Class A noise zone) is 44 dBA. The maximum wind turbine sound level under design wind conditions at the closest university receivers (Class B noise zone) are 43 dBA.
- The wind turbine Project fully complies with the Delaware Noise Regulations that set limits of 55 dBA and 75 dBA for the Class A and B noise zones, respectively, and limits the project sound level to no more than 10 dBA above the ambient level.
- The G90 wind turbine does not produce pure tones as defined in the Delaware Noise Regulations.

The acoustic modeling results are conservative due to the following assumptions:

1. All wind turbine sound power levels correspond to the IEC 64100-11 test values plus the IEC uncertainty level and approximate the vendor guaranteed maximum sound power levels.
2. The acoustic model assumed the most favorable conditions for sound propagation, corresponding to a ground-based temperature inversion, such as might occur on a calm, clear night or during a moderate (10 mph) downwind condition.
3. No attenuation from trees or other vegetation was assumed.
4. Winter frozen ground conditions were assumed for minimal ground absorption.

[1] The L_{90} sound level represents the quietest 10 percent of the time in any sampling interval.

2.0 COMMON MEASURES OF COMMUNITY SOUND

All sounds originate with a source – a human voice, vehicles on a roadway, or an airplane overhead. The sound energy moves from the source to a person's ears as sound waves, which are minute variations in air pressure. The loudness of a sound depends on the sound pressure level[2], which has units of decibel (dB). The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. On this scale, the quietest sound we can hear is 0 dB, while the loudest is 120 dB. Every 10-dB increase is perceived as a doubling of loudness. Most sounds we hear in our daily lives have sound pressure levels in the range of 30 dB to 90 dB.

A property of the decibel scale is that the numerical values of two separate sounds do not directly add. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB) on the decibel scale, not a doubling to 140 dB. In terms of sound perception, 3 dB is the minimum change most people can detect. Table 1 describes the subjective effect of different changes in sound levels.

TABLE 1

SUBJECTIVE EFFECT OF CHANGES IN SOUND PRESSURE LEVELS

Change in Sound Level	Apparent Change in Loudness
3 dB	Just perceptible
5 dB	Noticeable
10 dB	Twice (or half) as loud

[2] The sound pressure level is defined as $20 \log_{10}(P/P_o)$ where P is the sound pressure and P_o is the reference pressure of 20 micro-Pascals (20 μPa), which by definition corresponds to 0 dB.

Sound exposure in a community is commonly expressed in terms of the A-weighted sound level (dBA); A-weighting approximates the frequency response of the human ear. Typical sound levels associated with various activities and environments are presented in Table 2.

Sound levels change from moment to moment. Some are sharp impulses lasting one second or less, while others rise and fall over much longer periods of time. There are various measures of sound pressure designed for different purposes. To establish the background ambient sound level in an area, the $\mathbf{L_{90}}$ metric, which is the sound level exceeded 90 percent of the time, is sometimes used. The $\mathbf{L_{90}}$ can be thought of as the level representing the quietest 10 percent interval of any time period. The $\mathbf{L_{eq}}$, or equivalent sound level, is the steady-state sound level over a period of time that has the same acoustic energy as the fluctuating sounds that actually occurred during that same period. It is commonly referred to as the average sound level. The $\mathbf{L_{max}}$, or maximum sound level, represents the 1/8th-second peak level recorded during a given time period.

Sound level measurements typically include an analysis of the sound spectrum into its various frequency components to determine tonal characteristics. The unit of frequency is Hertz (Hz), measuring the cycles per second of the sound pressure waves, and typically the frequency analysis examines nine octave bands from 32 Hz to 8,000 Hz. A source creates a pure tone, as defined by American National Standards Institute (ANSI) Standard S12.9, if acoustic energy is concentrated in a narrow frequency range and a 1/3-octave band has a sound level 5 to 15 dB greater than both adjacent bands (5 dB for high frequencies, 8 dB for middle frequencies, and 15 dB for low frequencies).

TABLE 2

COMMON INDOOR AND OUTDOOR SOUND PRESSURE LEVELS

Outdoor Sound Levels	Sound Pressure (μPa)	Sound Level (dBA)	Indoor Sound Levels
	6,324,555	110	Rock Band at 5 m
Jet Over-Flight at 300 m		105	
	2,000,000	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		95	
	632,456	90	Food Blender at 1 m
Diesel Truck 60 mph at 15 m		85	
Noisy Urban Area--Daytime	200,000	80	Garbage Disposal at 1 m
		75	Shouting at 1 m
Automobile 45 mph at 15 m	63,246	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		65	Normal Speech at 1 m
	20,000	60	
Quiet Urban Area--Daytime		55	Quiet Conversation at 1m
	6,325	50	Dishwasher Next Room
Quiet Urban Area--Nighttime		45	
	2,000	40	Empty Theater or Library
Quiet Suburb--Nighttime		35	
	632	30	Quiet Bedroom at Night
Quiet Rural Area--Nighttime		25	Empty Concert Hall
Rustling Leaves	200	20	Average Whisper
		15	Broadcast and Recording Studios
	63	10	
		5	Human Breathing
Reference Pressure Level	20	0	Threshold of Hearing

Notes: μPa, or micro-Pascals, describes sound pressure (force/area). dBA, or A-weighted decibels, describes sound the pressure level on a logarithmic scale with respect to 20 μPa (the reference pressure**).**

3.0 DELAWARE NOISE REGULATIONS

The Department of Natural Resources and Environmental Control administers the Delaware Noise Regulations (Part VII, 7 Del. C., Chapter 71), the full text for which is provided in Appendix A. Section 71-1-6.0.1 establishes a 24-hour L_{eq} limit for a new sound source that depends on the emitting and receiving noise zone. Class A noise zone includes single or multiple-family homes, hotels, or land intended for residential use. Class B noise zone includes colleges and universities, government lands, commercial and institutional uses, and agricultural lands. The proposed Gamesa G90 wind turbine is in a Class B noise zone and the nearest Class A receiving lands are residential areas to the northeast and two motel buildings next to the Virden Conference Center to the northeast. The nearest Class B receiving lands are the University of Delaware, Center of Marine Studies to the north and agricultural lands to the west and south. The L_{eq} sound limit for a Class A noise zone is 55 dBA, and that for Class B noise zone is 75 dBA.

Section 71-1-6.0.2 sets an incremental limit of 10 dBA above the ambient level for Class A noise zones. The ambient level is ambiguously defined in Section 71-1-3.0.1 as "the all-encompassing background noise associated with a given environment" without any time average specified. The term ambient level is elsewhere defined as the L_{90} sound level. Whereas the regulatory limit in Section 71-1-6.0.1 uses a 24-hour average, it is reasonable to assume that time interval applies to both regulatory limits, and thus the incremental limit for a new source is 10 dBA above the 24-hour L_{90} background level. For this study, the 24-hour ambient level was determined by averaging L_{90} measurements taken day and night at several locations in Class A and B noise zones during hours when winds were high enough to sustain wind turbine operation.

For the Gamesa G90 wind turbine examined in this report, operation occurs whenever the wind speed at the 78-meter hub height is greater than the turbine cut-in wind speed of 4.2 m/s. At the cut-in wind speed the G90 produces a guaranteed sound power level of 94.8 dBA (IEC 61400 test value of 92.8 dBA plus a 2-dBA uncertainty margin). The design wind speed is the hub height wind speed of 9.7 m/s and it is the lowest speed at which the maximum guaranteed sound power level of 108.4 dBA occurs (IEC 61400 test value of 106.4 dBA plus a 2-dBA uncertainty margin).

4.0 AMBIENT SOUND LEVEL AND WIND MEASUREMENTS

The Gamesa G90 2.0MW wind turbine will be located on land currently owned by the State of Delaware that is south of the University of Delaware (UD) College of Marine Studies; the land will be transferred to the University as part of this project. Figure 1 shows the four sound monitoring locations: 1) At the UD College of Marine Studies (Class B noise zone); 2) At the residential units next to the Virden Center (Class A noise zone); 3) Hoornkill Avenue residential area (Class A noise zone); and 4) Cedar Street residential area (Class A noise zone).

All sound level measurements were taken with a CEL Model 593 real-time sound level analyzer, equipped with precision condenser microphones having an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. This instrument meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) Standards for Type 1 for quality and accuracy. Prior to and immediately following both measurement sessions, the sound analyzer was calibrated (no level adjustment was required) with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). All instrumentation was laboratory calibrated per ANSI recommendations. For all measurement sessions, the microphone was fitted with an environmental windscreen to negate wind noise and mounted at a height of 1.3 meters above grade. Measurements were made away from any vertical reflecting surfaces in compliance with ANSI Standard S12.9.[3]

Sound level and wind measurements were made on Monday/Tuesday November 16/17, 2009. The skies were clear, the temperature ranged from 49-57^{o}F, and the winds at the surface were at the surface ranged from calm to 5-10 mph from the north. Audible sounds near the UD Marine Studies buildings (NSA 1) included an exhaust stack on the roof of the Cannon Laboratory, small compressors outside the west wall of the Cannon Laboratory and natural sounds such as crickets and birds. At the Virden Conference Center residential units (NSA 2), audible sounds were HVAC equipment on the south side of the conference center, the Cannon Laboratory building exhaust stack, wind in the trees, some local and distant traffic, and natural sounds such as crickets and birds.

