LARGE FILING SEPARATOR SHEET

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SECTION 2 OF 3

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DESCRIPTION OF DOCUMENT

APPLICATION CONTINUED

Table 3. Summary of groups and individual observations from fall and spring passerine migration surveys at the Hardin Wind Resource Area.

Species	Scientific Name	Fall # grps	Fall # obs	Spring # grps	Spring # obs	Overall # grps	Overall # obs
Thrushes		*14*	*20*	*18*	*21*	*32*	*41*
American robin	*Turdus migratorius*	14	20	17	20	31	40
Swainson's thrush	*Catharus ustulatus*	0	0	1	1	1	1
Titmice/Chickadees		*3*	*3*	*1*	*2*	*4*	*5*
black-capped chickadee	*Poecile atricapillus*	2	2	0	0	2	2
carolina chickadee	*Poecile carolinensis*	1	1	1	2	2	3
Warblers		*1*	*1*	*2*	*2*	*3*	*3*
common yellowthroat	*Geothlypis trichas*	1	1	0	0	1	1
palm warbler	*Dendroica palmarum*	0	0	1	1	1	1
yellow-rumped warbler	*Dendroica coronata*	0	0	1	1	1	1
Wrens		*0*	*0*	*1*	*1*	*1*	*1*
Carolina wren	*Thryothorus ludovicianus*	0	0	1	1	1	1
Corvids		*26*	*37*	*8*	*14*	*34*	*51*
American crow	*Corvus brachyrhynchos*	9	13	5	10	14	23
blue jay	*Cyanocitta cristata*	19	26	3	4	22	30
Other Birds		**23**	**23**	**15**	**17**	**38**	**40**
downy woodpecker	*Picoides pubescens*	7	7	1	1	8	8
hairy woodpecker	*Picoides villosus*	1	1	4	5	5	6
northern flicker	*Colaptes auratus*	5	5	6	7	11	12
red-bellied woodpecker	*Melanerpes carolinus*	6	6	0	0	6	6
red-headed woodpecker	*Melanerpes erythrocephalus*	1	1	0	0	1	1
Unidentified woodpecker		3	3	4	4	7	7
Unidentified Birds		**2**	**2**	**0**	**0**	**2**	**2**
unidentified bird		2	2	0	0	2	2
Overall		**107**	**223**	**93**	**135**	**200**	**358**

Table 4. Summary of groups and individual observations during fall sandhill crane migration surveys at the Hardin Wind Resource Area.

Species/Type	Scientific Name	# grps	# obs
Waterbirds		**5**	**52**
Bonaparte's gull	*Larus philadelphia*	1	3
great blue heron	*Ardea herodias*	1	1
ring-billed gull	*Larus delawarensis*	1	5
sandhill crane	*Grus canadensis*	1	3
unidentified gull		1	40
Waterfowl		**7**	**251**
Canada goose	*Branta canadensis*	5	116
Mallard	*Anas platyrhynchos*	1	63
tundra swan	*Cygnus columbianus*	1	72
Shorebirds		**10**	**23**
Killdeer	*Charadrius vociferus*	10	23
Raptors		**101**	**106**
Accipiters		*8*	*8*
Cooper's hawk	*Accipiter cooperii*	7	7
sharp-shinned hawk	*Accipter striatus*	1	1
Buteos		*48*	*52*
rough-legged hawk	*Buteo lagopus*	9	10
red-shouldered hawk	*Buteo lineatus*	5	5
red-tailed hawk	*Buteo jamaicensis*	34	37
Northern Harrier		*32*	*33*
northern harrier	*Circus cyaneus*	32	33
Falcons		*11*	*11*
American kestrel	*Falco sparverius*	11	11
Other Raptors		*2*	*2*
unidentified hawk		2	2
Vultures		**1**	**6**
turkey vulture	*Cathartes aura*	1	6
Upland Gamebirds		**1**	**1**
ring-necked pheasant	*Phasianus colchicus*	1	1
Doves/Pigeons		**23**	**170**
mourning dove	*Zenaida macroura*	12	120
rock pigeon	*Columba livia*	11	50
Passerines		**148**	**1,298**
American crow	*Corvus brachyrhynchos*	48	140
blue jay	*Cyanocitta cristata*	8	12
European starling	*Sturnus vulgaris*	23	383
horned lark	*Eremophila alpestris*	42	327
house sparrow	*Passer domesticus*	7	96
Lapland longspur	*Calcarius lapponicus*	15	313
northern mockingbird	*Mimus polyglottos*	1	1
snow bunting	*Plectrophenax nivalis*	3	25
unidentified sparrow		1	1

Table 4. Summary of groups and individual observations during fall sandhill crane migration surveys at the Hardin Wind Resource Area.

Species/Type	Scientific Name	# grps	# obs
Other Birds		**3**	**3**
downy woodpecker	*Picoides pubescens*	1	1
red-bellied woodpecker	*Melanerpes carolinus*	2	2
Total		**298**	**1,909**

Table 5. Results of mistnet surveys at seven sites within the project area.

Site #	# of Captures[1]	UTM (Zone 17, NAD 83)	Date
1	2 EPFU, 1 MYLU	0268088, 4507764	June 15 & 17, 2009
2	2 MYLU, 1 LABO, 5 EPFU, 1 LANO	0271017, 4506299	June 15 & 17, 2009
3	2 EPFU, 1 LANO	0267426, 4501565	June 15 & 17, 2009
4	2 MYSE	0266692, 4497969	June 16 & 18, 2009
5	1 EPFU	0268384, 4499349	June 16 & 18, 2009
6	1 EPFU	0269465, 4500401	June 19 & 24, 2009
7	2 EPFU	0266819, 4503222	June 19 & 24, 2009

[1] EPFU = *Eptesicus fuscus* (Big Brown Bat), MYLU = *Myotis lucifugus* (Little Brown Bat), LABO = *Lasiurus borealis* (Eastern Red Bat), LANO = *Lasionycteris noctivagans* (Silver-haired Bat), MYSE = *Myotis septentrionalis* (Northern Myotis)

Table 6. Incidental wildlife observed while conducting all surveys at the Hardin Wind Resource Area, September 3, 2008 – May 1, 2009.

Species	Scientific Name	#grps	# obs
Birds			
American kestrel	*Falco sparverius*	32	40
turkey vulture	*Cathartes aura*	9	27
red-tailed hawk	*Buteo jamaicensis*	17	17
Canada goose	*Branta Canadensis*	2	15
American crow	*Corvus brachyrhynchos*	5	13
wild turkey	*Meleagris gallopavo*	1	7
northern harrier	*Circus cyaneus*	6	6
rough-legged hawk	*Buteo lagopus*	6	6
great blue heron	*Ardea Herodias*	3	3
Mallard	*Anas platyrhynchos*	1	2
Cooper's hawk	*Accipiter cooperii*	1	1
red-shouldered hawk	*Buteo lineatus*	1	1
ring-necked pheasant	*Phasianus colchicus*	1	1
short-eared owl	*Asio flammeus*	1	1
Unidentified raptor		1	1
Bird Subtotal	**14 species**	**87**	**141**
Mammals			
white-tailed deer	*Odocoileus virginianus*	10	26
Raccoon	*Procyon lotor*	2	2
Coyote	*Canis latrans*	1	1
ground hog	*Marmota monax*	1	1
unknown flying squirrel	*Glaucomys* spp.	1	1
Mammal Subtotal	**5 species**	**15**	**31**

Table 7. Number of raptors (excluding turkey vultures) observed per surveyor hour at three established Hawk Watch sites, the Hardin Wind Resource Area, and another Ohio wind resource area during the Fall of 2008.

Date	Hardin, OH*	Amherstburg, Ontario, Canada[a]	Port Stanley, Ontario, Canada[a]	Waiteville, WV[a]	Buckeye Wind Project, OH[b]
9/3/2008	2.00	1.23	1.50	NS	0.25
9/4/2008	0.50	NS	6.00	0.89	NS
9/5/2008	1.00	0.25	1.33	0.67	NS
9/8/2008	0.38	NS	11.88	NS	NS
9/10/2008	0.14	8.50	24.00	0.00	NS
9/14/2008	1.71	7.09	4.47	5.38	NS
9/15/2008	0.29	116.30	279.70	15.13	NS
9/17/2008	0.29	48.40	1450.49	98.44	NS
9/20/2008	1.01	59.25	20.78	50.91	NS
9/22/2008	1.14	NS	138.80	3.37	NS
9/24/2008	0.43	28.00	6.83	0.71	NS
9/29/2008	0.29	NS	74.78	NS	NS
10/1/2008	0.71	29.33	42.70	2.91	NS
10/3/2008	1.29	21.64	70.78	5.33	NS
10/6/2008	0.43	4.22	48.59	6.15	NS
10/8/2008	0.29	2.33	0.00	NS	NS
10/10/2008	0.86	21.45	15.70	NS	0.13
10/13/2008	0.14	6.25	18.97	0.67	0.38
10/15/2008	0.71	19.33	21.06	NS	NS
10/17/2008	0.86	16.50	37.07	NS	NS
10/20/2008	0.43	2.38	0.67	NS	NS
10/22/2008	0.57	42.93	58.63	2.35	0.50
10/24/2008	0.70	1.11	1.00	NS	NS
10/27/2008	0.14	3.56	9.00	NS	0.8
10/29/2008	0.43	13.17	21.00	NS	0.38
10/31/2008	0.29	2.31	3.04	0.00	NS
Average	**0.66**	**20.71**	**91.11**	**12.86**	**0.33**

*This study.

[a]Daily count data for 2008 surveys acquired from the Hawk Migration Association of North America (HMANA) website.

[b]From Stantec (2009)

NS – indicates no survey was performed on that date.

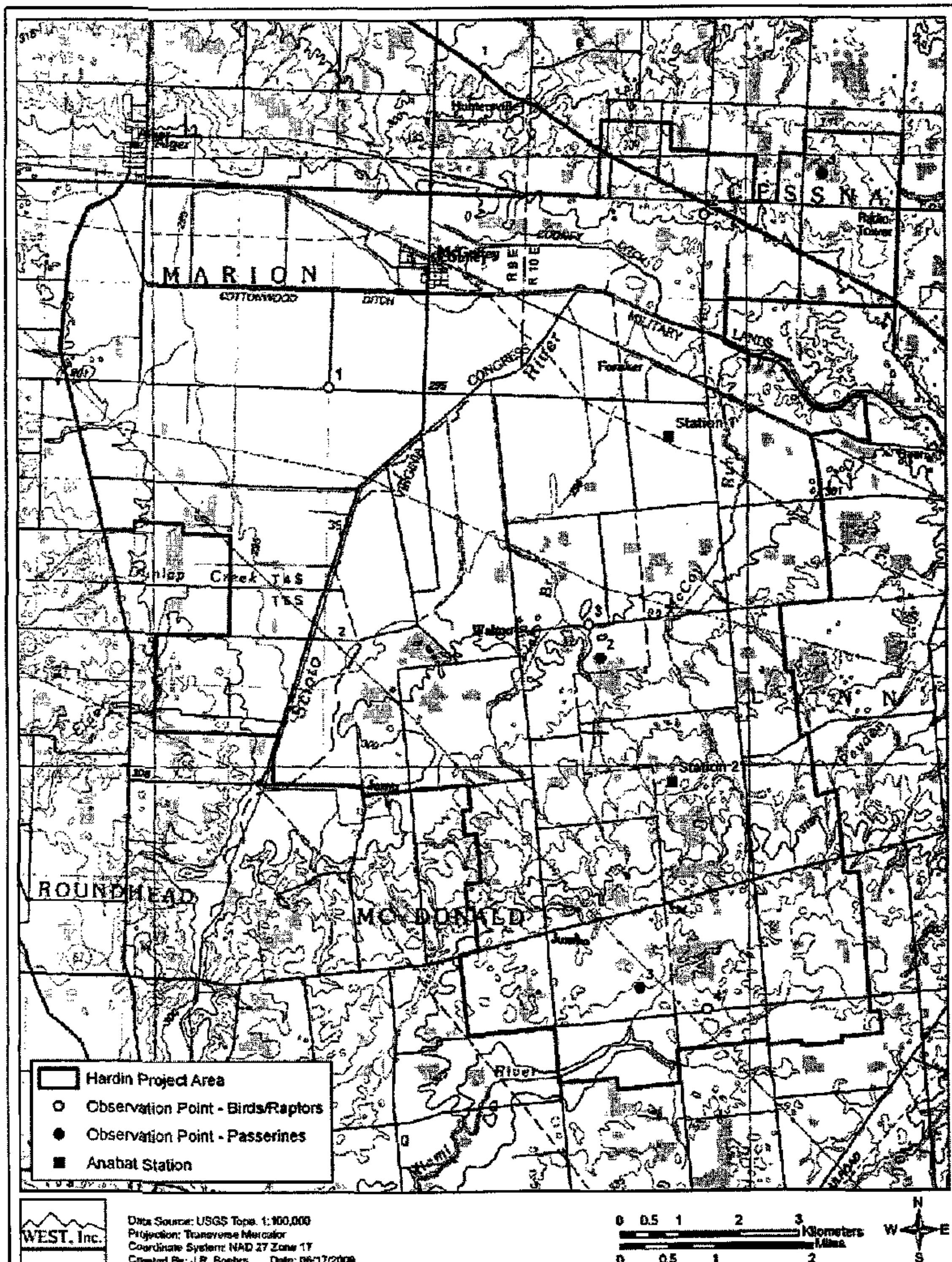

Figure 1. Study area map for the Hardin Wind Resource Area with observation points and Anabat locations.

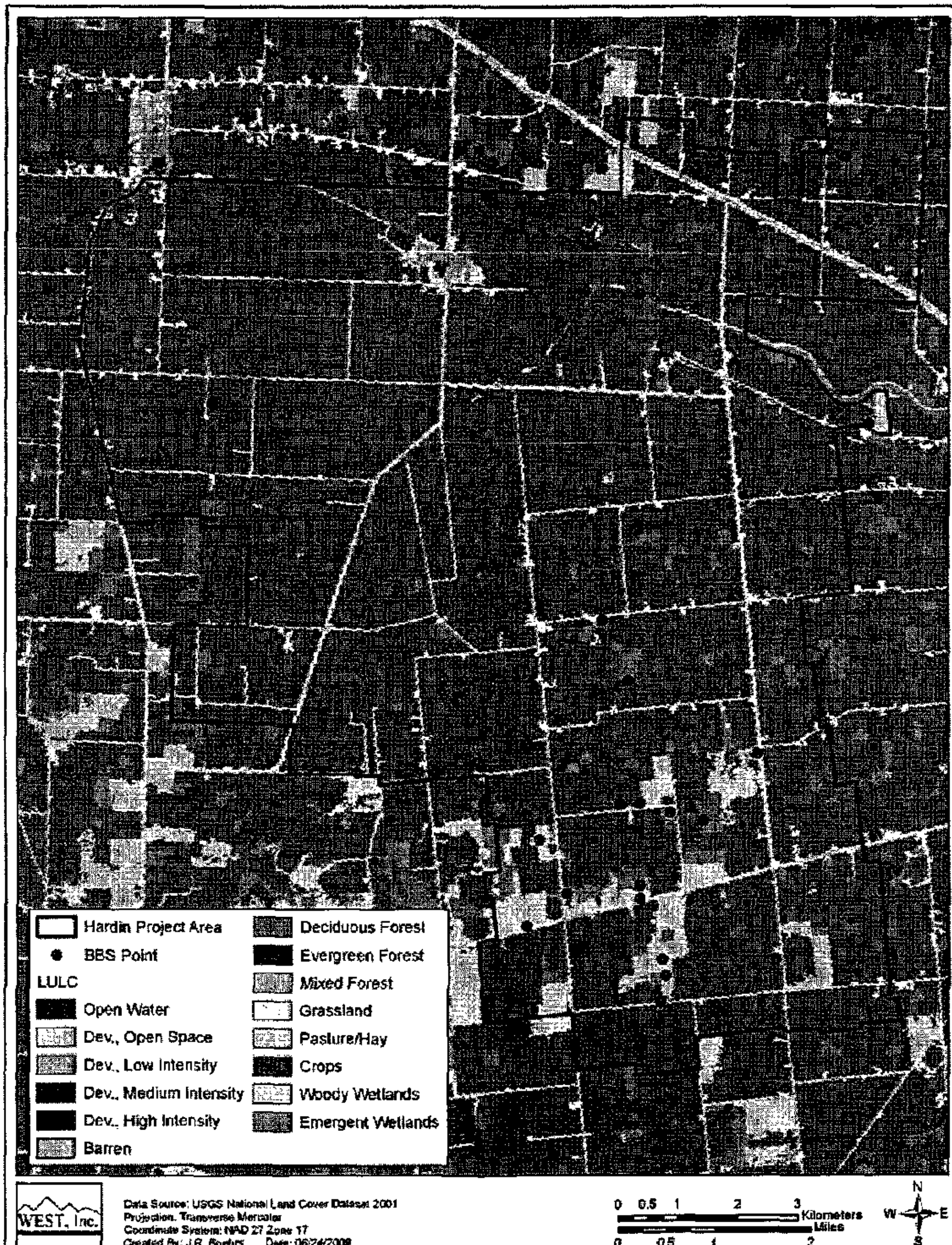

Figure 2. Study area map for the Hardin Wind Resource Area with USGS (2001) land cover data and breeding bird survey points.

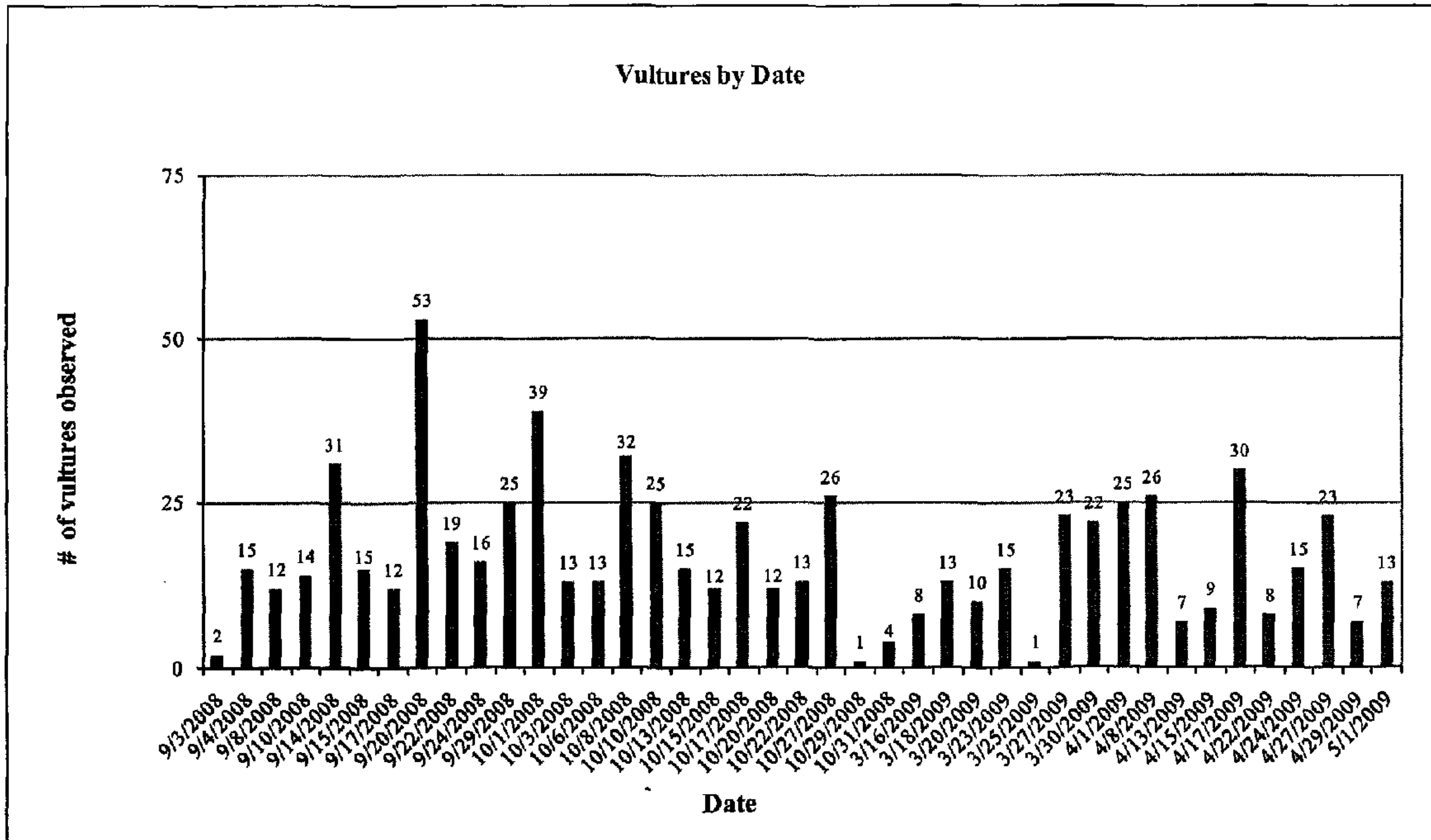

Figure 4. Number of vultures observed by date during diurnal bird/raptor migration studies at the Hardin Wind Resource Area, September 3, 2008 through May 1, 2009.

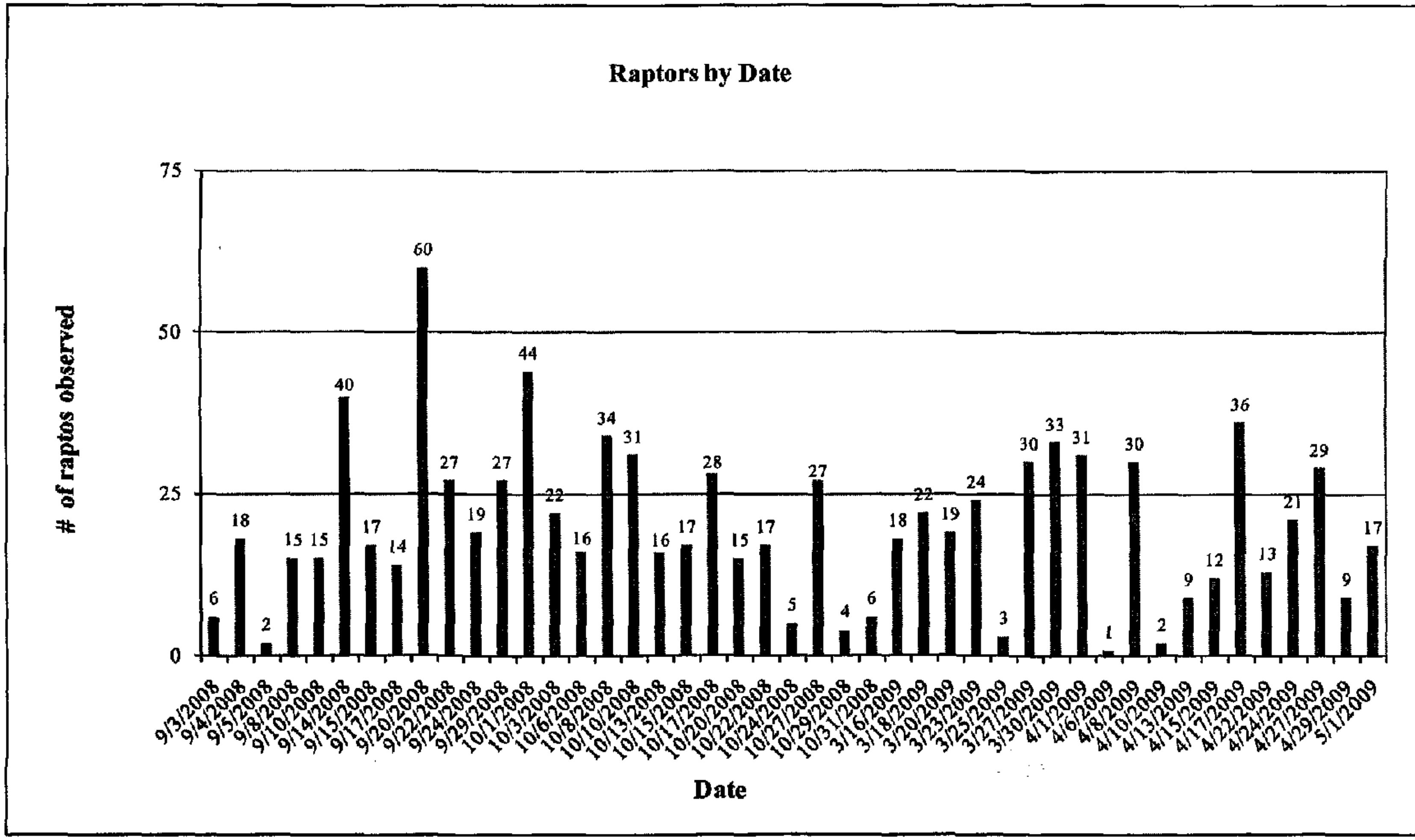

Figure 3. Number of raptors observed by date during diurnal bird/raptor migration studies at the Hardin Wind Resource Area, September 3, 2008 through May 1, 2009.

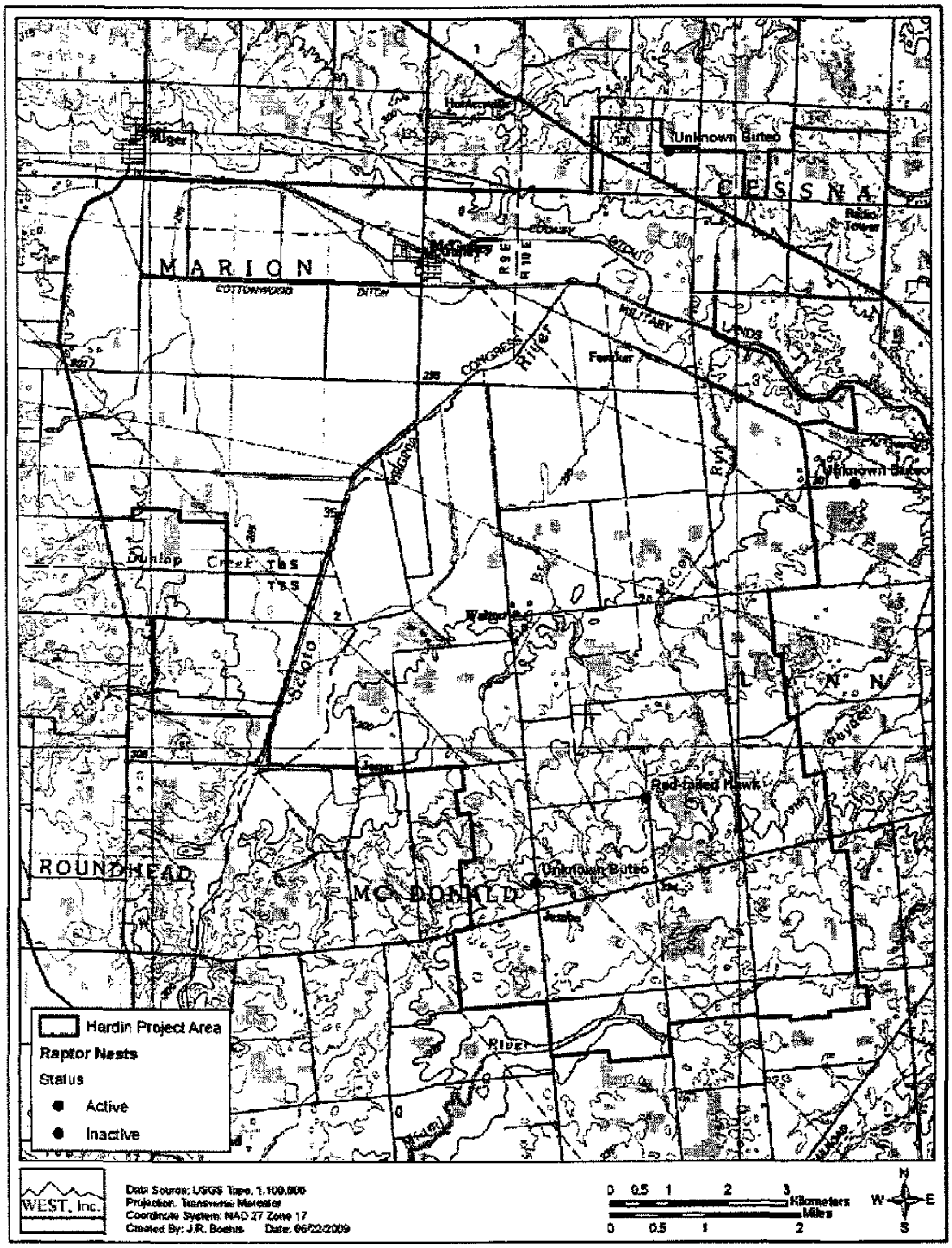

Figure 5. Study area map for the Hardin Wind Resource Area with raptor nest locations.

Figure 6. Study area map for the Hardin Wind Resource Area with seven sites used to survey for bats with mistnets. A total of nine sites were surveyed, and the results will be presented within the final wildlife report.