[3] Acoustical Society of America, ANSI Standard S12.9-1997/Part 2, "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 2: Measurement of Long-Term Wind-Area Sound."

At the end of Hoornkill Avenue (NSA 3), audible sounds were the Cannon Laboratory building exhaust stack, distant traffic, wind in the trees, natural sounds such as birds and crickets, and sounds from nearby residents such as car doors closing, dogs barking, people talking, and light home construction. During the final monitoring session a brush clearing operation occurring to the west of the Smith Laboratory was also audible at the first three monitoring locations. On Cedar Street (NSA 4), audible sound were waves crashing along the beach, local and distant traffic, wind in the trees and grass, and natural sounds such as crickets and birds.

Ten-minute average wind speeds were obtained from the 50-m instruments on the project's meteorological tower and extrapolated to the hub height using the wind profile law. A minimum of three 10-minute sound level measurements were made at each monitoring location, both day and night. The sound and wind speed data are provided in Tables B-1 through B-4 in Appendix B and are categorized by whether the winds were strong enough to support cut-in or design speed operation of the wind turbine. The L_{90} and L_{eq} sound levels for day and night were combined to form 24-hour average sound levels at each monitoring location. A summary of existing sound levels is presented in Table 3.

TABLE 3

SUMMARY OF EXISTING SOUND LEVELS

Sound Monitoring Location	24-Hour Average L_{90} (dBA)	24-Hour Average L_{eq} (dBA)	Range of L_{90} (dBA)	Range of L_{eq} (dBA)
UD College of Marine Studies	53.4	54.7	51-55	52-56
Virden Center Residential Units	44.2	46.1	36-47	38-49
Hoornkill Avenue Residences	37.4	39.5	32-40	34-42
Cedar Street Residences	40.6	52.1	36-49	46-55

The sound monitoring data in Table 3 reveal that during periods when the turbine will operate the existing L_{eq} average sound levels range from 34 to 56 dBA, levels typical of a suburban area. The existing L_{90} (quietest 10% of the time) sound levels range from 31 to 55 dBA. The Delaware Noise Regulations set a sound limit for the wind turbine of 10 dBA above the 24-hour L_{90} ambient levels, which are listed in the first column of Table 3.

FIGURE 1.

Sound Monitoring and Potential Turbine Locations
Lewes, Delaware

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5.0 CALCULATED FUTURE SOUND LEVELS

5.1 Methodology

Future sound levels from the UD/Gamesa wind turbine were calculated with the Cadna/A acoustic model. Cadna/A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613[4]. Atmospheric absorption, the process by which sound energy is absorbed by the air, was calculated using ANSI S1.26-1995.[5] Absorption of sound assumed standard day conditions and is significant at large distances. Ground surfaces were assumed to be mixed ground consisting of both hard and porous (vegetated) surfaces.[6] This is a reasonable worst-case assumption and approximates winter frozen ground conditions in the area between the turbine and the nearest residences. United States Geological Survey (USGS) 30-meter (7.5 minute) ASCII Digital Elevation Models were utilized to obtain terrain heights. The model assumes favorable sound propagation, as occurs under downwind conditions or a ground-based temperature inversion, such as might occur on a clear night. At other times, atmospheric turbulence and wind shadow effects will reduce sound levels by 5 to 20 dBA from those presented below.

5.2 Results and Conclusions

Figures 2 and 3 show color-coded decibel contours (5 feet above ground level) for the operation of the wind turbine in cut-in wind speed and design wind speed conditions, respectively. Note that Figures 2 and 3 present a composite worst-case in which all locations are simultaneously downwind of the wind turbine. The broadband acoustic modeling results are summarized in Tables 4 and 5 for the cut-in wind speed and design wind speed operating conditions. The Gamesa wind turbine will not create a pure tone condition, as defined in the Delaware Noise Regulations.

Maximum project sound levels at the Class A receivers are 36.9 to 44.4 dBA and in compliance with the Delaware Noise Regulation limit of 55 dBA. The maximum project sound level at the nearest

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[4] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.

[5] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.

[6] Ground absorption factor G set equal to 0.5 in Cadna-A.

Class B receiver is 43.2 dBA and in compliance with the Delaware Noise Regulation limit of 75 dBA. Tables 4 and 5 reveal that all project sound levels are in compliance with the 10 dBA incremental limit in the Delaware Noise Regulations.

In conclusion, the proposed Gamesa G90 wind turbine at the University of Delaware Lewes campus fully complies with the Delaware Noise Regulations.

TABLE 4

DELAWARE NOISE REGULATION COMPLIANCE FOR THE CUT-IN WIND SPEED OPERATING CONDITION (dBA)

Residential Location (Land Use Zone)	Maximum Project Sound	Sound Limit	Ambient L_{90} Level	Project Sound Exceeds Ambient By
UD College of Marine Studies	29.6	55	53.4	0.0
Virden Center Residential Units	30.8	75	44.2	0.0
Hoornkill Avenue Residences	24.6	55	37.4	0.0
Cedar Street Residences	23.3	55	40.6	0.0

Note: Delaware Noise Regulations limit the Project Sound Level to no more than 10 dBA above the Ambient Level.

TABLE 5

DELAWARE NOISE REGULATION COMPLIANCE FOR THE DESIGN WIND SPEED OPERATING CONDITION (dBA)

Residential Location (Land Use Zone)	Maximum Project Sound	Sound Limit	Ambient L_{90} Level	Project Sound Exceeds Ambient By
UD College of Marine Studies	43.2	55	53.4	0.0
Virden Center Residential Units	44.4	75	44.2	0.2
Hoornkill Avenue Residences	38.2	55	37.4	0.8
Cedar Street Residences	36.9	55	40.6	0.0

Note: Delaware Noise Regulations limit the Project Sound Level to no more than 10 dBA above the Ambient Level.

FIGURE 2.

Sound Level Impacts – Cut-In Speed
Lewes, Delaware

TECH environmental

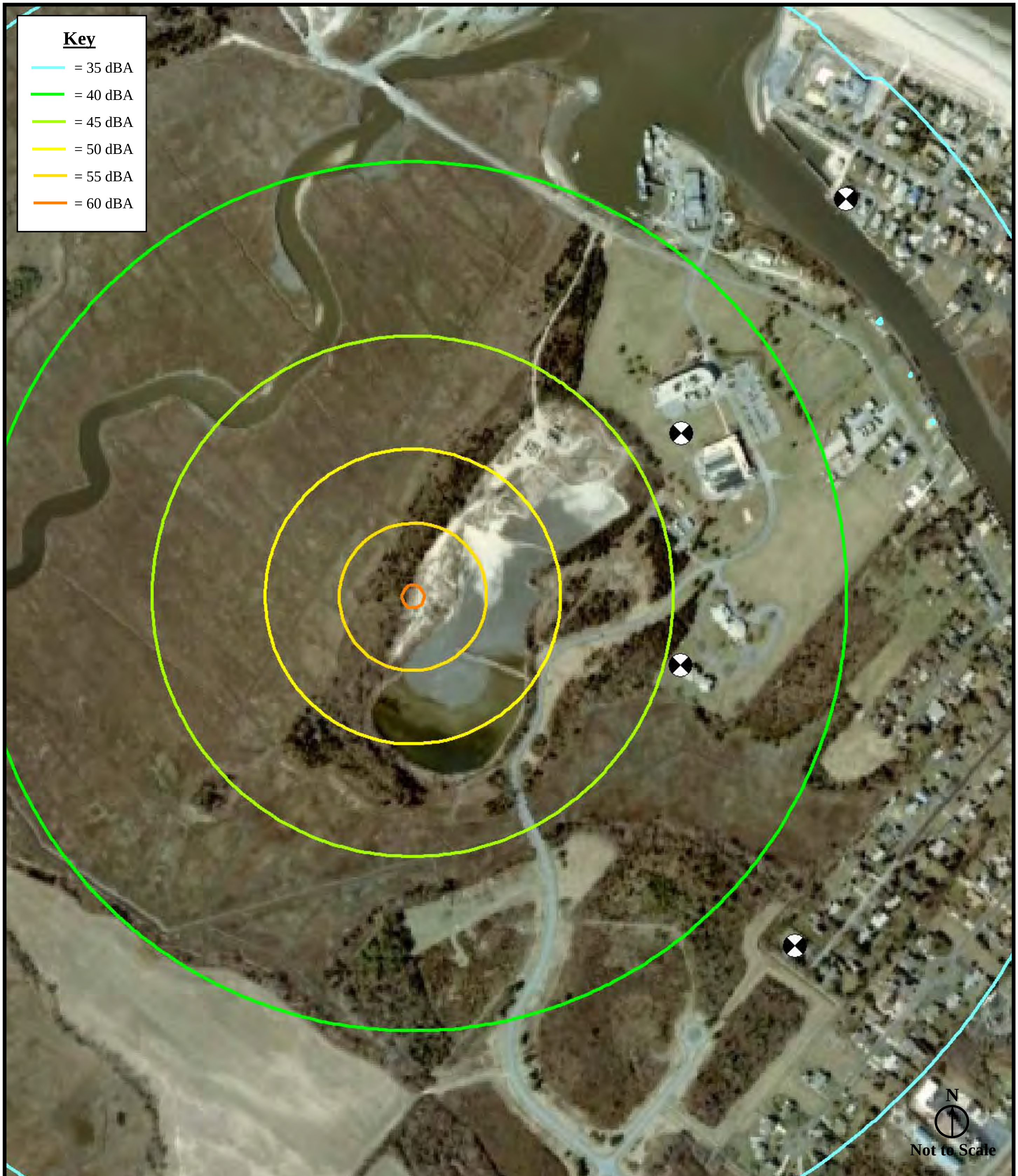

FIGURE 3.

Sound Level Impacts – Design Speed
Lewes, Delaware

APPENDIX A

DELAWARE NOISE REGULATION

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF ENVIRONMENTAL CONTROL
AIR RESOURCES SECTION
EDWARD TATNALL BUILDING
PO Box 1401
DOVER, DELAWARE 19901

TELEPHONE (302) 736 - 4791

Pursuant to Provisions of
Part VII, 7 Del. C., Chapter 71, Section 7105
Regulations Governing the Control of Noise
Per 0rder No. 82-A-2 of January 20, 1982
As Amended July 8, 1982

Sec. 71-I-1 Short Title

These regulations may be cited as the "Noise Regulations of the State of Delaware".

Sec. 71-I-2 Scope

Pursuant to the provisions of Part VII, Title 7, Chapter 71 of the Delaware Code, these regulations are to prevent, prohibit and provide for the abatement of excess and unnecessary noise and/or vibration which may endanger the health, safety and welfare, jeopardize the value of property and erode the integrity of the environment of the people of this state.

Sec. 71-I-3 Definitions

3.0.1 "Ambient Noise" means the all-encompassing background noise associated with a given environment without the sound contribution of the specific source in question.

3.0.2 "A-Weighted Sound Level" means the sound pressure level in decibels as measured with a sound level meter using the A-weighting network, which compensates for human hearing characteristics. The level so read is designated dB(A) or dBA.

3.0.3 "Best Practical Noise Control Measures" means noise control devices, technology, and procedures determined or approved by the Secretary to be the best practical, taking into consideration the age of the equipment and facilities involved, the process employed, capital expenditures, maintenance cost, technical feasibility and the engineering aspects of the applicable noise control techniques in relation to the control achieved and the non-noise control environmental impact.

3.0.4 "Commercial Area" means land used for purposes such as retail sales, personal services, civic centers, hotels, offices and office buildings, wholesale and warehouse storage.

3.0.5 "Construction" means any site preparation, assembly, erection, placement, demolition, substantial repair, alteration or similar action for public or private rights-of-way, structures, utilities or similar property.

3.0.6 "Day" means the hours between 7:00 a.m. and 10:00 p.m.

3.0.7 "Day-Night Average Sound Level (Ldn)"means the 24-hour energy average of the A-weighted sound pressure level, with the levels during the period 10:00 p.m. to 7 a.m. weighted by 10 dBA before averaging.

3.0.8 "Decibel (dB)" means a standard unit for measuring the sound pressure level. It is equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to a reference pressure, which is 20 micropascals.

3.0.9 "Emergency" means any occurrence or set of circumstances involving actual or imminent physical trauma or property damage which demands immediate actions.

3.0.10 "Equivalent A-Weighted Sound Level, abbreviated Leq (x)dB(A), means the constant sound level that, in a given situation and time period (x),contains the same sound energy as the actual time-varying A-weighted sound.

3.0.11 "Farm Vehicle" means a wheeled device used for transportation in farming operations.

3.0.12 "Hertz (Hz) means a unit of measurement of frequency formerly stated as, and numerically equal to, cycles per second.

3.0.13 "Impulse Sound" means sound of sshort duration, much less than one second, with an abrupt onset and rapid decay, separated in time by at least one second.

3.0.14 "Industrial Area" means land used for purposes such as publishing, research, development, testing, manufacturing, processing, fabricating or repairing, and may include residential land use, for a caretaker, watchman or janitor.

3.0.15 "Infrasonic Sound" means sound pressure levels having frequencies below16 Hz.

3.0.16 "Intrusion Alarm" means a device with an audible signal which, when activated, indicates intrusion by an unauthorized person.

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page three

3.0.17 "Intrusive Noise" means unwanted sound which intrudes over and above the existing noise at a given location. The relative intrusiveness of the sound depends upon its amplitude, duration, frequency, time of occurrence and tonal or informational content as well as the prevailing ambient noise level. A sound pressure level of 3 dB(A) above the ambient level is normally just discernable, with levels of 5 dB(A) to10 dB(A) the lower level region for complaints.

3.0.18 "Motorboat" means any vessel which operates on water and is propelled by machinery.

3.0.19 "Night" means the hours between 10:00 p.m. and 7:00 a.m.

3.0.20 "Noise" means any sound which annoys or disturbs humans or which causes or tends to cause an adverse psychological or physiological effect on humans, excluding all aspects of noise regulated by the Federal occupational Safety and Health Act.

3.0.21 "Noise Disturbance" means any sound which (a) endangers or injures the safety or health of humans or animals, or (b) ' annoys or disturbs a reasonable person of normal sensitivities, or (c) jeopardizes the value of property and erodes the integrity of the environment. Compliance with Sec. 71-I-6 herein shall constitute elimination of a noise disturbance.

3.0.22 "0ctave" means the interval embracing eight diatonic degrees between two sounds having a basic frequency ratio of two. (0ne unit of the musical scale).

3.0.23 "Percentile Level" means the sound levels exceeded for the percentage of time in any measured period. L10, L50 and L90, the levels exceeded for 10%, 50% and 90% of the time, are frequently used as measures of peak, average and ambient levels respectively.

3.0.24 "Person" means any individual(s), corporation, company, association, society, firm, partnership or joint stock company, and includes the State and all of its political subdivisions, agencies and instrumentalities as well as any department, board or agency of the government of the United States.

3.0.25 "Pure Tone" means any sound which can be distinctly heard as a single pitch or a set of single pitches. For the purpose of this section, a pure tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands by 15 dB for bands with center frequencies less than 160 Hz, by 8 dB for bands with center frequencies of 160 Hz to 400 Hz, and by 5 dB for bands with center frequencies greater than 400 Hz.

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page four

3.0.26 "Real Property Boundary" means an imaginary line along the ground surface, and its vertical extension, which separates the real property owned by one person from that owned by another person, but not including intra-building real property divisions.

3.0.27 "Residential Area" means land used for the primary purpose of providing human living accommodations.

3.0.28 "Secretary" means the Secretary of the Department of Natural Resources and Environmental Control.

3.0.29 "Sound" means an oscillation in pressure, particle displacement, particle velocity or other phyysical parameters, in a medium with internal forces that causes compression and rarefaction of that medium. The description of sound may include any characteristic of such sound, including duration, intensity and frequency.

3.0.30 "Sound Amplifying Equipment" means any device for increasing the magnitude of the human voice, music or other sound.

3.0.31 "Sound Level" means the sound pressure level (SPL) obtained by the use of a sound level meter and frequency weighting network, such as A, B or C as specified in American National Standards Institute specifications for sound level meters (ANSI Sl.4-1971, or the latest approved revision thereof). The unit of measurement is the decibel. If the frequency weighting employed is not indicated, the A-weighting shall apply.

3.0.32 "Sound Pressure" means the instantaneous difference between the actual pressure and the average or barometric pressure at a given point in space, as produced by sound energy.

3.0.33 "Stationary Noise Source" means a device which creates sound while fixed in position, including but not limited to residential, commercial or industrial machinery, pumps, fans, compressors, air conditioners and refrigeration equipment.

3.0.34 "Ultrasonic Sound" means sound pressure levels above 20,000 Hz. having frequencies

3.0.35 "Vibration" means an oscillatory motion of solid bodies of deterministic or random nature described by displacement, velocity, or acceleration with respect to a reference point, such that;

Peak

v = 2Àf d where v = Velocity, f = Frequency and d = Displacement

a = 2Àf v where a = Acceleration Amplitude

3.0.36 "Weekday" means any day Monday through Friday which is not a legal holiday.

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page five

Sec. 71-1-4 Prohibited Acts

4.0.1 Noise Disturbance Prohibited - No person shall make, continue, or cause to be made or continued, any noise disturbance. Non-commercial public speaking and public assembly activities conducted on any public space or public right-of-way shall be exempt from this section provided they conform to all local ordinances.

4.0.2 Specific Prohibitions

(1) Radios, Television Sets, Musical Instruments and Similar

Devices - 0perating, playing or permitting the operation or playing of any radio, television, phonograph, drum, musical instrument, sound amplifier, automobile radio, automobile stereo or high fidelity equipment or similar device which produces, reproduces or amplifies sound:

(a) In such a manner as to create a noise disturbance within a receiving property.

(b) In such a manner as to create a noise disturbance within any receiving property when operated in or on a motor vehicle on a public right-of-way or public space, or in a boat on public waters.