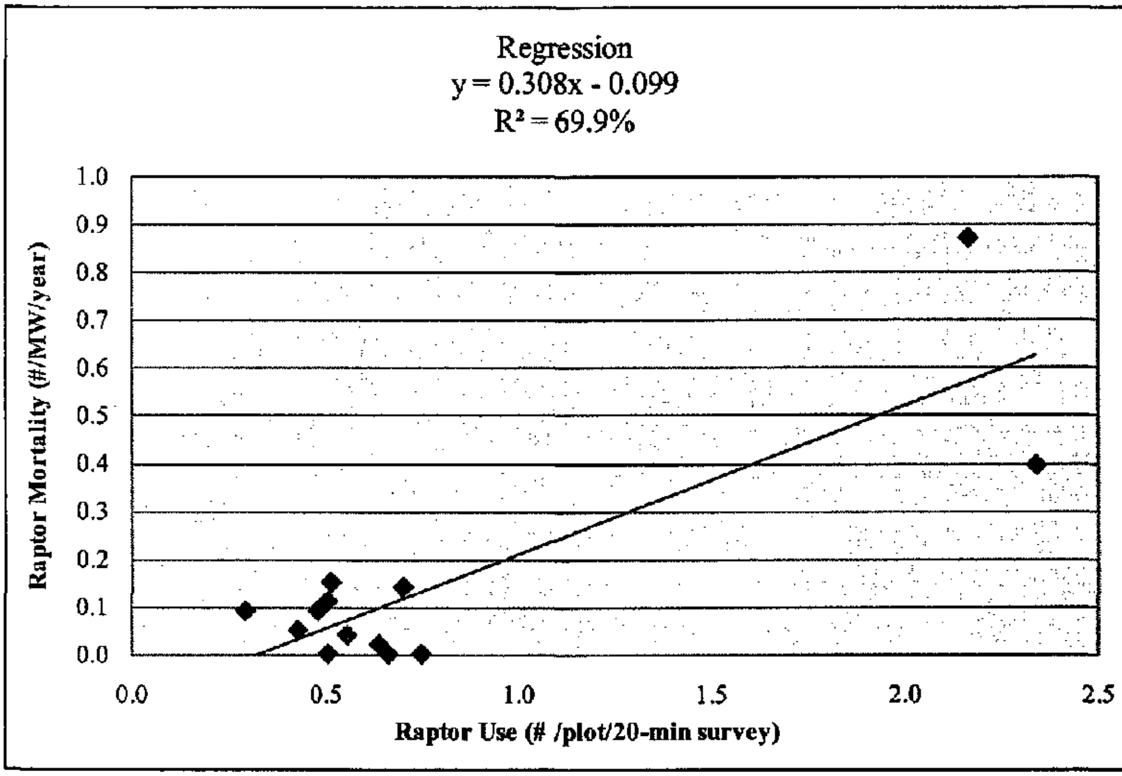

Figure 7. Regression analysis comparing raptor use estimations from new generation wind projects versus estimated raptor mortality.

Data from the following sources:

Study and Location	Raptor Use (birds/plot/20-min survey)	Source	Raptor Mortality (fatalities/MW/yr)	Source
Buffalo Ridge, MN	0.64	Erickson et al. 2002b	0.02	Erickson et al. 2002b
Combine Hills, OR	0.75	Young et al. 2003c	0.00	Young et al. 2005
Diablo Winds, CA	2.161	WEST 2006a	0.87	WEST 2006a
Foote Creek Rim, WY	0.55	Erickson et al. 2002b	0.04	Erickson et al. 2002b
High Winds, CA	2.34	Kerlinger et al. 2005	0.39	Kerlinger et al. 2006
Hopkins Ridge	0.70	Young et al. 2003a	0.14	Young et al. 2007a
Klondike II, OR	0.50	Johnson 2004	0.11	NWC and WEST 2007
Klondike, OR	0.50	Johnson et al. 2002a	0.00	Johnson et al. 2003
Stateline, WA/OR	0.48	Erickson et al. 2002b	0.09	Erickson et al. 2002b
Vansycle, OR	0.66	WCIA and WEST 1997	0.00	Erickson et al. 2002b
Wild Horse, WA	0.29	Erickson et al. 2003a	0.09	Erickson et al. 2008
Zintel, WA	0.43	Erickson et al. 2002a	0.05	Erickson et al. 2002b
Bighorn, WA	0.51	Johnson and Erickson 2004	0.15	Kronner et al. 2008

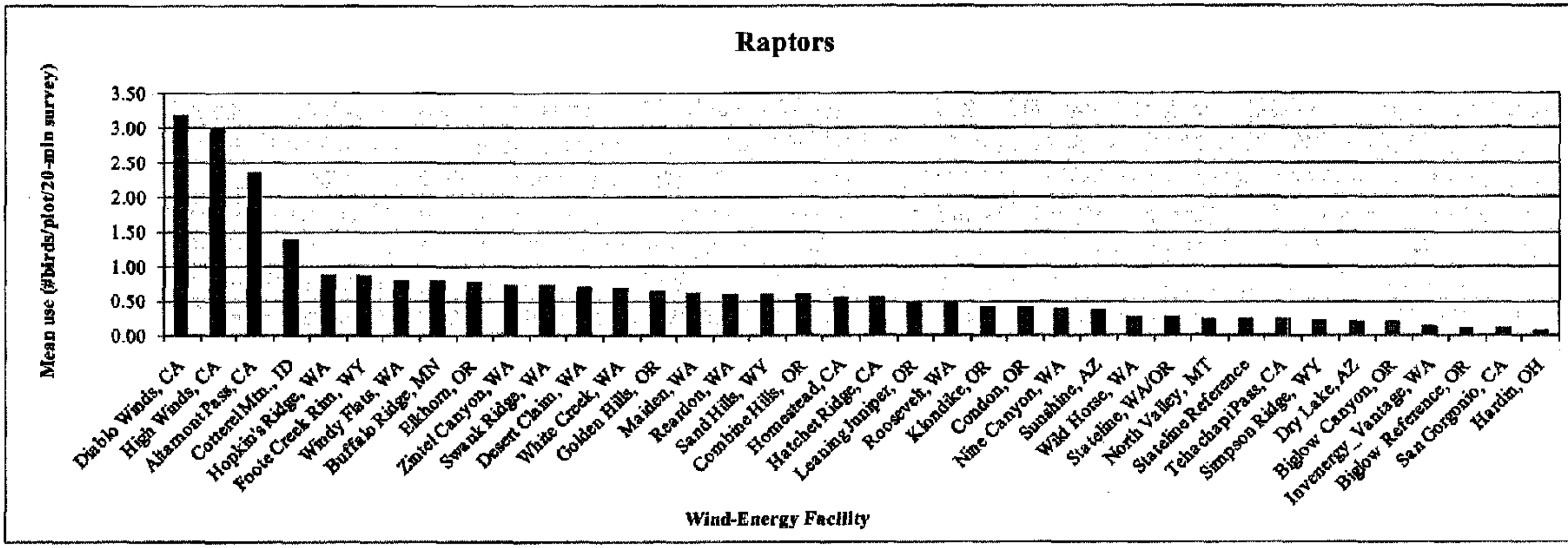

Figure 8. Comparison of fall raptor use between the Hardin Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

Hardin, OH	This study.				
Diablo Winds, CA	WEST 2006a	Golden Hills, OR	Jeffrey et al. 2008	Sunshine, AZ	WEST and CPRS 2006
High Winds, CA	Kerlinger et al. 2005	Maiden, WA	Erickson et al. 2002b	Wild Horse, WA	Erickson et al. 2003a
Altamont Pass, CA	Erickson et al. 2002b	Reardon, WA	WEST 2005b	Stateline, WA/OR	Erickson et al. 2002b
Cotterel Mtn., ID	Cooper et al. 2004	Sand Hills, WY	Johnson et al. 2006a	North Valley, MT	WEST 2006b
Hopkin's Ridge, WA	Young et al. 2003a	Combine Hills, OR	Young et al. 2003c	Stateline Reference	URS et al. 2001
Foote Creek Rim, WY	Erickson et al. 2002b	Homestead, CA	WEST et al. 2007	Tehachapi Pass, CA	Erickson et al. 2002b
Windy Flats, WA	Johnson et al. 2007	Hatchet Ridge, CA	Young et al. 2007b	Simpson Ridge, WY	Johnson et al. 2000
Buffalo Ridge, MN	Erickson et al. 2002b	Leaning Juniper, OR	NWC and WEST 2005b	Dry Lake, AZ	Young et al. 2007c
Elkhorn, OR	WEST 2005a	Roosevelt, WA	NWC and WEST 2004	Biglow Canyon, OR	WEST 2005c
Zintel Canyon, WA	Erickson et al. 2002a	Klondike, OR	Johnson et al. 2002a	Invenergy_Vantage, WA	WEST 2007
Swauk Ridge, WA	Erickson et al. 2003b	Condon, OR	Erickson et al. 2002b	Biglow Reference, OR	WEST 2005c
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001b	San Gorgonio, CA	Erickson et al. 2002b
White Creek, WA	NWC and WEST 2005a				

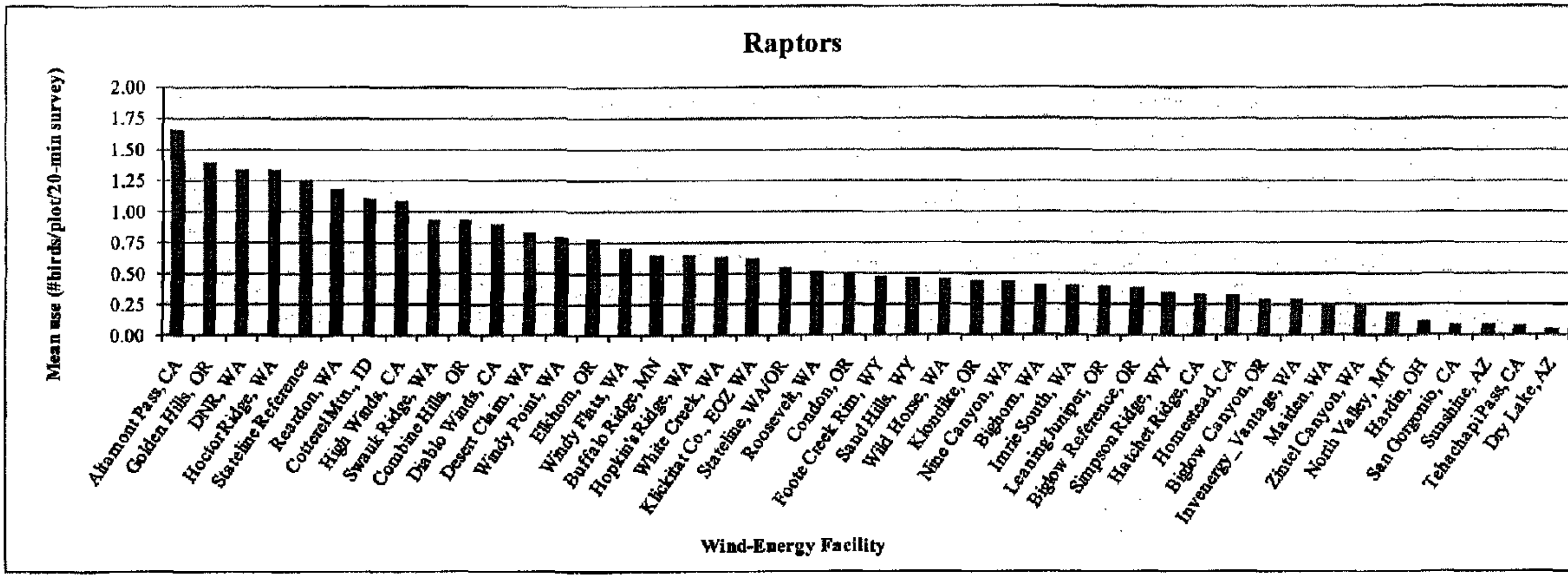

Figure 9. Comparison of spring raptor use between the Hardin Wind Resource Area and other US wind-energy facilities.

Data from the following sources:

Hardin, OH	This study.				
Altamont Pass, CA	Erickson et al. 2002b	Buffalo Ridge, MN	Erickson et al. 2002b	Leaning Juniper, OR	NWC and WEST 2005b
Golden Hills, OR	Jeffrey et al. 2008	Hopkin's Ridge, WA	Young et al. 2003a	Biglow Reference, OR	WEST 2005c
DNR, WA	Johnson et al. 2006c	White Creek, WA	NWC and WEST 2005a	Simpson Ridge, WY	Johnson et al. 2000
Hoctor Ridge, WA	Johnson et al. 2006d	Klickitat Co., EOZ WA	WEST and NWC 2003	Hatchet Ridge, CA	Young et al. 2007b
Stateline Reference	URS et al. 2001	Stateline, WA/OR	Erickson et al. 2002b	Homestead, CA	WEST et al. 2007
Reardon, WA	WEST 2005b	Roosevelt, WA	NWC and WEST 2004	Biglow Canyon, OR	WEST 2005c
Cotterel Mtn., ID	Cooper et al. 2004	Condon, OR	Erickson et al. 2002b	Invenergy_Vantage, WA	WEST 2007
High Winds, CA	Kerlinger et al. 2005	Foote Creek Rim, WY	Erickson et al. 2002b	Maiden, WA	Erickson et al. 2002b
Swauk Ridge, WA	Erickson et al. 2003b	Sand Hills, WY	Johnson et al. 2006a	Zintel Canyon, WA	Erickson et al. 2002a
Combine Hills, OR	Young et al. 2003c	Wild Horse, WA	Erickson et al. 2003a	North Valley, MT	WEST 2006b
Diablo Winds, CA	WEST 2006a	Klondike, OR	Johnson et al. 2002a	San Gorgonio, CA	Erickson et al. 2002b
Desert Claim, WA	Young et al. 2003b	Nine Canyon, WA	Erickson et al. 2001b	Sunshine, AZ	WEST and the CPRS 2006
Windy Point, WA	Johnson et al. 2006b	Bighorn, WA	Johnson and Erickson 2004	Tehachapi Pass, CA	Erickson et al. 2002b
Elkhorn, OR	WEST 2005a	Imrie, WA	Johnson et al. 2006e	Dry Lake, AZ	Young et al. 2007c
Windy Flats, WA	Johnson et al. 2007				

APPENDIX A

Ohio Department of Natural Resources

TED STRICKLAND, GOVERNOR SEAN D. LOGAN, DIRECTOR

Division of Natural Areas and Preserves
Steven D. Maurer, Chief
2045 Morse Rd., Bldg. F-1
Columbus, OH 43229-6693
Phone: (614) 265-6453; Fax: (614) 267-3096

September 10, 2008

Jay Schoenberger
Invenergy Wind Development LLC
7564 Standish Place, Suite 123
Rockville, MD 20855

Dear Mr. Schoenberger:

After reviewing our Natural Heritage maps and files, I find the Division of Natural Areas and Preserves has no records of rare or endangered species in the Hardin County Wind Farm project area in Marion, Cessna, Roundhead, Lynn and Taylor Creek Townships of Hardin County, Ohio, and on the Alger, Foraker, Roundhead and Silver Creek Quads.

There are no state nature preserves or scenic rivers at the project site. We are also unaware of any unique ecological sites, geologic features, animal assemblages, state parks, state forests or state wildlife areas within the project area.

Our inventory program has not completely surveyed Ohio and relies on information supplied by many individuals and organizations. Therefore, a lack of records for any particular area is not a statement that rare species or unique features are absent from that area. Although we inventory all types of plant communities, we only maintain records on the highest quality areas.

Please contact me at 614-265-6818 if I can be of further assistance.

Sincerely,

Debbie Woischke, Ecological Analyst
Natural Heritage Program

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4625 Morse Road, Suite 104
Columbus, Ohio 43230
614-416-8993 / FAX 614-416-8994

February 3, 2009

Ms. Michelle Carder
WEST, Inc.
2003 Central Ave.
Cheyenne, WY 82001

TAILS# 31420-2009-TA-0333

Dear Ms. Carder:

This is in response to your October 20, 2008 letter, received by this office on November 17, 2008, requesting our review of a proposed wind energy project in Hardin County, Ohio. Representatives from WEST, Inc., the project developer, the U.S. Fish and Wildlife Service, and Ohio Department of Natural Resources participated in a meeting on September 3, 2008 to discuss the project proposal and wildlife survey recommendations. Additionally, a wildlife survey protocol for the project area was submitted by Rhett Good, WEST, Inc. via e-mail on November 24, 2008. The project area is predominantly rural and agricultural, however several woodlots greater than 10 hectares exist within the project boundaries. We agree that the wildlife surveys proposed in your November 24, 2008 protocol are appropriate for the project site, and are the same as what we discussed during our meeting.

The following comments are being provided pursuant to the Endangered Species Act (ESA), Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and Fish and Wildlife Act of 1956. This information is being provided to assist you in making an informed decision regarding wildlife issues, site selection, project design, and compliance with applicable laws. The Service has been working closely with the Ohio Department of Natural Resources (ODNR) Division of Wildlife to develop recommended survey protocols and site evaluations that will satisfy both state and federal wildlife statutes, and this letter describes these measures, in part. We appreciate your early coordination with both ourselves and ODNR, and recommend continued collaboration on this project to ensure wildlife issues are fully and appropriately addressed.

The Fish and Wildlife Service (Service) supports the development of wind power as an alternative energy source, however, wind farms can have negative impacts on wildlife and their habitats if not sited and designed with potential wildlife and habitat impacts in mind. Selection of the best sites for turbine placement is enhanced by ruling out sites with known, high concentrations of birds and/or bats passing within the rotoswept area of the turbines or where the effects of habitat fragmentation will be detrimental. In support of wind power generation as a wildlife-friendly, renewable source of power, development sites with comparatively low bird, bat and other wildlife values, would be preferable and would have relatively lower impacts on wildlife.

<u>WATER RESOURCE COMMENTS:</u>

The Service recommends that impacts to streams and wetlands be avoided, and buffers surrounding these systems be preserved. Streams and wetlands provide valuable habitat for fish and wildlife resources, and the filtering capacity of wetlands helps to improve water quality. Naturally vegetated buffers surrounding these systems are also important in preserving their wildlife-habitat and water quality-enhancement properties. Furthermore, forested riparian systems (wooded areas adjacent to streams) provide important stopover habitat for birds migrating through the region. The proposed activities do not constitute a water-dependent activity, as described in the Section 404(b)(1) guidelines, 40 CFR 230.10. Therefore, practicable alternatives that do not impact aquatic sites are presumed to be available, unless clearly demonstrated otherwise. Therefore, before applying for a Section 404 permit, the client should closely evaluate all project alternatives that do not affect streams or wetlands, and if possible, select an alternative that avoids impacts to the aquatic resource. If water resources will be impacted, the Buffalo District of the Corps of Engineers should be contacted for possible need of a Section 404 permit.

ENDANGERED SPECIES COMMENTS:

Because of the potential for wind power projects to impact endangered bird, bat, or other listed species, they are subject to the Endangered Species Act (16 U.S.C. 1531-1544) section 9 provisions governing "take", similar to any other development project. Take incidental to a lawful activity may be authorized through the initiation of formal consultation, if a Federal agency, is involved; or if a Federal agency, Federal funding, or a Federal permit are not involved in the project, an incidental take permit pursuant to section 10(a)(1)(B) of the ESA may be obtained upon completion of a satisfactory habitat conservation plan for the listed species. However, there is no mechanism for authorizing incidental take "after-the-fact."

The proposed project lies within the range of the **Indiana bat** (*Myotis sodalis*), a Federally-listed endangered species. Since first listed as endangered in 1967, their population has declined by nearly 60%. Several factors have contributed to the decline of the Indiana bat, including the loss and degradation of suitable hibernacula, human disturbance during hibernation, pesticides, and the loss and degradation of forested habitat, particularly stands of large, mature trees. Fragmentation of forest habitat may also contribute to declines. During the winter Indiana bats hibernate in caves and abandoned mines. Summer habitat requirements for the species are not well defined but the following are considered important:

1. Dead or live trees and snags with peeling or exfoliating bark, split tree trunk and/or branches, or cavities, which may be used as maternity roost areas.

2. Live trees (such as shagbark hickory and oaks) which have exfoliating bark.

3. Stream corridors, riparian areas, and upland woodlots which provide forage sites.

The Service currently has no records for Indiana bats within Hardin County, however this is due to an absence of survey data for this area. Suitable summer habitat exists within the project area. Additionally, wind power developments within Pennsylvania, West Virginia, and other states are known to cause take of relatively large numbers of bats (no Indiana bats to date). Therefore further assessment of the bat community within the project area is warranted to determine if take of Indiana bats (or other bat species) is likely to occur.

Mist Net Surveys: Based on ODNR's On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio, five mist net sites are recommended for the project area. Your wildlife survey protocol describes proposed Indiana bat mist net survey protocols that meet ODNR's recommendations, and exceed Service recommendations, therefore we agree that this protocol is acceptable to confirm the presence or likely absence of Indiana bats within the project area. We recommend that the highest quality Indiana bat habitat areas within the project area be selected for mist netting. Mature woodlots greater than 100 acres in size with permanent water sources should be the primary focus of mist net surveys. Service biologists would be happy to aid in identification and selection of suitable mist net sites, if necessary. Please note that Indiana bat surveys may only be conducted by individuals with a Federal permit (please see attached list). If an Indiana bat is captured, this office shall be notified within 24 hours, or by the next business day.

Radio Transmitters: Up to four Indiana bats should be fitted with radio transmitters and tracked to roost site(s) and foraging areas until daily activity patterns are fairly well established, or as long as the transmitter remains attached and activated. Preference shall be given to tracking female bats, though one male Indiana bat may be tracked if captured prior to capturing four female Indiana bats. Please see ODNR's recommended survey protocol for additional information on radiotracking non-Indiana bats.

Acoustic Surveys: Your survey protocol includes installation of AnaBat II detectors on the meterological tower within the project area, and recording of bat echolocation calls from March 15-November 15, 2009. We agree that this is appropriate and inline with ODNR's recommendations.

Coordination of Survey Results: Please submit survey results to this office for review. Survey results will be interpreted to determine areas with relatively low bat activity/diversity as opposed to areas with relatively high bat activity/diversity. Based on the survey results, we may make recommendations as to turbine placement and operation, additional consultation under Section 7 or 10 of the Endangered Species Act of 1973, as amended, or pre- or post-construction monitoring.

The project lies within the range of the **clubshell mussel** (*Pleurobema clava*) and **rayed bean mussel** (*Villosa fabalis*), federally-listed endangered and candidate species. Clubshell is known from the Scioto River watershed in areas with sand or gravel substrate and riffles and runs. The rayed bean is generally known from smaller, headwater creeks, but records exist in larger rivers such as Blanchard River, and suitable habitat is generally present in the Scioto River. Rayed bean are usually found in or near shoal or riffle areas, and in the shallow, wave-washed areas of lakes. Substrates typically include gravel and sand, and they are often associated with, and buried under the roots of, vegetation, including water willow (*Justicia americana*) and water milfoil (*Myriophyllum* sp.). Should the proposed project directly or indirectly impact the Scioto or Blanchard Rivers, further coordination with this office is warranted, and surveys to determine the presence or probable absence of mussels may be necessary.

The proposed project lies within the range of the copperbelly watersnake and eastern massasauga, Federally listed endangered and candidate species. Due to the project type, location, and onsite habitat, none of these species would be expected within the project area, and no impacts to these species are expected. Relative to these species, this precludes the need for further action on this project as required by the 1973 Endangered Species Act, as amended.

MIGRATORY BIRD COMMENTS:

The Migratory Bird Treaty Act (16 U.S.C. 703-712; MBTA) implements four treaties that provide for international protection of migratory birds. The MBTA prohibits taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Department of the Interior. Bald and golden eagles are afforded additional legal protection under the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d). Unlike the

Endangered Species Act, neither the MBTA nor its implementing regulations at 50 CFR Part 21, provide for permitting of "incidental take" of migratory birds. While bald eagles are known to occur in Hardin County, none are within 5 miles of the project area. Therefore, we do not anticipate any impact on this species.

The Service's Office of Law Enforcement serves its mission to protect Federal trust wildlife species, in part, by actively monitoring industries known to negatively impact wildlife, and assessing their compliance with Federal law. These industries include oil/gas productions sites, cyanide heap/leach mining operations, industrial waste water sites, and wind power sites. There is no threshold as to the number of birds incidentally killed by wind power sites, or other industry, past which the Service will seek to initiate enforcement action. However, the Service is less likely to prioritize enforcement action against a site operator that is cooperative in seeking and implementing measures to mitigate takes of protected wildlife.

The Service and ODNR Division of Wildlife have worked together to develop a recommended bird survey protocol for wind turbine projects. As noted above, your proposed wildlife survey protocols generally conform to ODNR's On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio. Bird survey results will be interpreted to determine if potential risk to birds is relatively high or low in various portions of the project area. Based on survey results we may make recommendations as to turbine placement and operation, or pre- or post-construction monitoring.

Research into the actual causes of bat and bird collisions with wind turbines is limited. To assist Service field staffs in review of wind farm proposals, as well as aid wind energy companies in developing best practices for siting and monitoring of wind farms, the Service published *Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines* (2003). We encourage any company/licensee proposing a new wind farm to consider the following excerpted suggestions from the guidelines in an effort to minimize impacts to migratory birds and bats.

1) Pre-development evaluations of potential wind farm sites to be conducted by a team of Federal and/or State agency wildlife professions with no vested interest in potential sites;

2) Rank potential sites by risk to wildlife;

3) Avoid placing turbines in documented locations of federally-listed species;

4) Avoid locating turbines in known bird flyways or migration pathways, or near areas of high bird concentrations (i.e., rookeries, leks, refuges, riparian corridors, etc.);

5) Avoid locating turbines near known bat hibernation, breeding, or maternity colonies, in migration corridors, or in flight paths between colonies and feeding areas;

6) Configure turbine arrays to avoid potential avian mortality where feasible. Implement storm water management practices that do not create attractions for birds, and maintain contiguous habitat for area-sensitive species;

7) Avoid fragmenting large, contiguous tracts of wildlife habitat;

8) Use tubular supports with pointed tops rather than lattice supports to minimize bird perching and nesting opportunities;

9) If taller turbines (top of rotorswept area is greater than 199 feet above ground level) require lights for aviation safety, the minimum amount of lighting specified by the Federal Aviation Administration (FAA) should be used. Unless otherwise requested by the FAA, only white strobe lights should be used at night, and should be of the minimum intensity and frequency of flashes allowable. Red lights should not be used, as they appear to attract night-migrating birds at a higher rate than white lights;

10) Adjust tower height to reduce risk of strikes in areas of high risk for wildlife.

The full text of the guidelines is available at http://www.fws.gov/habitatconservation/wind.pdf. The Service believes that implementing these guidelines may help reduce mortality caused by wind turbines. We encourage you to consider these guidelines in the planning and design of the project. We particularly encourage placement of turbines away from any large wetland, stream corridor, or wooded areas, including the areas mentioned previously, and avoid placing turbines between nearby habitat blocks.

Thank you for the opportunity to provide comments on this proposed project. Please contact biologist Megan Seymour at extension 16 in this office if we can be of further assistance.

Sincerely,

Mary Knapp

Mary Knapp, Ph.D.
Supervisor

Cc: Mr. Keith Lott, ODNR, Old Woman Creek, 2514 Cleveland Road East, Huron, OH 44839
Mr. Brian Mitch, ODNR, REALM, Columbus, OH

Attachments: Indiana bat surveyor list

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4625 Morse Road, Suite 104
Columbus, Ohio 43230
(614) 416-8993 / FAX (614) 416-8994
January 7, 2009

USFWS permittees for Indiana bat surveys in Ohio*

Alliance Consulting Inc. T. Sydney Burke 124 Philpott Lane Beaver, WV 25813 (304) 255-0491 ext. 343 / FAX (304) 255-4232 sburke@aci-wv.com	**Appalachian Technical Services** P.O. Box 3537 6741 Indian Creek Road Wise, VA 24293 (276) 328-4200 / FAX (276) 328-4900 wise@atsone.com
BHE Environmental Russ Romme 11733 Chesterdale Road Cincinnati, OH 45246 (513) 326-1500 / FAX (513) 326-1550 RRomme@BHEEnvironmental.com	**Eric Britzke** 815 Dillard Street Forrest City, AR 72335 (870) 261-3666 ebritzke@hotmail.com
Timothy Carter Ball State University Department of Biology, CL 121 Muncie, IN 47306-0440 (765) 285-8842 / FAX (765) 285-8804 tccarter@bsu.edu	**Civil & Environmental Consultants** 3600 Park 42 Drive, Suite 130B Cincinnati, OH 45241-2072 (513) 985-0226 / (800) 759-5614 Neil Bossart – Pittsburgh Office 333 Baldwin Road Pittsburgh, PA 15205-9702 (412) 429-2324 / (800) 365-2324 FAX (412) 429-2114 nbossart@cecinc.com
Copperhead Environmental Consulting, Inc. P.O. Box 73 11641 Richmond Road Paint Lick, KY 40461 (859) 925-9012 mwgumbert@copperheadconsulting.com	
Davey Resource Group Michelle Malcosky 1500 N. Mantua St., P.O. Box 5193 Kent, OH 44240-5193 (800) 828-8312 / FAX (330) 673-0860 Jessica Hickey, ext.27 Ken Christensen, ext. 34 mmalcosky@davey.com	**Kathleen Dunlap** Professional Service Industries, Inc. 4960 Vulcan Ave. Columbus, OH 43228 (614) 876-8000 (office) / (614) 638-5941 (mobile) FAX (614) 876-0548 kathleen.dunlap@psiusa.com
Eco-Tech, Inc. Peter Lee Droppelman Eco-Tech, Inc. 1003 E. Main St. Frankfort, KY 40601 (502) 695-8060 / FAX (510) 695-8061 ldroppelman@ecotechinc.com	**Ecological Specialties LLC** William D. Hendricks 1785 Symsonia Highway Symsonia, KY 42082 (270) 832-1883 / FAX (270) 851-4363 myotis@hughes.net

Brianne Lorraine Walters Dept. of Ecology and Organisimal Biology Indiana State University Terre Haute, IN 47809 (812) 237-8294 / FAX (812) 237-2526 bwalters2@isugw.indstate.edu	**Western Ecosystems Technology, Inc.** 2003 Central Avenue Cheyenne, WY 82001 (307) 634-1756 / FAX (307) 637-6981 admin@west-inc.com
John O. Whitaker, Jr. Department of Life Sciences Indiana State University Terre Haute, IN 47809 (812) 237-2383 / FAX (812) 237-2526 jwhitaker3@isugw.indstate.edu	

*This list reflects permit data available as of January 7, 2009, and is subject to periodic revision to reflect permit changes

Rhett Good

From: Lott, Keith [Keith.Lott@dnr.state.oh.us]
Sent: Tuesday, December 02, 2008 3:13 PM
To: rgood@west-inc.com; Megan_Seymour@fws.gov
Cc: Nazre Adum; Jay Schoenberger; Scott, Dave
Subject: RE: Invenergy Hardin County Protocol

Rhett,

After reviewing the draft pre-construction monitoring protocol for the wind energy facility Invenergy's proposed for Hardin County, the Ohio Department of Natural Resources, Division of Wildlife has no objection to either the types of studies proposed nor the methodologies entailed. We appreciate the opportunity to comment on this plan, and look forward to working with you in the future on this or other sites proposed within Ohio.