(c) In such a manner as to create a noise disturbance to any person other than the operator of the device, when operated by any passenger on a common carrier.

(2) Animals and Birds - 0wning, possessing, harboring or controlling any animal or bird which barks, bays, cries, squawks or makes any other noise continuously or incessantly for a period of ten minutes or makes such noise intermittently for one-half hour or more causing a noise disturbance within a receiving property; provided, however, that at the time the animal or bird is making such noise no person is trespassing or threatening to trespass upon private property in or upon which the animal or bird is situated or for any other legitimate cause which teased or provoked the animal or bird.

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page six

(3) Loading or Unloading - Loading, unloading, opening, closing, or other handling of boxes, crates, containers, building materials, garbage cans, or similar objects between the hours of 10:00 p.m. and 7:00 a.m. the following day in such a manner as to cause a noise disturbance within a Class A receiving property. This section shall not apply during an emergency.

(4) Construction - 0perating or permitting the operation of any tools or equipment used in construction, drilling, or demolition work:

(a) Between the hours of 10:00 p.m. and 7:00 a.m. the following day, on weekdays and Saturdays, or at any time on Sundays or holidays, such that the sound therefrom creates a noise disturbance within a Class A receiving property, except during an emergency.

(b) At any other time such that the sound level within any receiving property exceeds an Leq of 85 dBA for a period of one hour.

(c) This section shall not apply to the use of domestic power tools subject to Section 4.0.2(8).

(5) Vehicle, Motorboat, or Aircraft Repairs and Testing - Repairing, rebuilding, or testing any motor vehicle, motorcycle, motorboat, or aircraft in such a manner as to cause a noise disturbance within a Class A receiving property between the hours of10 p.m. and 7 a.m.

(6) Places of Public Entertainment - 0perating, playing, or permitting the operation or playing of any radio, television, phonograph, drum, musical instrument, sound amplifier or any other device which produces, reproduces, or amplifies sound within any place of public entertainment at a sound level greater than 85 dB(A) as read by the slow response on a sound level meter at any point that is normally occupied by a customer unless a conspicuous and legible sign is located outside such place, near each public entrance stating "WARNING: SOUND LEVELS WITHIN MAY CAUSE PERMANENT HEARING IMPAIRMENT". All places of public entertainment shall also be required to comply with all of the provisions of this Regulation, specifically Section 6.

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page seven

(7) Explosives, Firearms, and Similar Devices - The use or firing of explosives, firearms, or similar devices which create impulsive sound so as to cause a noise disturbance within a Class A receiving property or on a public right-of-way, except for licensed game-hunting activities on property where such activities are authorized.

(8) Domestic Power Tools - 0perating or permitting the operation of any mechanically powered saw, drill, sander, grinder, lawn or garden tool, snowblower, or similar device in residential areas between the hours of 10:00 p.m. and 7:00 a.m. so as to cause a noise disturbance within a Class A receiving property.

(9) Tampering

(a) No person shall operate any equipment unless all noise and/or vibration control devices installed hereon are in full operation.

(b) No person shall tamper with, circumvent or remove any sound level monitoring instrument, meter or device positioned by or for the Department.

(c) No person shall remove or deface a noise label on any product.

4.0.3 Motor Vehicle Prohibitions.

(1) Motor Vehicle and motorcycles on Public Rights-of-Way.

No person shall operate or cause to be operated a public or private motor vehicle or motorcycle, or any equipment attached to such a vehicle, on a public right-of-way at any time in such a manner that the sound level emitted by the motor vehicle or motorcycle, or any equipment attached to such a vehicle, exceeds the level set forth in Title 7, Chapter 71, Subchapter II, Delaware Motor Vehicle Noise Regulations.

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(2) Standing Motor Vehicles and Motorcycles - No person shall operate or permit the operation of any motor vehicle, motorcycle, or any auxiliary equipment attached to such a vehicle in such a way as to cause a noise disturbance within a Class A receiving property, for a period longer than twenty minutes in any hour while the vehicle is stationary, for reasons other than traffic congestion. (Also see Sec. 71-I-4.02 (3) Loading or Unloading).

(3) Unnecessary Horn Blowing - No person shall at any time sound the horn or other warning device of a vehicle in such a way as to cause a noise disturbance within a Class A receiving property except when absolutely necessary as a warning while actually driving such vehicle. Sec. 71-1-5 Classification of Land According to Use

5.01 Class A noise zone

Lands designated Class A shall generally be residential areas where human beings sleep or areas where serenity and tranquility are essential to the intended use of the land.

The land uses, in this category shall include, but not be limited to, single and multiple family homes, hotels, prisons, hospitals, religious facilities, cultural activities, forest preserves, and land intended for residential or special uses requiring such protection.

5.0.2 Class B noise zone

Lands designated Class B shall generally be commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land.

The land uses in this category shall include, but not be limited to, retail trade, personal, business and legal services, educational institutions, government services, amusements, agricultural activities, and lands intended for such commercial or institutional uses.

5.0.3 Class C noise zone

Lands designated Class C shall generally be industrial where protection against damage to hearing is essential, and the necessity for conversation is limited.

The land uses in this category shall include, but not be limited to, manufacturing activities, transportation facilities, warehousing, military bases, mining, and other lands intended for such uses.

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5.0.4 Mixed Class Noise Zone

Good land planning arranges for Class A zones to be buffered from Class C zones by a Class B zone. Some areas are mixed zones in practice, wherein Class C land uses abut, adjoin or include Class A use. Whenever this situation comes to the attention of the Department, the person responsible for the objectionable noise source shall make every effort to conform with Section 71-1-6. A final acceptable noise limit shall be determined by the Secretary based on Best Practical Noise Control Measures.

Sec. 71-1-6 Maximum Noise and Vibration Limits

6.0.1 No person(s) shall operate or cause to be operated any stationary source of sound in such a manner as to create a 24-hour equivalent A-weiqhted sound level which exceeds the Leq limits set forth for the receiving land use category in Table I when measured at the point of complaint origination within the property boundary of the receiving land use. Any excedence of these values shall constitute a noise disturbance.

Table I Sound Levels by Receiving Land Use Zones, Leq (24) dBA

Emitter(s)	Receptor-C	Receptor-B	Receptor A 7 a.m. - 10 p.m.	Receptor A 10 p.m. - 7a.m.
A	65	65	65	55
B	75	75	65	55
C	85	75	65	55

6.0.2 INTRUSIVE NOISE LEVEL

NOT WITHSTANDING THE PROVISIONS 0F SECTION 6.0.1 A SOURCE

SHALL BE CONSIDERED T0 CAUSE A NOISE DISTURBANCE IF THE SOUND

LEVEL, OTHER THAN AN IMPULSE, INFRASONIC 0R ULTRASONIC SOUND,

EMITTED BY SUCH SOURCE EXCEEDS THE AMBIENT NOISE LEVEL BY 10

dBA WHEN MEASURED AT THE POINT 0F C0MPLAINT ORIGINATION WITHIN THE RECEIVING PROPERTY.

Note: The relative intrusiveness of sound depends upon its amplitude, duration, frequency, time of occurrence and tonal or informational content as well as the prevailing ambient noise level. A sound pressure level of 3 dB(A) above the ambient level is normally just discernable, with levels of 5 dB(A) to 10 dB(A) the lower level region for complaints.

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6.0.3 Correction for Character of Sound

For any stationary source of sound which emits a pure tone, cyclically varying sound or repetitive impulse sound, the limits set forth in Sec. 71-I-6 shall be reduced by 5 dBA.

6.0.4 Impulse Peak Limit

For any source of sound which emits an impulse (duration less than one second with an abrupt onset and rapid decay) including metal to metal impacts or exploding impacts, shall not exceed the peak levels set forth below when measured at the point of complaint origination within the receiving property.

Class A zone Nighttime -------------------------- 80 dB

Anytime Any Zone except the above -------------- 100 dB

6.0.5 Infrasonic and Ultrasonic Peak Limit

For any source of sound which emits infrasound (below 16 Hertz) or ultrasound (above 20 kHz) frequencies, the sound pressure level shall not exceed 100 dB when measured at the point of complaint origination within the receiving property.

6.1.0 Maximum Permissible Vibration Levels

No person shall operate or cause to be operated any single vibration source or combination of sources in such a manner as to cause vibration levels in excess of those set forth below as measured at the point of complaint origination within the boundary of the receiving property.

a) Class A Zone Stationary Source --- Velocity of 0,15 inch per second

b) Class A Zone Temporary or Mobile Source --- Velocity of 0.7 inch per second

c) Class B Zone --- Velocity of 0.7 inch per second

d) Any Zone under any condition --- Velocity of 3 inches per second. (Caution level for structure damage)

REGULATIONS GOVERNING THE CONTROL 0F NOISE - page eleven

Sec. 71-I-7 Exceptions.

Exempted from these regulations are:

7.0.1 FAA Controlled 0perations - Noise directly caused by aircraft flight operations specifically preempted by the Federal Aviation Administration.

7.0.2 Recreational, Sports and Musical Activities - Noise created by the use of property for the purposes of recreational, sports or musical activities, provided such exemption is effective only during the specific period of time authorized by the political subdivision or government entity having lawful jurisdiction to sanction such use.