Keith

Keith Lott, Wind Energy Wildlife Biologist

Old Woman Creek Nat'l Estuarine Research Reserve and State Nature Preserve
Ohio Division of Wildlife
2514 Cleveland Road East
Huron, OH 44839
Office phone: 419-433-4601
Cell: 419-602-3141
Fax: 419-433-2851

-----Original Message-----
From: Rhett Good [mailto:rgood@west-inc.com]
Sent: Monday, November 24, 2008 10:32 PM
To: Lott, Keith; Megan_Seymour@fws.gov
Cc: 'Nazre Adum'; 'Jay Schoenberger'; Scott, Dave
Subject: Invenergy Hardin County Protocol

Hello All,

Thank you again for meeting with Invenergy and WEST on September 3rd to discuss Invenergy's proposed wind power project, located in Hardin County, Ohio. As we discussed, the proposed project falls within the "moderate" survey effort category, following the Ohio Department of Natural Resources' *On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio – Final Version.*

Please find attached a copy of the draft pre-construction wildlife study protocols that WEST has prepared on Invenergy's behalf. The proposed baseline studies are designed to estimate project impacts on wildlife and closely follow the ODNR Final guidelines. We welcome your feedback and comments, which will be considered and incorporated into the final study design. Studies were started during early September, 2008, and are currently ongoing.

Thank you in advance for your consideration and review. Please feel free to give me a call, should you have any questions.

Regards,

Rhett

Rhett E. Good
Research Biologist / Project Manager
Western EcoSystems Technology, Inc. (WEST)
804 North College, Suite 103
Bloomington, Indiana 47404
(812) 339-1756 office
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Ohio Department of Natural Resources

TED STRICKLAND, GOVERNOR | SEAN D. LOGAN, DIRECTOR

Division of Wildlife
David M. Graham, Chief
2045 Morse Rd., Bldg. G
Columbus, OH 43229-6693
Phone: (614) 265-6300

June 17, 2009

To all interested parties,

Based upon the revised project boundary map received on 16 June 2009, the Ohio Department of Natural Resources Division of Wildlife (DOW) has revised the previous survey recommendations (sent 26 August 2008) to reflect the increase in scope for the Hardin County.

The table below was created based upon the project maps provided and summarizes the types and level of effort recommended by the DOW. The level of effort recommended in this letter supersedes the recommendations provided in previous letters for this project. Results from these studies will help the Department of Natural Resources assess the potential impact these turbines may pose, and influence our recommendations to the Ohio Power Siting Board. Monitoring should follow those criteria listed within the "On-shore Bird and Bat Pre-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio."

	Project
Survey type	**Invenergy Hardin County**
Breeding bird	Breeding bird surveys should be conducted at all sites. The number of survey points may be based on the amount of available habitat, or twice the maximum number of turbines proposed for the site. Because agricultural land is not considered to be suitable nesting habitat for most species of bird, turbines placed within these types of habitat are exempt of this recommendation.
Raptor nest searches	Nest searches should occur on, and within a 1-mile buffer of the proposed facility.
Raptor nest monitoring	There are currently no known raptor nests that occur on or within 2-miles of the proposed project area. Should a nest of a protected species of raptor be located during nest searches, monitoring should commence as outlined in the on-shore protocols.
Bat acoustic monitoring	Acoustic monitoring should be conducted at all meteorological towers.

Passerine migration (# of survey points)	3
Diurnal bird/raptor migration (# of survey point)	Yes
Sandhill crane migration (same points as raptor migration)	Yes
Owl playback survey points	NS
Barn owl surveys	NS
Bat mist-netting (# of survey points)	9
Nocturnal marsh bird survey points	NS
Waterfowl survey points	NS
Shorebird migration points	NS
Radar monitoring locations	NS

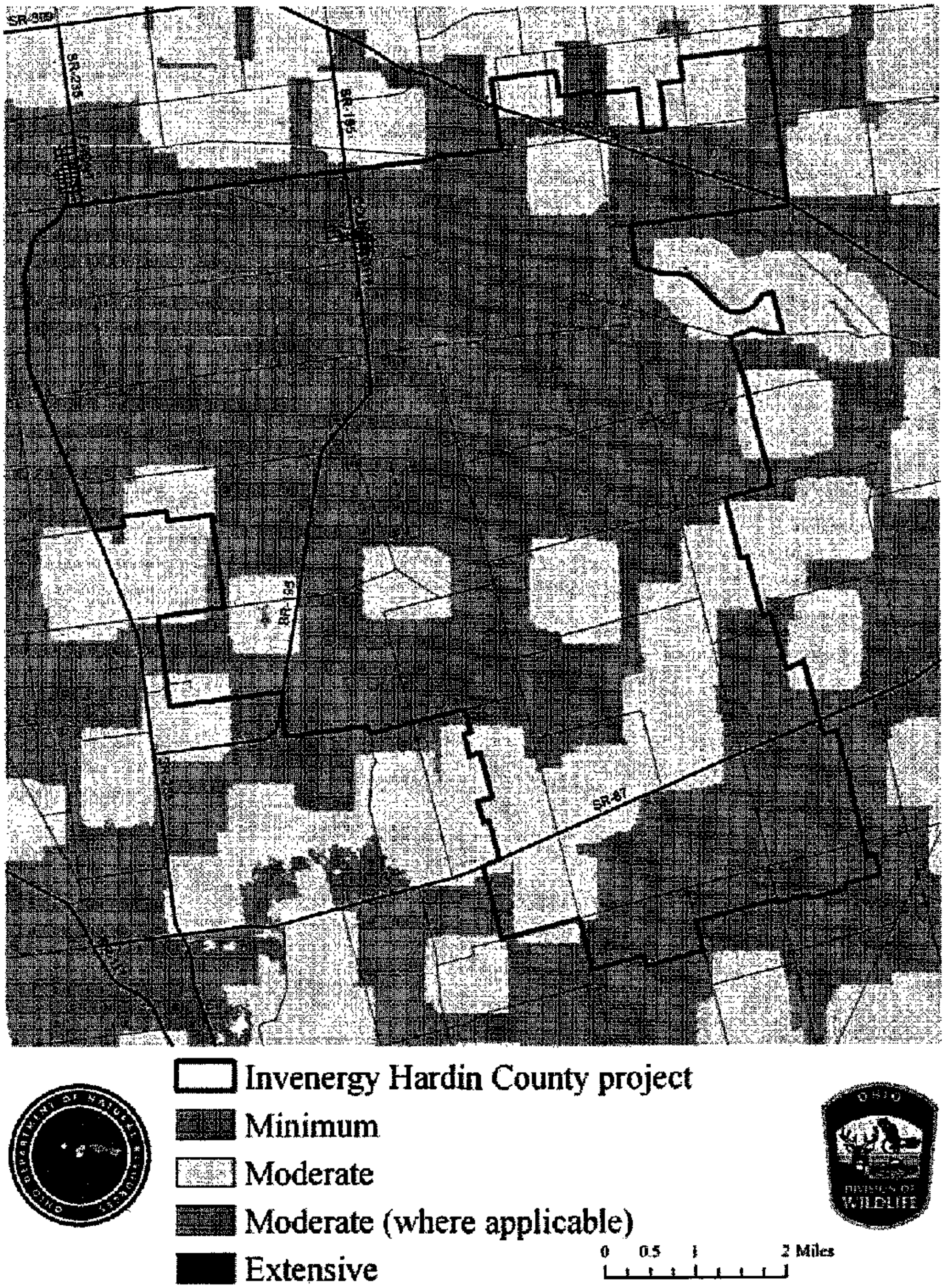
NS = Not required based on the lack of suitable habitat.

The DNR looks forward to working with you on this or any other proposed project in the future. If you have any questions, please feel free to contact me.

Keith

Old Woman Creek Nat'l Estuarine Research Reserve and State Nature Preserve
Ohio Division of Wildlife
2514 Cleveland Road East
Huron, OH 44839
Office phone: 419-433-4601
Cell: 419-602-3141
Fax: 419-433-2851

cc: Mr. Stuart Siegfried, Ohio Power Siting Board
Ms. Megan Seymour, United States Fish and Wildlife Service


SR-309
SR-67
Invenergy Hardin County project
Minimum
Moderate
Moderate (where applicable)
Extensive
0 0.5 1 2 Miles


SR-309
SR-235
FRONT
SR-195
SR-309
SR-195
SR-235
SR-117
Invenergy Hardin County project
Forest cover
0 0.5 1 2 Miles

Rhett Good

From: Lott, Keith [Keith.Lott@dnr.state.oh.us]
Sent: Friday, June 26, 2009 12:01 PM
To: rgood@west-inc.com
Cc: Nazre Adum
Subject: RE: Revised Protocol for Invenergy Hardin County

All,

The survey recommendations within the "Wildlife Baseline Protocol for the Proposed Hardin County Wind Farm" concur with the level of effort suggested by the Ohio Department of Natural Resources Division of Wildlife. Please contact me if you have any questions or are in need of bat bands.

Keith

-----Original Message-----
From: Rhett Good [mailto:rgood@west-inc.com]
Sent: Thursday, June 25, 2009 3:22 PM
To: Lott, Keith
Cc: Nazre Adum
Subject: Revised Protocol for Invenergy Hardin County

Hello Keith,

Please find attached the revised protocol for Hardin for your review, based on the revised effort letter and new boundary for the project and the latest version of the ODNR wildlife monitoring protocols. The methods described are identical to the previous version, with the following exceptions:

1 – The number of mistnet sites has been increased to nine, per the revised effort letter
2 – Anabat detectors have been added to the two new met towers, per the revised effort letter

Would you mind reviewing, and letting us know if the protocol is acceptable to the ODNR? Please feel free to call with any questions.

Best regards,

Rhett

Rhett E. Good
Research Biologist / Senior Manager
Western EcoSystems Technology, Inc. (WEST)
804 North College, Suite 103
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(812) 320-0948 cell
www.west-inc.com

Statement of Evidence of
Tony Gregory Coggan

Truescape – 3D Visualizations

INTRODUCTION

1.1 My name is Tony Gregory Coggan. I am the Vice President of International Development for the firm Truescape Limited (Truescape).

1.2 I am a computer simulation specialist and prior to joining Truescape I worked in the surveying industry for 17 years. I have 8 years experience working in the 3D photo and video simulations industry, and have completed a wide range of different visualisation projects from photo-simulations for simple projects to full computer generated 3D video simulations for complex projects across New Zealand, Australia and in the United States.

1.3 I have been involved with many simulations that have been commissioned to support permitting applications in New Zealand, Australia and the USA. I have played an integral part in refining the methodology behind the accurate simulation technology used to produce the simulations before the hearing panel today. In 2008, I acted in an Expert Witness capacity on 8 occasions before New Zealand hearing panels and 1 occasion before the Victorian Civil and Administrative Tribunal in Australia.

2. SCOPE OF EVIDENCE

2.1 Hardin Wind Energy LLC engaged Truescape in May 2009 to provide:

- A series of 3 TrueView™ 2 "human field of view" survey controlled photo simulations depicting the proposed Hardin Wind Farm provided as **ATTACHMENT A** (Ref Page 24) in large scale photo format and also in a reduced size booklet format as **ATTACHMENT B** (Ref Page 25).

- Two Zones of Visual Influence (ZVI) diagrams showing the visibility of turbine tips and hubs over the project site provided as **ATTACHMENT C** (Ref Pages 26 and 27).

- A 3D animated shadow simulation. Provided as a CD Attached to this report as **ATTACHMENT D** (Ref Page 28)

2.2 The simulations are a tool to assist with the visual assessment of the proposed Hardin Wind Farm.

2.3 The scope of Truescape's work does not extend to the assessment or interpretation of the simulations for issues relating to the proposed Hardin Wind Farm Project's visibility and its landscape and visual effects.

2.4 The TrueView™2 simulations have been produced in the large scale format which is the correct format to be used when making any visual assessment. To assist the Ohio Power Siting Board the TrueView™2 simulations have also been produced in a reduced size reference booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams".

2.5 It should be noted that the Ohio Power Siting Board regulations call for "*Photographic interpretation or artists pictorial sketches of the proposed facility from public vantage points within five miles of the proposed facility*" and that the survey accurate simulations attached to this report exceed that requirement with respect to both realism and accuracy.

2.6 The locations of each photo point position complies with the requirement of the Ohio Power Siting Board regulations in that they are all public vantage points that are positioned within five miles of the proposed facility.

2.7 Truescape were directed to each of the Photo Point locations by representatives of Hardin Wind energy LLC.

2.8 The Zone of Visual influence diagrams have been created using Arc GIS software and do not account for conditions that may block or diminish turbine visibility. This includes objects such as buildings, structures and vegetation. The diagrams are attached as **APPENDIX C** (Ref pages 26 and 27) in the booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams".

2.9 The 3D Animated Shadow simulation depicts the length of shadow that each turbine would generate under sunny conditions. The animation Attached as **APPENDIX D** (Ref page 28) reflects sunlight conditions on the 30th May 2009.

2.10 To validate the Truescape methodology I have provided on page 21 a comparison of a simulation against an actual built wind farm. This comparison relates to a simulation Truescape produced for a project in Southland New Zealand called Project White Hill for New Developer Meridian Energy.

2.11 I have set out the following in this report:

- An overview of the TrueView™2 Photo Simulation; (Pages 3-4)
- Methodology; (Pages 5-12)
- Photopoint Locations; (Page 13)
- Model Input Data used to create the simulations; (Pages 14-16)
- Camera Lens Commentary (Page 17 – 19)
- Validation of Truescape Methodology (Page 20)
- Truescape Credentials (Pages 21-22)

- **APPENDIX A** – TrueView™ 2 Large Scale Photo Simulations. Attached as hard copy photo simulations (See Page 24)

- **APPENDIX B** – Reduced Size TrueView™2 Photo Simulations attached in hard copy in booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams". (See Page 25)

- **APPENDIX C** – Zone of Visual Influence Diagrams attached in hard copy in booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams". (See pages 26 and 27)

- **APPENDIX D** – Animated Shadow Simulation attached as CD (See page 28)

3 SUMARY AND CONCLUSION

3.1 The TrueView™2 photo simulations have been created using a robust methodology which when combined with the datasets outlined in this evidence sees these simulations generated using the most advanced and accurate technology available at the time of creation. Truescape considers the TrueView™2 photo simulations accurately represent the primary human field of view of the Hardin Wind Farm Project when viewed from the surveyed photo-point positions at the same time of day and reflecting the same conditions as those on the day the photographs were taken.

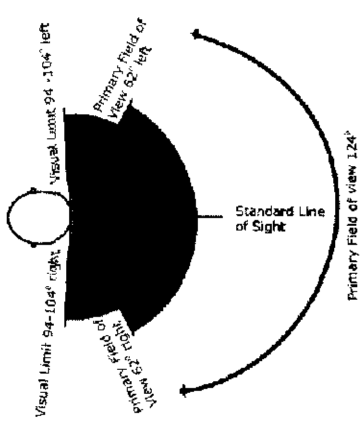
TONY COGGAN

JUNE 2009

TrueView™2 PHOTO SIMULATIONS

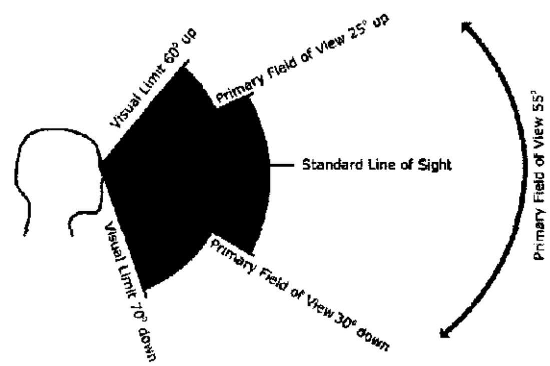
- A TrueView™2 is a high resolution, true scale format photo simulation that represents **The Primary Human Field of View** that would be seen if standing 19.7inches back from actual photopoint position at the same time of day and reflecting the same climatic conditions as those experienced on the day the photograph was taken.