7.0.3 Emergencies - Noise created as a result of, or related to, an emergency, including (a) the emission of sound for the purpose of alerting persons to the existence of an emergency, or (b) the emission of sound in the performance of emergency work.

7.0.4 Emergency Signaling Device Tests -

(a) Testing of emergency signaling devices the same time of day each time such tests are performed, using a minimum cycle test time.

(b) Testing of the complete emergency signaling system, including the function of signaling devices and the personnel response to the signal, shall not occur more than once in each calendar month.

7.0.5 Religious Activities - Sounds created by bells, carillons or chimes associated with religious observances.

7.0.6 Public Celebrations - Patriotic or public celebrations not extending more than one day or as authorized by the public subdivision or government entity empowered to sanction such activity.

7.0.7 Farm - All farm vehicles are exempt while engaged in farming operations.

7.0.8 The Unamplified Human Voice - including children at schools, playgrounds, etc.

7.0.9 Interstate Railway Locomotives and Rail Cars - Noise directly caused by railway operations specifically preempted by the Federal Government.

Sec. 71-1-8 Validity of Regulations

If any section or subsection of these regulations is found invalid the remainder shall continue to be valid and enforceable.

APPENDIX B

MEASURED SOUND LEVEL AND WIND DATA

TABLE B-1

MEASURED AMBIENT SOUND LEVELS AND MEASURED WIND SPEEDS AT THE UD COLLEGE OF MARINE STUDIES

Date	Starting Time (EST)	10-Min. L_{90} Sound Level (dBA)	10-Min. L_{eq} Sound Level (dBA)	10-Min. Average Wind Speed at 80 m Hub Height (m/s)
11/16/2009	17:16	51.0	52.3	**6.2**
11/16/2009	17:26	51.0	51.9	**5.5**
11/16/2009	17:36	51.0	56.3	**4.9**
11/17/2009	0:15	52.0	52.7	**6.5**
11/17/2009	0:25	52.0	52.7	**7.2**
11/17/2009	0:35	52.0	52.8	**8.3**
11/17/2009	9:24	55.0	56.4	**7.5**
11/17/2009	9:34	55.0	56.4	**6.9**
11/17/2009	9:44	55.0	56.4	**5.8**

Wind speeds in bold are at or above the cut-in speed of 4.2 m/s. Wind speeds in bold and italics are at or above the design wind speed of 9.7 m/s.

TABLE B-2

MEASURED AMBIENT SOUND LEVELS AND MEASURED WIND SPEEDS AT THE VIRDEN CONFERENCE CENTER

Date	Starting Time (EST)	10-Min. L_{90} Sound Level (dBA)	10-Min. L_{eq} Sound Level (dBA)	10-Min. Average Wind Speed at 80 m Hub Height (m/s)
11/16/2009	17:54	36.0	37.9	**4.9**
11/16/2009	18:04	36.0	37.6	4.1
11/16/2009	18:14	36.0	37.3	3.9
11/17/2009	0:49	39.0	41.5	**8.2**
11/17/2009	0:59	40.0	41.1	**7.4**
11/17/2009	1:09	39.0	40.8	**7.3**
11/17/2009	9:57	47.0	48.5	**8.8**
11/17/2009	10:07	48.0	49.0	**9.0**
11/17/2009	10:17	47.0	49.1	**9.4**

Wind speeds in bold are at or above the cut-in speed of 4.2 m/s. Wind speeds in bold and italics are at or above the design wind speed of 9.7 m/s.

TABLE B-3

MEASURED AMBIENT SOUND LEVELS AND MEASURED WIND SPEEDS AT THE HOORNKILL AVENUE RESIDENTIAL AREA

Date	Starting Time (EST)	10-Min. L_{90} Sound Level (dBA)	10-Min. L_{eq} Sound Level (dBA)	10-Min. Average Wind Speed at 80 m Hub Height (m/s)
11/16/2009	18:30	32.0	34.5	**4.2**
11/16/2009	18:40	32.0	34.2	3.9
11/16/2009	18:50	31.0	35.4	3.4
11/17/2009	1:25	32.0	33.3	**7.4**
11/17/2009	1:35	32.0	33.5	**7.9**
11/17/2009	1:45	32.0	34.1	**8.0**
11/17/2009	10:33	40.0	41.9	**8.9**
11/17/2009	10:43	41.0	42.6	**8.7**
11/17/2009	10:53	39.0	41.8	**8.9**

Wind speeds in bold are at or above the cut-in speed of 4.2 m/s. Wind speeds in bold and italics are at or above the design wind speed of 9.7 m/s.

TABLE B-4

MEASURED AMBIENT SOUND LEVELS AND MEASURED WIND SPEEDS AT THE CEDAR STREET RESIDENTIAL AREA

Date	Starting Time (EST)	10-Min. L_{90} Sound Level (dBA)	10-Min. L_{eq} Sound Level (dBA)	10-Min. Average Wind Speed at 80 m Hub Height (m/s)
11/16/2009	19:13	35.0	39.9	4.1
11/16/2009	19:23	36.0	38.6	4.1
11/16/2009	19:33	37.0	50.5	3.8
11/17/2009	2:05	45.0	46.3	**8.8**
11/17/2009	2:15	45.0	46.3	**8.7**
11/17/2009	2:25	45.0	46.8	**9.2**
11/17/2009	11:17	49.0	55.7	***10.4***
11/17/2009	11:27	49.0	51.7	***10.8***
11/17/2009	11:37	49.0	55.8	**9.1**

Wind speeds in bold are at or above the cut-in speed of 4.2 m/s. Wind speeds in bold and italics are at or above the design wind speed of 9.7 m/s.

Appendix F
Visual Assessment

Corporate Headquarters
317 Route 104
Ontario, NY 14519-8958
Phone: (585) 265-2384
Fax: (585) 265-1148

Massachusetts Office
1 Bean Rd.
Sterling, MA 01564
Phone: (978) 422 7744

Visualization Assessment

SED performed a visual assessment to determine how a Gamesa G90 wind turbine would appear from a representative location in Lewes. This location was chosen based on a number of factors, including cultural and historical significance, turbine visibility and traffic. After careful review, SED chose to perform a photomontage from a bridge on East Savannah Rd. near Front St, and from New Road. These are two of the few locations in Lewes that is heavily trafficked, familiar to most local residents and from which a Gamesa G90 wind turbine would be clearly visible.

Figure 1. Proposed turbine location with photomontage location shown.

In order to determine how a wind turbine would appear from these locations, SED considered the dimensions of the Gamesa G90 wind turbine, as well as the distance and elevation from the photomontage location to the proposed wind turbine location. A balloon was floated to hub height of 81 meters (266 feet) at the proposed turbine

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site on December 15, 2009. Conditions were favorable for the balloon float with light winds, partial cloud cover, and adequate visibility. SED used the balloon's position as a reference, as well as a model to determine the height of the turbine and length of the blades, using pixel ratios. The photograph used in this simulation was taken at a 35mm focal length equivalent of 55mm, which provides a perspective that is very similar to what would be perceived by the human eye.

The wind turbine is shown at its maximum visual impact, with the rotor facing the viewer. The bridge on East Savannah Rd. is approximately 2,500 meters (8,202 feet) from the proposed turbine location, and the photomontage location at New Road is approximately 1,080 meters (3,542 feet) from the proposed turbine location. The proposed turbine location and the sites chosen for the visual assessment are shown on a satellite image, below, and the visual simulations are included on pages 3-4 of this document.

Figure 2. Photomontage from Savannah Rd. Bridge.

Figure 3. Photomontage from New Road

Appendix G
Shadow Flicker Analysis for the University of Delaware

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Shadow Flicker Analysis for the University of Delaware

The University of Delaware has proposed the installation of a wind turbine at their College of Marine & Earth Studies campus in Lewes, DE to act as an educational and research tool for on-site and offshore wind turbine development in Delaware, as well as provide electricity cost savings for University of Delaware. A feasibility study was commissioned to evaluate numerous areas to site the wind turbine utilizing wind industry best practices, setbacks from residential and/or sensitive environmental areas. Shadow flicker is one effect of wind turbines that requires additional investigation, particularly as it relates to nearby residential areas.

Shadow flicker occurs when wind turbine blades cast a shadow on the surrounding area when the blades pass in front of the sun. The location and occurrence of the shadow effect depends on the time of year, time of day and the position of the sun in the sky. The shadow effects' main disturbance area is any unshaded windows of buildings, especially residential areas where people would be most likely to experience these effects. Generally, the discernable shadow flicker effect only occurs on properties within ten turbine rotor diameters from the wind turbine[1]. In the case of the University of Delaware wind turbine this would equal a radius of 900 meters from the wind turbine.
Shadow flicker effects will only occur under certain conditions:

- During daylight hours
- When the sun is shining, no overcast or foggy conditions
- Within 10 rotor diameters of turbine
- When wind turbine is in operation or spinning

Receptors

The wind turbine to be installed is a Gamesa G90 2.0MW wind turbine with an 80 meter hub height and a 90 meter rotor diameter. This turbine will be located to the southwest of the main campus off of Pilottown Road in the City of Lewes, adjacent to an existing dredge spoils area. SED identified six receptor areas to evaluate the shadow flicker impacts from the UD wind turbine. The receptors are representative of areas that could

[1] http://www.meridianenergy.co.nz

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be impacted by shadow flicker or have been identified as sites of particular concern. These areas were selected based on several criteria:

- Distance to wind turbine location - within 10 rotor diameters of site or 900 meters (2950')
- Areas most likely to be effected by shadow effects related to position of sun in the sky – locations to the east, west, and north of wind turbine
- Current use of facility (residence, classroom, overnight lodging)
- Areas of cultural and historical significance
- Line of site to wind turbine from windows at site

Shadows will be cast on specific days of the year and will move from one point to another relatively quickly. And certain areas are more susceptible to shadow effects at certain times of the day. Areas to the west of the wind turbine would experience these effects as the sun rises. Areas to the north would experience the effects during the day. Areas to the east would experience these as the sun sets. The shadows cast by the wind turbine blades will be narrow, be of low intensity and move rapidly at the receptor. The closer a receptor is to the wind turbine, the more intense the shadows, as a greater proportion of the sun is blocked by the rotating wind turbine blades.

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An image showing the proposed turbine location as well as the receptor sites used for this analysis is shown below:

Methodology

SED used the Shadow Flicker module of the software program Wind Farm version 4.1.1, as well as a digital elevation model and dimensions of the G90 wind turbine assumed to represent the impact of shadow flicker on 6 receptor sites. Each receptor site was assumed to be a residence with a single bay window 3 meters wide by 2 meters high (9.84 x 6.56 ft.), and elevated 2 meters off above ground level. For the purposes of this analysis, SED assumed that each of these windows is directly facing the wind turbine. The results of the shadow flicker analysis are attached to this document in the form of

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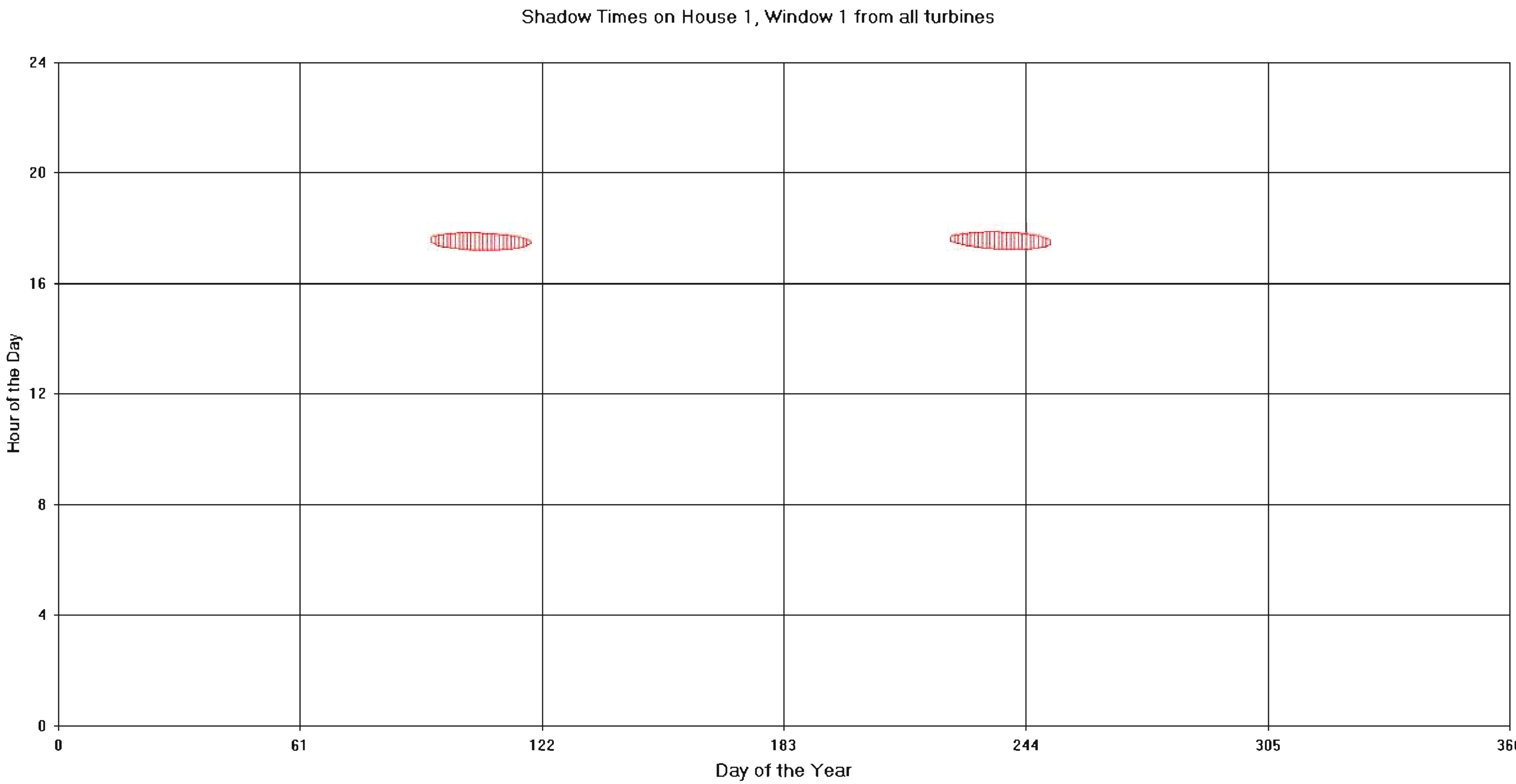
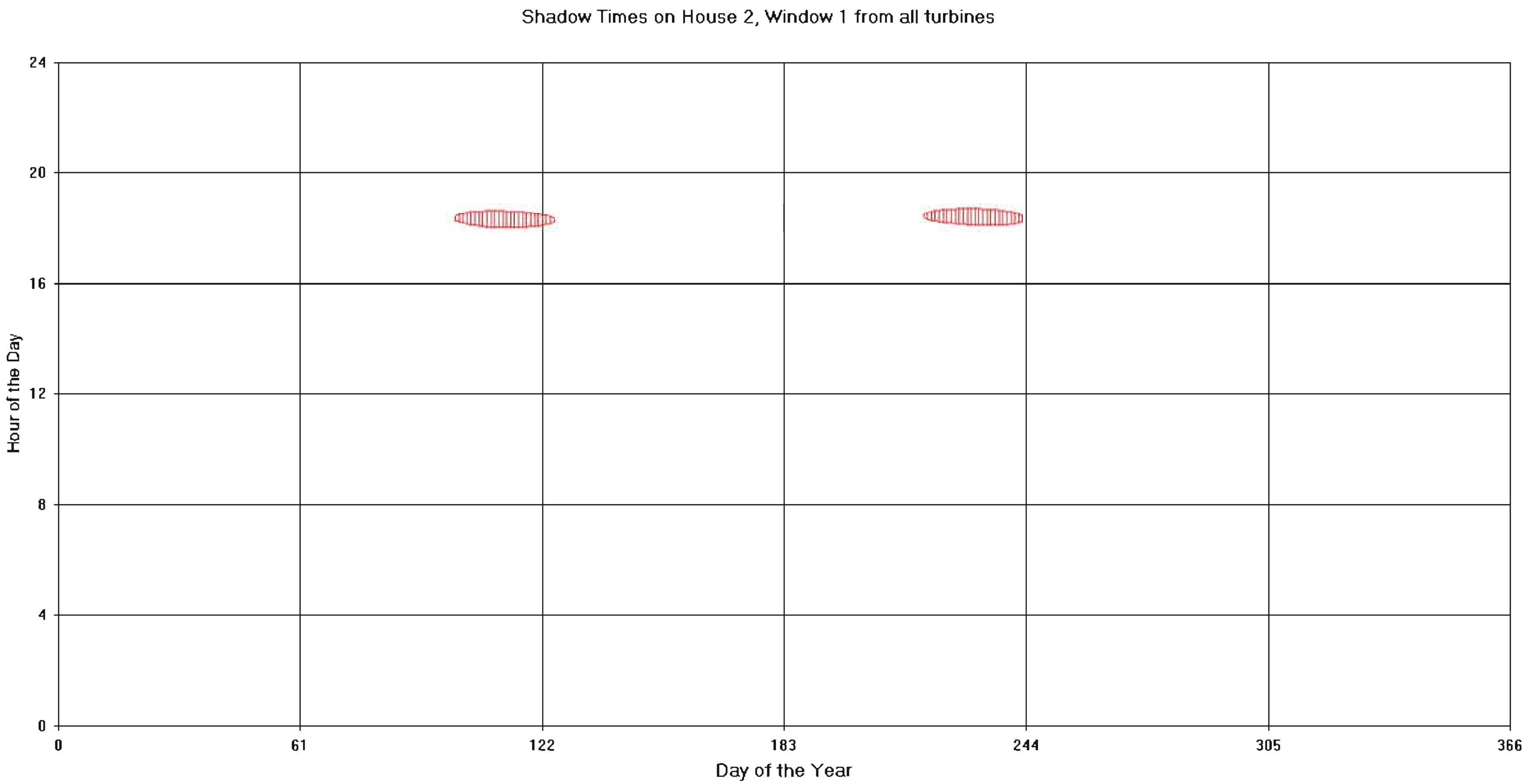
"shadow calendars." These shadow calendars offer a graphical representation of when each receptor site might be impacted by shadow flicker assuming that the wind turbine is constantly spinning, the rotor is always facing the sun, and that the sun shines during every daytime hour of a given year. Because these conservative assumptions were used for the purposes of this analysis, it is likely that the impact of shadow flicker on these receptor sites will be significantly less than the model predicts. Shadow calendars show the times of year as well as the time of day that shadow flicker may be visible at each receptor sites. Note that these graphical representations refer to receptor sites as "houses."