PRIMARY HUMAN FIELD OF VIEW



Primary Human Horizontal Field of View

Reference: Panero J. and Zelnick M. (1979) *Human dimension and interior space: A source book of design reference standards*, London: The Architectural Press Ltd



Primary Human Vertical Field of View

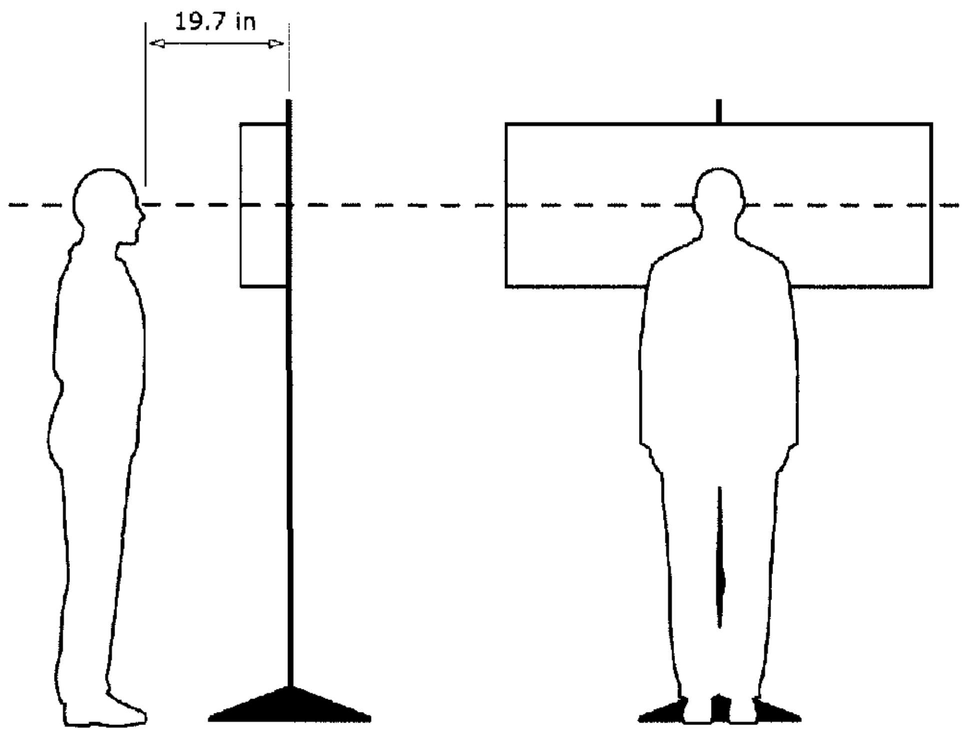
TrueView™2 PHOTO SIMULATIONS

Correct Viewing of TrueView™2 Photo Simulations

- The TrueView™2 simulations when viewed at the correct height and from a distance of 19.7inches from the centre of the image completely fill your field of view with the same view you would see at the photo point position.

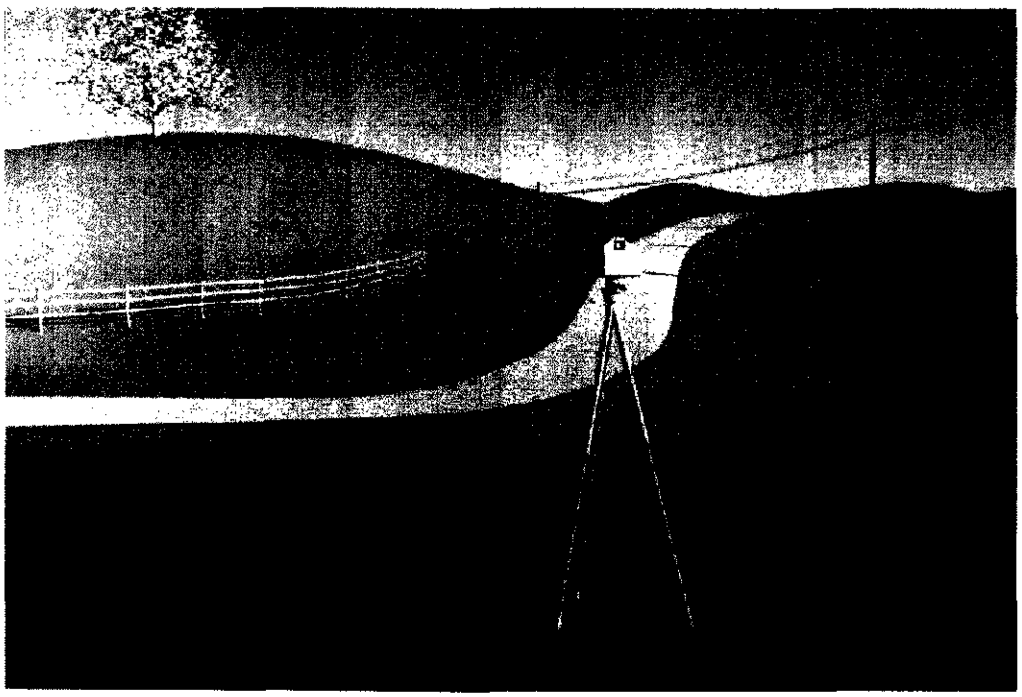
- The image should be displayed level at such a height to allow the viewer line of sight to be directly at the centre of the image.

- The viewer should be looking forward at the centre of the image at all times to ensure correct viewing as shown below.



METHODOLOGY

THE SITE VISIT

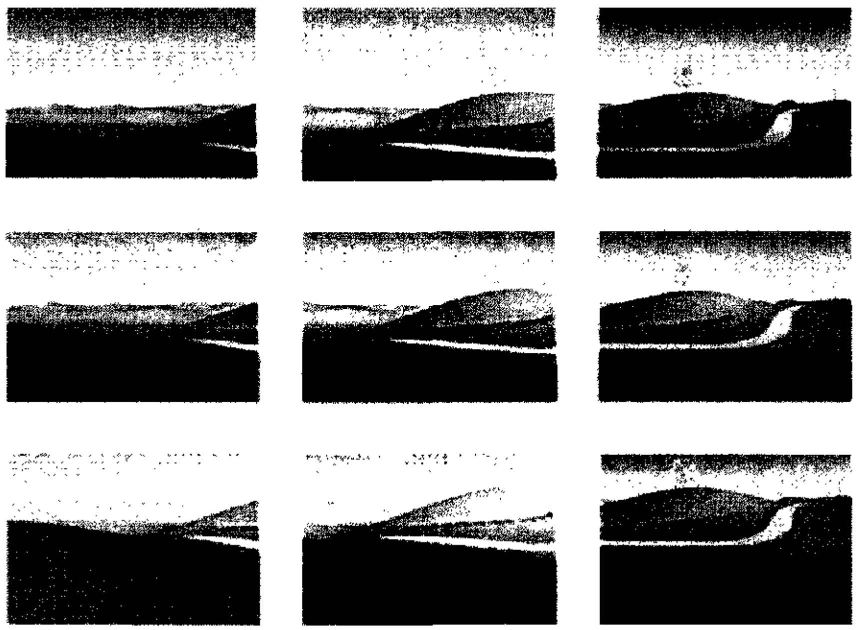


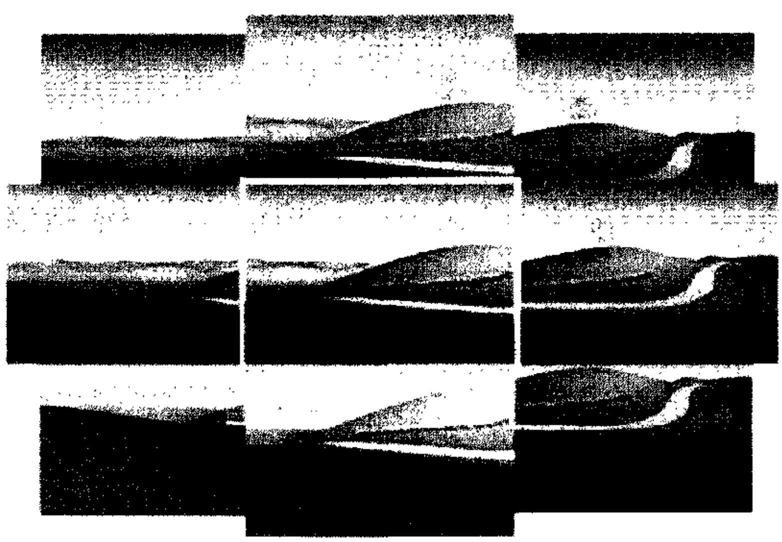
- The site visit is undertaken to take the necessary photographs and ground mark the photo point position and identify additional reference points to enable the surveyor to survey fix the exact location of the camera.

- A digital SLR 1:1 16 mega pixel camera is used to take the photography. This camera produces photographs at a resolution and clarity as good as current technology will allow when generating simulations.

METHODOLOGY

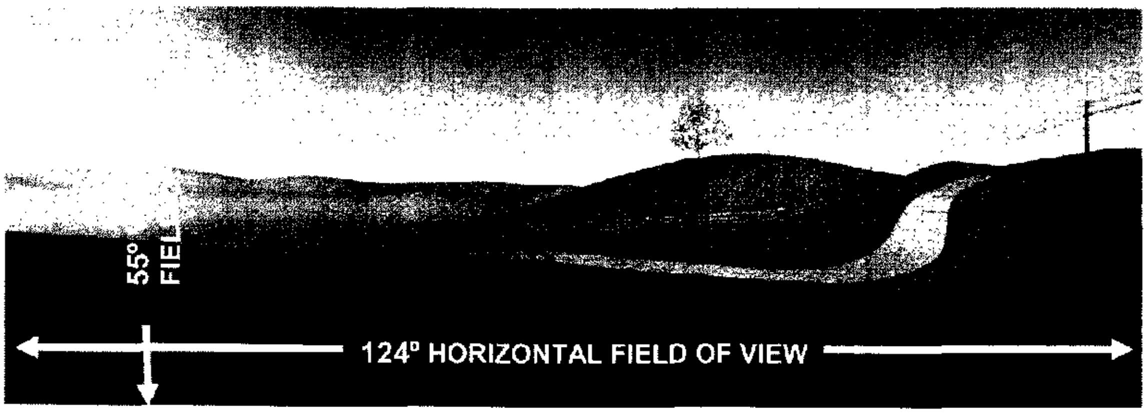
CREATING THE PRIMARY HUMAN FIELD OF VIEW IMAGE





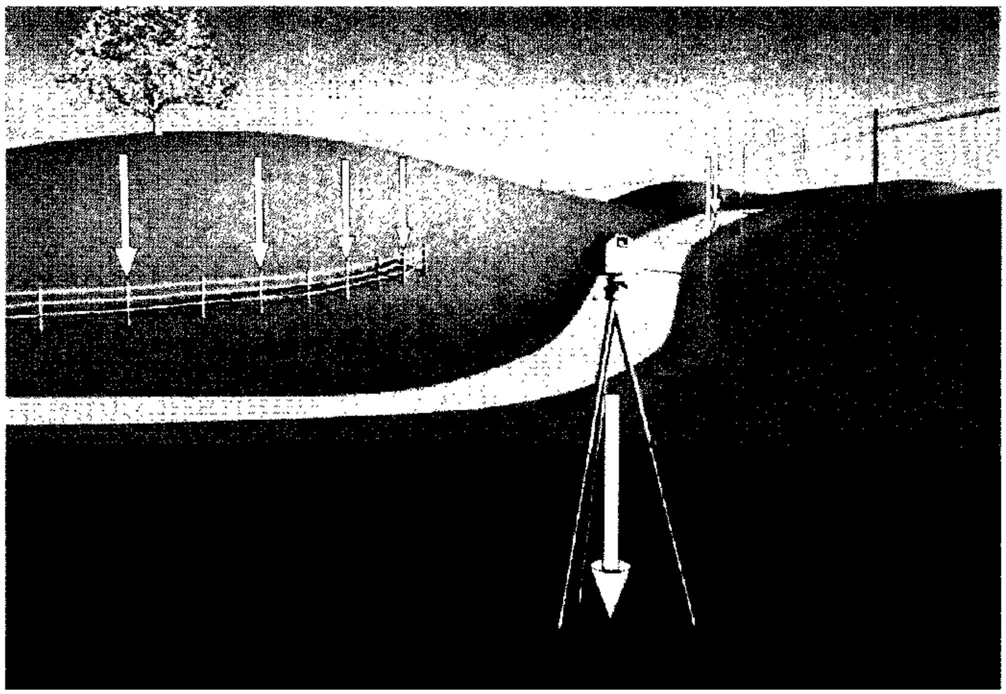
- The photographs are taken so that they overlap precisely to allow both the Primary Human Vertical and Horizontal Field of View to be recreated into a single primary human field of view image.

THE FINAL COLOUR ADJUSTED TrueView™2 PHOTOGRAPHY



- Using the middle photographs as the benchmark, each of the adjoining photographs are colour adjusted to ensure consistency throughout the image. The TrueView™2 photograph is now complete.

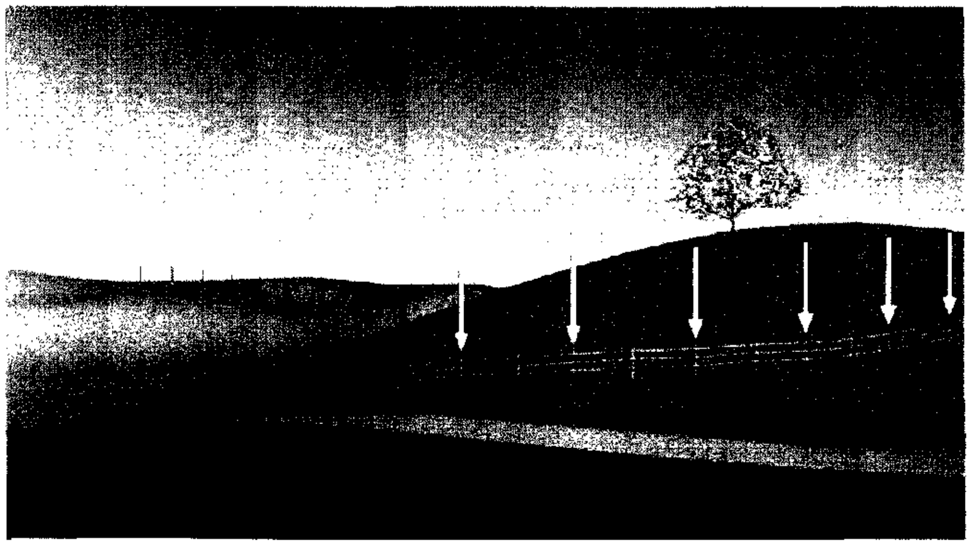
CAPTURING THE SURVEYED REFERENCE POINTS

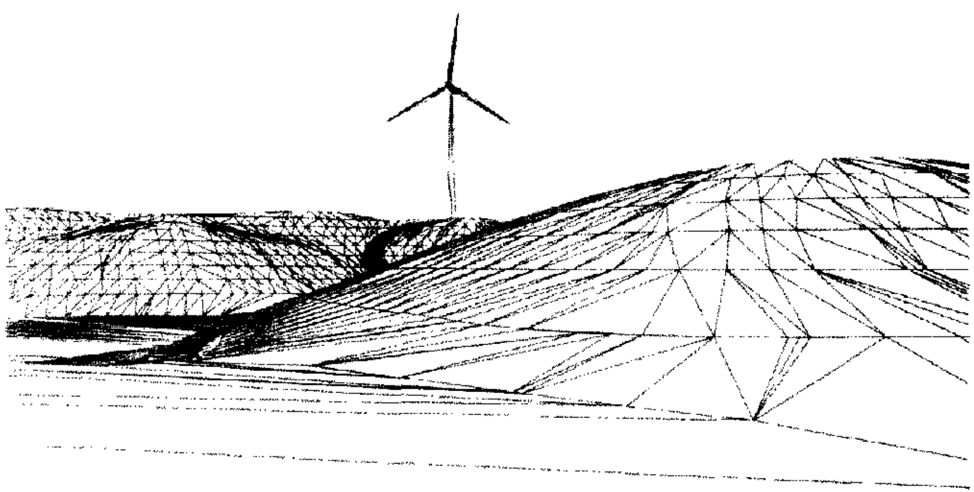


- To accurately create a TrueView™2 photo simulation the exact position of the camera is survey fixed by a surveyor.