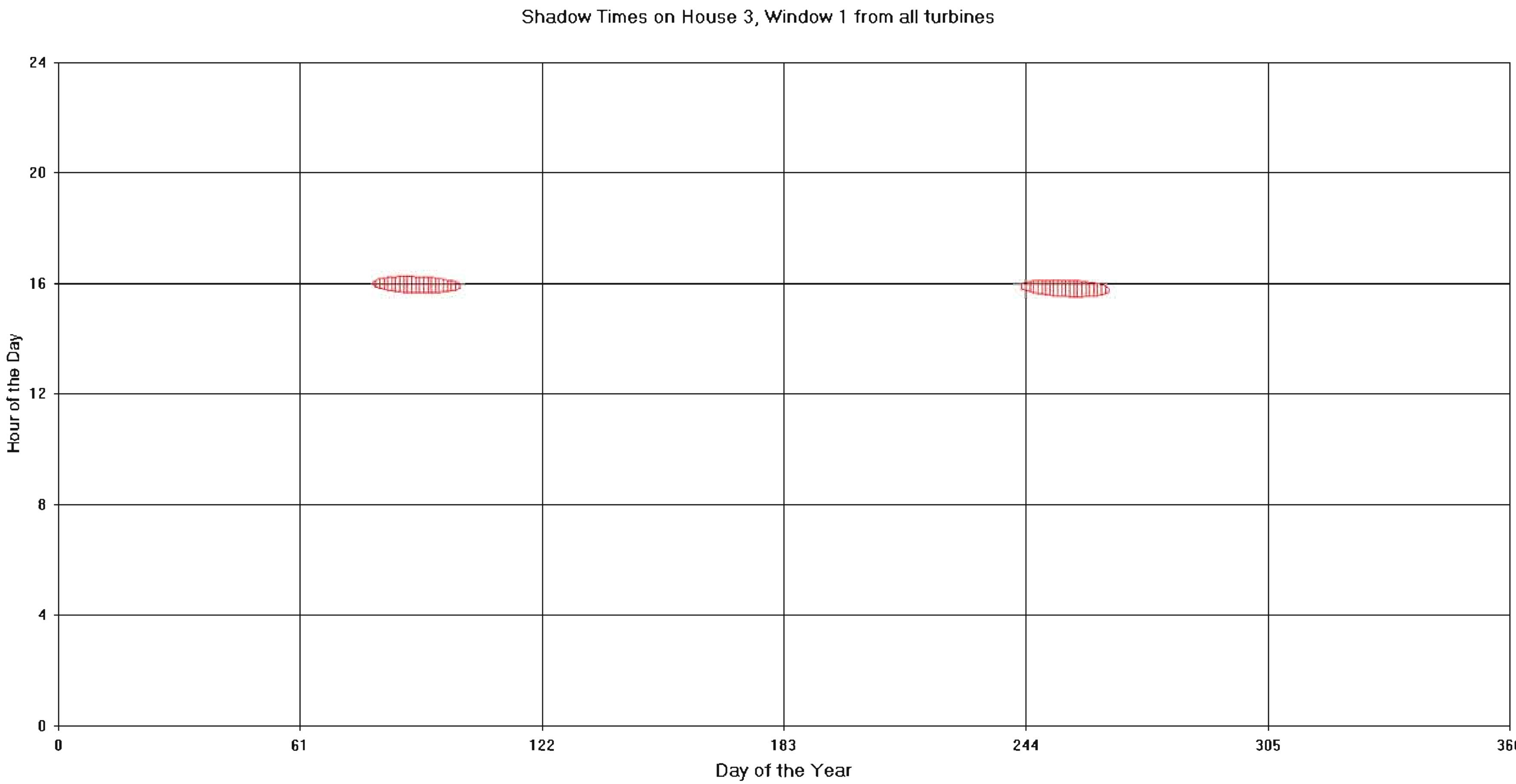
Conclusion

In Delaware there are no specific regulations relating to acceptable degrees of shadow flicker impact at a specific location. Based on the results presented in this assessment, SED does not consider that the proposed wind turbine will have any adverse shadow flicker impacts to the surrounding area. The most impacted receptor would be the University buildings, but the majority of the windows face away from where the wind turbine would be located. While all 6 receptor sites may experience some shadow flicker, it will occur only during brief periods on any given day, and will not occur at any sites for the vast majority of the year.