- Additional reference points are identified during the site visit so that the 3D model can be accurately placed into the photograph. These reference points include things like fences, vegetation, houses and roads. The surveyor is directed to each of these points.

ALIGNING THE SURVEYED REFERENCE POINTS



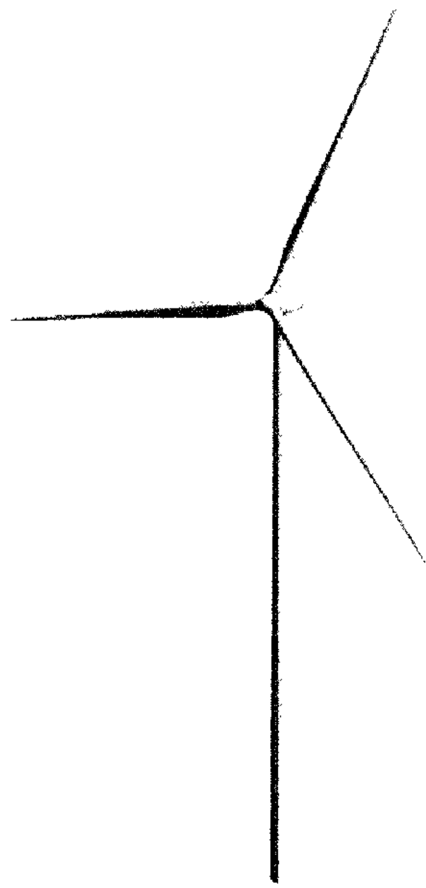


- The next step is to construct the 3D computer model. Using Autodesk® 3ds Max® 3D computer simulation software the survey fixed photo and reference points are imported into the 3D model. A "computer camera" is created to simulate the camera that captured the original photographs, including matching the focal length. The simulated "computer camera" is then positioned at the same survey coordinates as the physical photopoint positions.

- The photographs are then incorporated into the computer model. This is done by correctly aligning the "computer camera" to match the surveyed reference points to the reference objects, and to the terrain if required.

METHODOLOGY

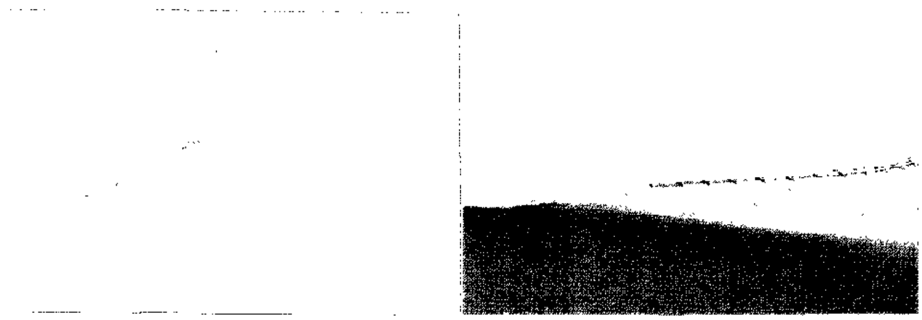
BUILDING THE PROPOSED PROJECT IN 3D

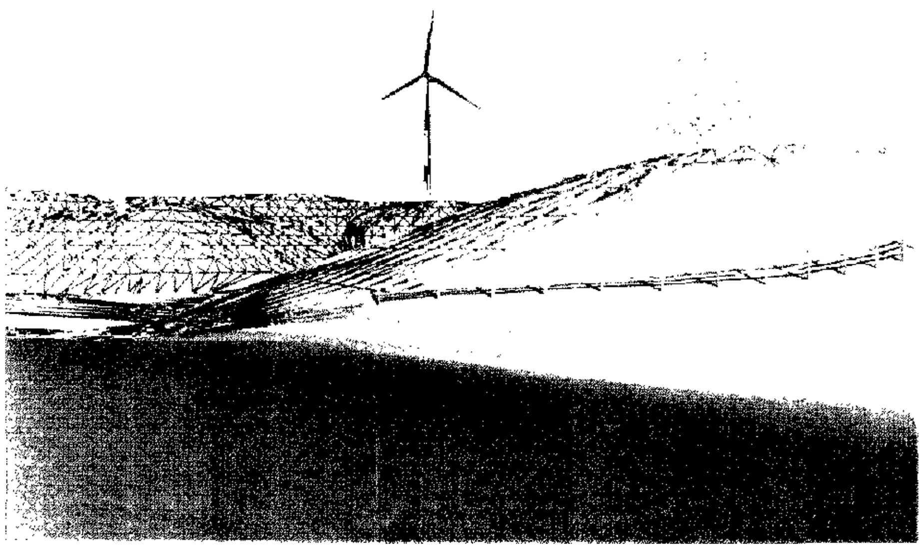


- The proposed development is then modelled in 3D in accordance with all dimensions, site layouts, colours and textures. (See "Model Input Data" section on pages 14 – 16)

METHODOLOGY

BUILDING THE PROPOSED PROJECT IN 3D



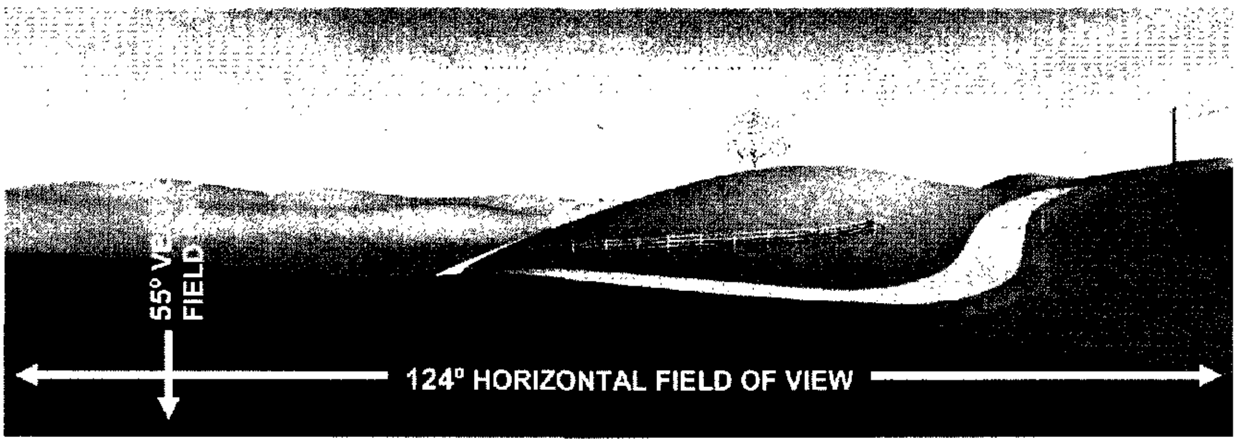


- The 3D terrain model of the site has been generated using the land contour data. The proposed development (turbines) have now been modelled in 3D and are now imported and positioned accurately into the scene.

- The simulation software allows the sun to be simulated at the precise time the original photography was captured. This ensures the lighting of the turbines as well as the shadows they cast are an accurate depiction of how the Project would appear in the photograph at the same time of day and reflecting the same climatic conditions as those experienced at the time the photograph was taken.

METHODOLOGY

THE FINAL TrueView™2 SIMULATION



- In order to correctly place existing objects that are in front of the 3D model of the development these foreground objects are overlaid, from the original photograph, onto the computer generated image using photo shop software.

- Our extensive experience in researching how to accurately simulate the "Primary Human Field of View" has determined that the lens type is irrelevant when generating such simulations. The key factors are the aligning of the raw photographs in 3D, the size that the simulations are output at, and the viewing distance.

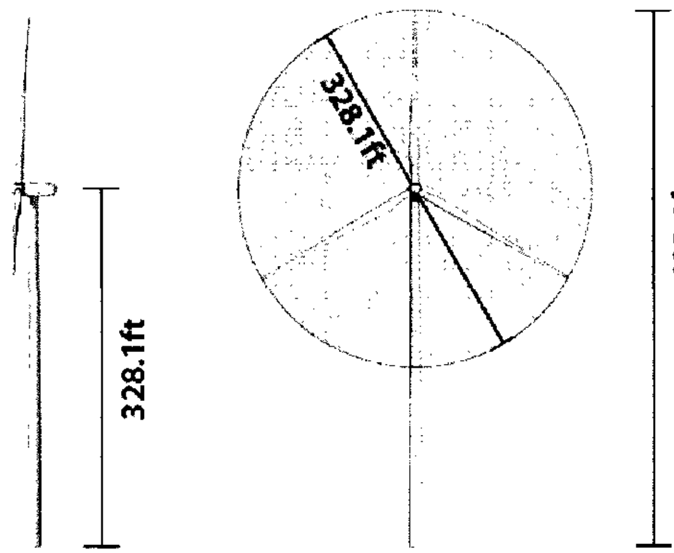
- The full size TrueView™2 simulations are printed at a size that represents the "Primary Human Field of View", being 124° horizontal field of view and 55° vertical field of view when standing 19.7inches from the centre of the image.

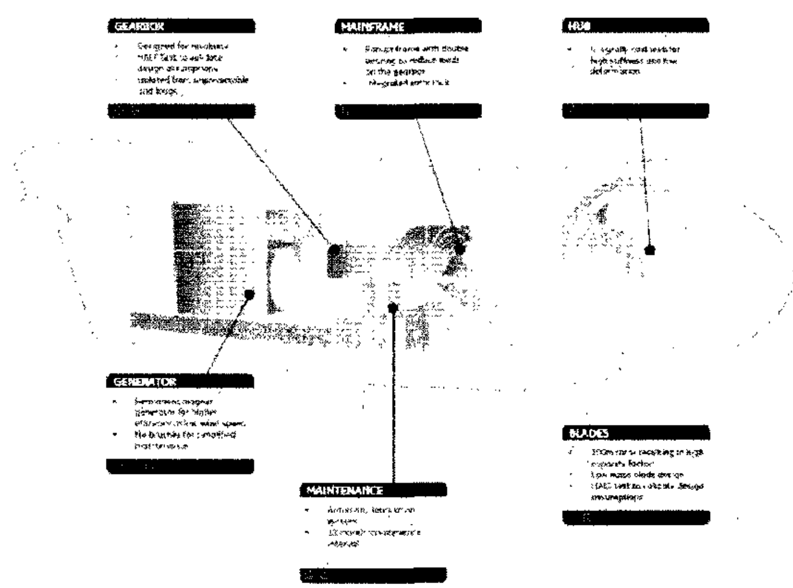
PHOTOPOINT LOCATIONS

- Location map referencing the three TrueView™ 2 photo simulations.

- **View Point 04 -** Quickstep Church, TR 120
- **View Point 11 -** Farm Complex, junction CR 75 and TR 190
- **View Point 14 -** Farm Complex, CR 95 south of CR 130

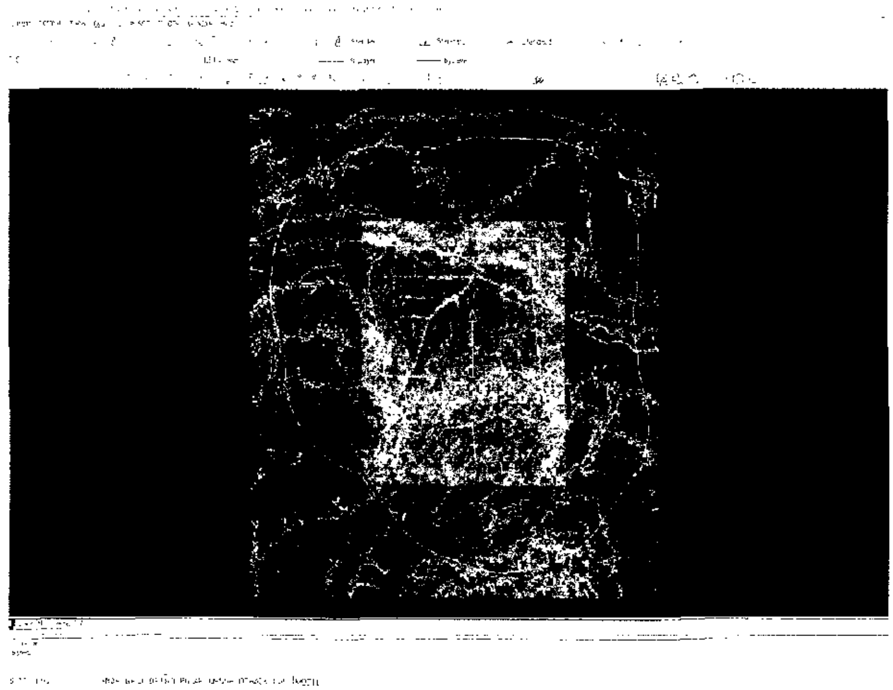
- GE 2.5mw XL Turbine. Data downloaded from GE Energy website.