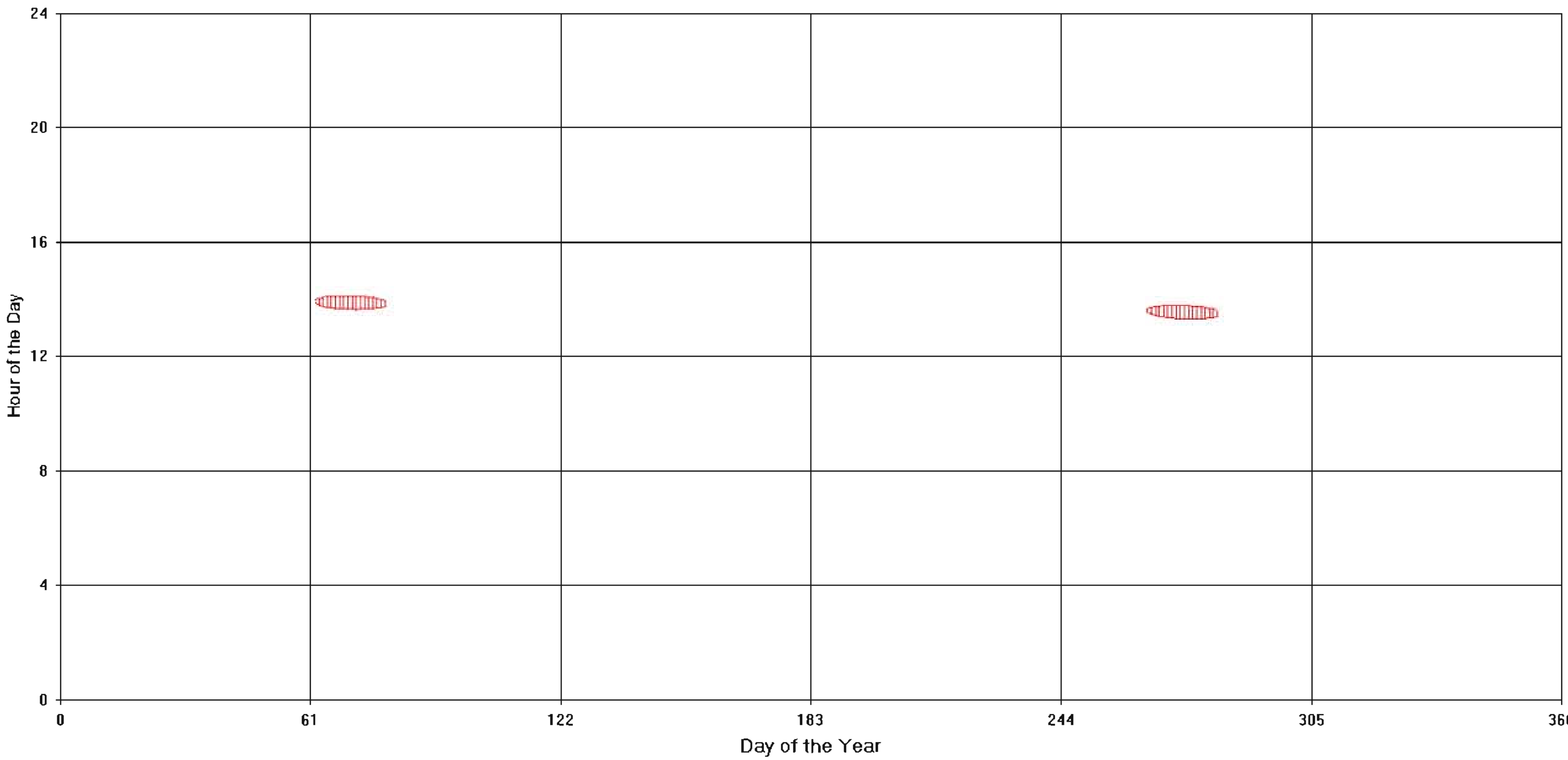


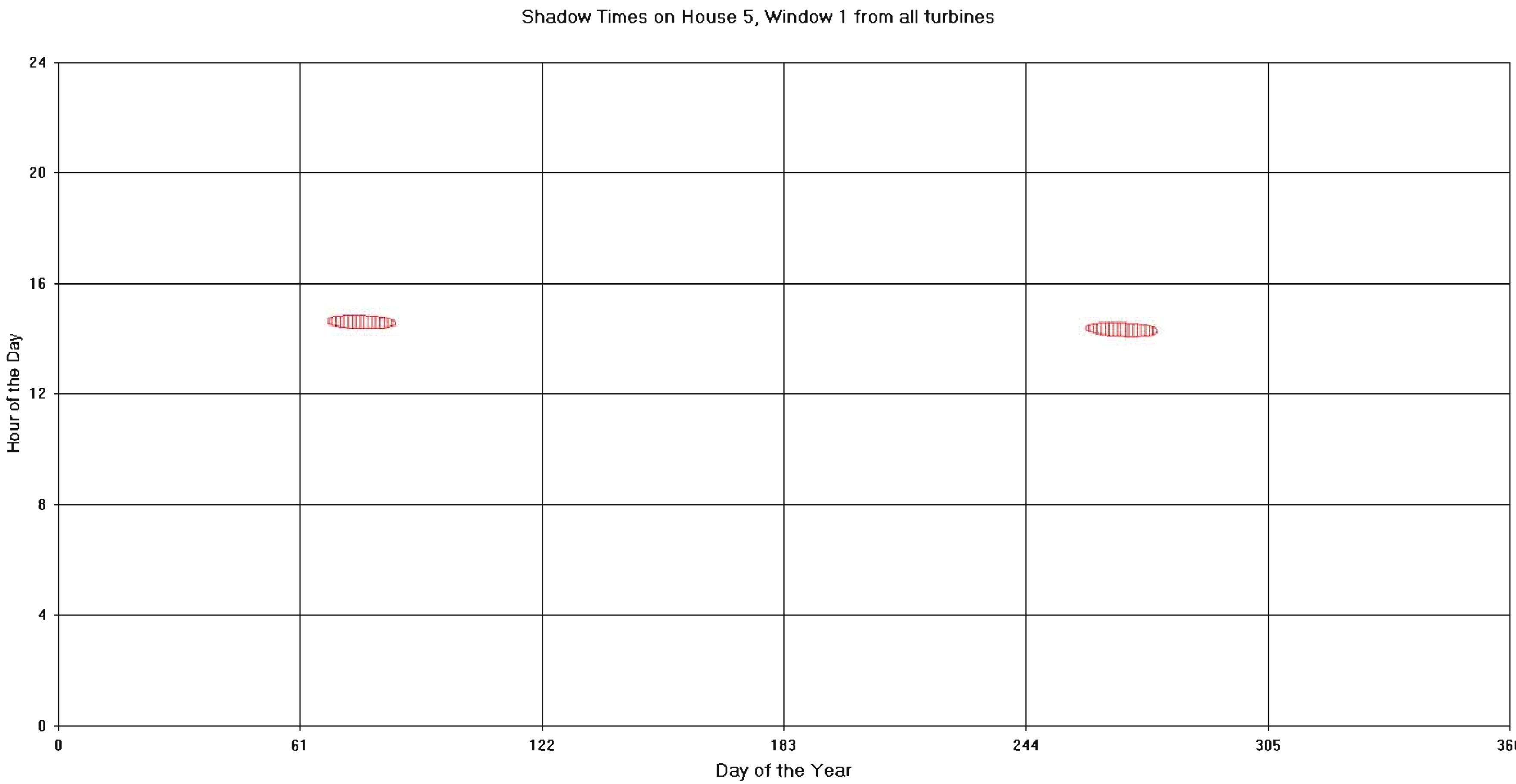
Shadow Times on House 1, Window 1 from all turbines
Hour of the Day
Day of the Year
0
4
8
12
16
20
24
0
61
122
183
244
305
366

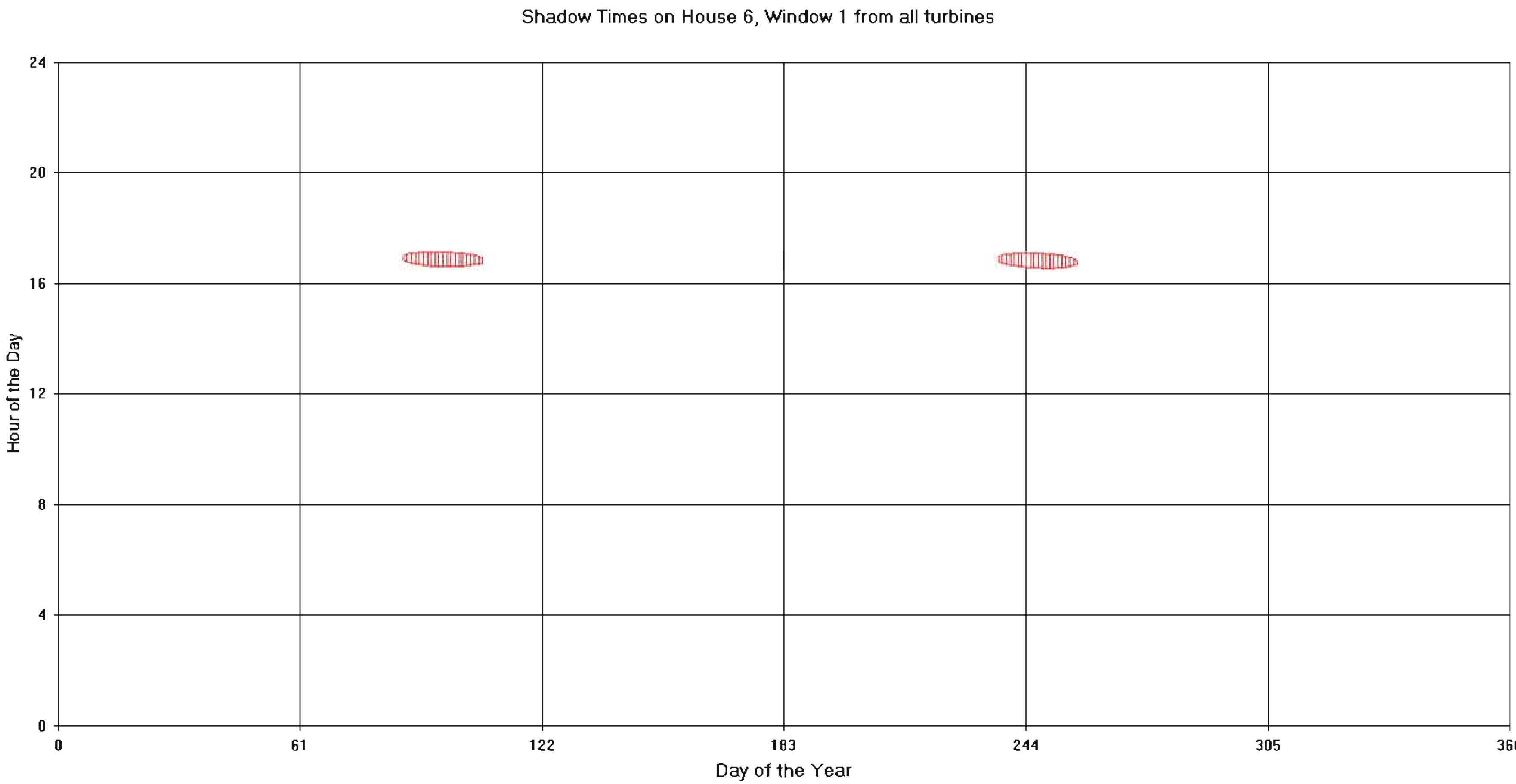

Shadow Times on House 2, Window 1 from all turbines
Hour of the Day
24
20
16
12
8
4
0
0
61
122
183
244
305
366
Day of the Year


Shadow Times on House 3, Window 1 from all turbines
24
20
16
12
8
4
0
Hour of the Day
0
61
122
183
244
305
366
Day of the Year

Shadow Times on House 4, Window 1 from all turbines




Shadow Times on House 5, Window 1 from all turbines
Hour of the Day
Day of the Year
0
4
8
12
16
20
24
0
61
122
183
244
305
366


Shadow Times on House 6, Window 1 from all turbines
Hour of the Day
Day of the Year
0
4
8
12
16
20
24
0
61
122
183
244
305
366

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Title :
Time : 13:17:30, 23 Feb 2010

SUMMARY OF SHADOW TIMES ON EACH WINDOW

House/ Window	Easting	Northing	Width (m)	Depth (m)	Height (m)	Degrees from North	Tilt angle	Days per year	Max hours per day	Mean hours per day	Total hours
1/ 1	486273	4292543	3.0	2.0	2.0	285.0	0.0	51	0.59	0.46	23.3
2/ 1	486259	4292401	3.0	2.0	2.0	295.0	0.0	50	0.57	0.44	22.2
3/ 1	486308	4292819	3.0	2.0	2.0	260.0	0.0	44	0.56	0.44	19.5
4/ 1	486256	4293267	3.0	2.0	2.0	225.0	0.0	35	0.46	0.36	12.5
5/ 1	486336	4293127	3.0	2.0	2.0	237.0	0.0	36	0.47	0.36	13.1
6/ 1	486378	4292651	3.0	2.0	2.0	270.0	0.0	42	0.52	0.41	17.1