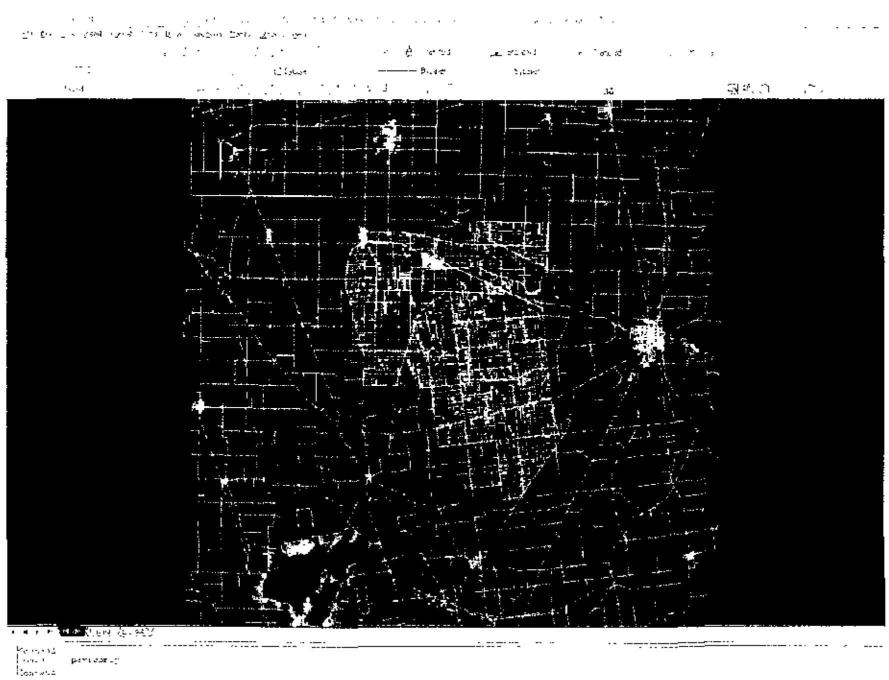




MODEL INPUT DATA

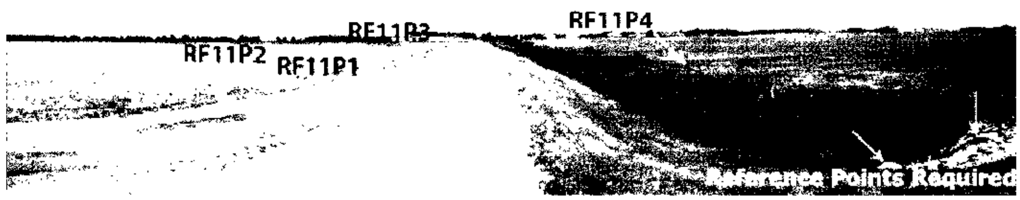
Contour data (3ft) and turbine positions were supplied by Tim R. Mayle – Hardin County GIS Coordinator. Wider contour data sourced from USGS and generated using by ArgGIS and Global Mapper software.





MODEL INPUT DATA

All survey work was carried out by Attwell – Hicks, Ohio.



Arrows indicate reference points that have been survey fixed

Survey points accurately aligned to photograph

Final TrueView™2 photo simulation

CAMERA LENS COMMENTARY

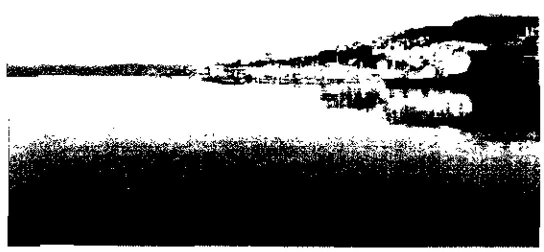
In recent times throughout Asia Pacific, UK and the USA there have been many debates relating to the appropriateness of certain lens types used to generate accurate photo simulations. The following commentary outlines how the composite imagery used to generate the TrueView™2 photo simulations resolves the lens issue.

THE LENS ISSUE

1. Camera lens of different focal length create images of different fields of view. None of these fields of view are the same as the human field of view (see page 10). A camera lens does not encompass the same horizontal and vertical "degree of arc" that is captured by human binocular vision. This is why a picture taken with a "non-human" does not represent what we actually see.

2. Look at the four photos below. The view captured with a 28mm lens looks further away than the view from the same spot taken with a 50mm lens. Standing at the same location, and using a 100mm lens, features in the picture look closer still, and with a 300mm lens, features that were far away now look much closer, and larger.

28 mm image



50 mm image

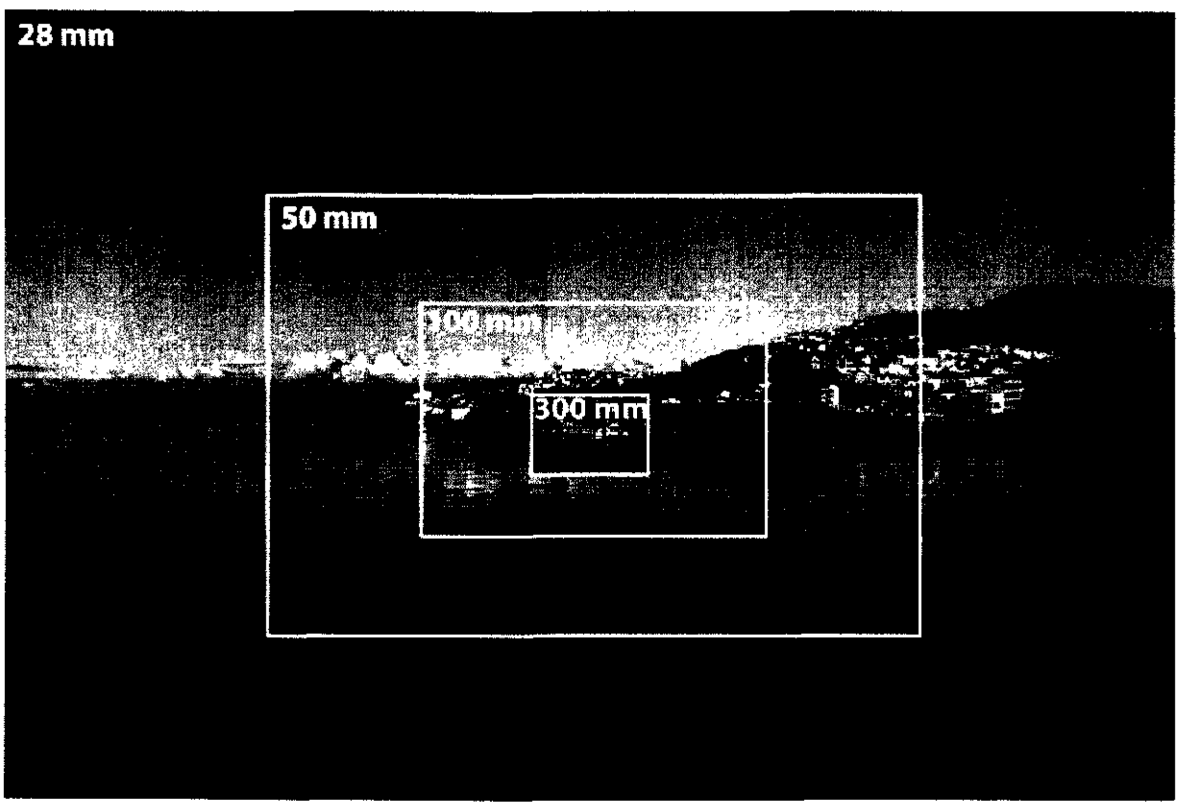
100 mm image

300 mm image

3. These different views are illusory, since all of the features in these photos are in reality a fixed size. Objects once built do not change in size. In reality, there is just one true view of what a person sees from any specified location.

4. To understand how illusions are created by lens size, one must understand depth of field, and how "depth of field" and "field of view" are related. As you increase the millimetre specification (or focal length) of a lens, the less field of view it incorporates – some of the view to the left and right, and above and below, is cropped out. The view is not only less wide, it is also less deep.

5. As you decrease your field of view you are decreasing the amount of visible foreground in the image, but leaving the vanishing point or distant center unaltered. It is this truncation of depth of field, which causes far objects in images to appear nearer to other physically closer objects in the scene. The image below shows the combined view when comparing 28mm, 50mm, 100mm and 300mm lenses.



6. For example, the field of view of a 50mm lens is contained *within* the field of view of a 28mm lens because a 28mm lens has a greater field of view than a 50mm lens. The 28mm image has a correspondingly greater depth of field because it incorporates more foreground image.

CAMERA LENS COMMENTARY

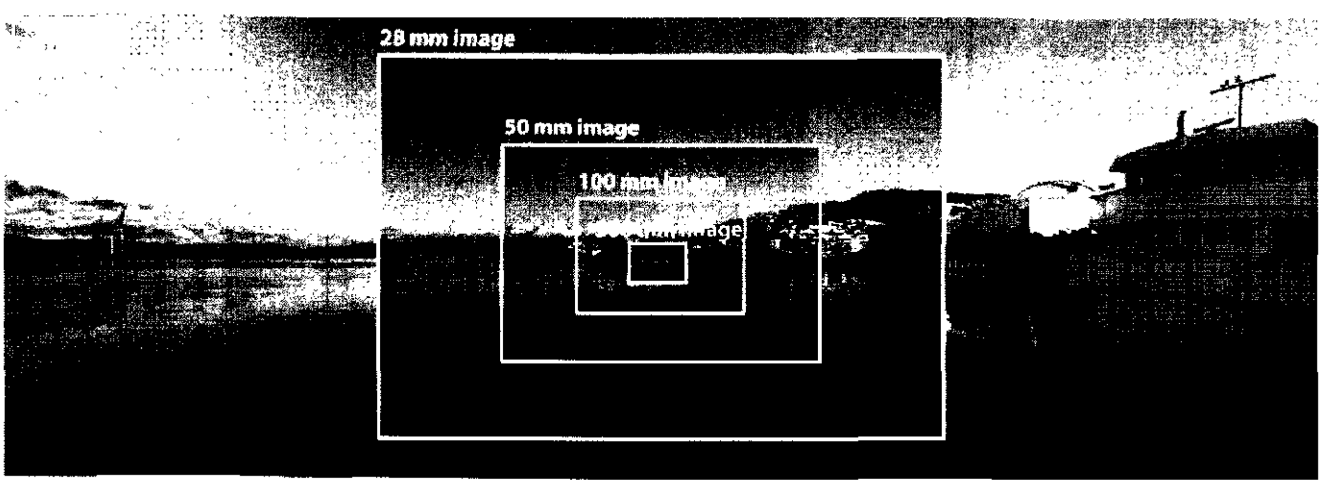
7. Photographs only represent a part of our primary field of vision. However photographs taken using a 28mm lens represent a far greater portion of our primary field of vision.

8. No camera lens duplicates the primary field of human vision. In order to be able to match exactly the field of view of the **vertical** extent of primary vision, we would need to use a camera lens of 25.933mm. (Thus, a 28mm lens is a much better starting point than a 50mm lens)

9. In order to match exactly the field of view of the **horizontal** extent of primary vision, we would need to use a camera lens of 9.571mm. However it is not practical to use a lens with a focal length of 9.571mm, as it becomes too difficult to compensate for the effects of distortion. A TrueView™2 image solves this problem.

10. Since it is not possible to take a photograph with a 9.571 mm lens, and print out that image on a flat plane, the horizontal length of the image itself must be made up of multiple images.

11. Truescape has chosen to create an image based upon a number of 28 mm images. We have selected this lens size for best accuracy and optimum efficiency in production. While it is theoretically possible to produce a similar outcome by processing a series of 50 mm, or 100 mm images, the complexity of production and the number of images required would be far greater, simply to produce the same result.

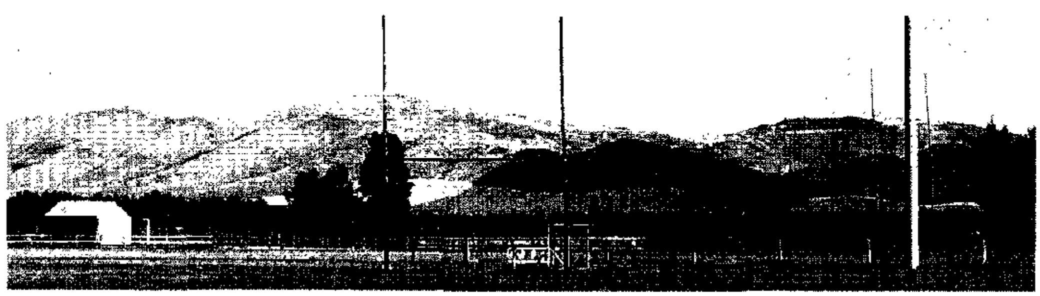


VALIDATION OF THE TRUESCAPE METHODOLOGY

1.1 I have attached below some post construction analysis of the White Hill wind farm that compared the simulations built using the constructed layout plan against the completed project. These simulations demonstrate the accuracy of the TrueView simulations. In particular, it can be seen that the size and placement of the turbines in this simulation is identical to the wind farm that was constructed. It should be noted that the turbines in the simulation seem more obvious than the actual turbines in the photograph.

1.2 The methodology by which the White Hills simulations were created is the same as that used for the simulations before the hearing today. It must be noted however, that the photography in the White Hills simulations is significantly inferior to that which was used for the simulations presented to this Hearing. Digital photography was not capable of capturing the high level of resolution now achievable, at the time the White Hills simulations were being produced.

SIMULATION OF WHITE HILL WIND FARM



ACTUAL PHOTOGRAPH OF BUILT WIND FARM

TRUESCAPE CREDENTIALS

1.3 Truescape has over 12 years experience working in the 3D Photo and Video Simulations industry. Truescape has completed a wide range of different visualisation projects from photo-simulations for simple projects to full computer generated 3D video simulations for complex projects. Truescape's client base crosses many industries, from Landscape Architecture and Engineering firms through to major New Zealand and Australian and US corporates.

1.4 Truescape adopts a team approach for project completion as each type and phase of a project calls for a different mix of specialised skill sets. This expertise crosses many disciplines including photography, engineering, architecture, surveying, landscape architecture, 3D computer modelling, evidence preparation and presenting evidence as expert witnesses. All members of our staff have either formal qualifications or have undergone professional training and have direct experience working in each these specialised areas.

1.5 Truescape simulations have been produced as evidence in forums such as the New Zealand Environment and High Courts, Australia's Victorian Civil and Administrative Tribunal and the Supreme Court. Members of Truescape's staff have presented evidence as expert witnesses in these Courts, where our work has been subjected to cross-examination and accepted as evidence.

1.6 Truescape has assisted in providing survey controlled simulations for the following Wind Farm Developments:

- 2003 – Meridian Energy's Te Apiti Farm, Council Hearing;
- 2004 – Meridian Energy's White Hill Farm, Council Hearing;
- 2004 – Southern Hydro's Dollar Wind Farm South Australia, Panel Hearing;
- 2005 – Genesis Energy's Awhitu Wind Farm, Environment Court;
- 2005 – Unison Energy's Hawkes Bay Wind Farm, Environment Court;
- 2006 – Meridian Energy's Project West Wind, Environment Court;
- 2006 – Acciona Energy's Wind Farm South Australia, Panel Hearing;
- 2007 – Invenergy, Moresville Wind Energy Park, New York; USA Permitting Hearing;

- 2008 – Bluewater Wind, Offshore Wind Farm, Maryland, USA; Permitting Hearing;
- 2008 – Bluewater Wind, Offshore Wind Farm, New Jersey, USA; Permitting Hearing
- 2008 – Meridian Energy, Project Hayes, Environment Court;
- 2008 – Hydro Tasmania, Victoria Australia, Permitting Hearing;
- 2008 – Meridian Energy, Mill Creek, Council Hearing;
- 2008 – Meridian Energy, Central Plains, Council Hearing

APPENDIX A

LARGE SCALE TRUEVIEW™SIMULATIONS [redacted]

SEE LARGE SCALE HARD COPY SIMULATIONS

APPENDIX B

REDUCED SIZE TRUEVIEW™SIMULATIONS

SEE REDUCED SIZE BOOKLET

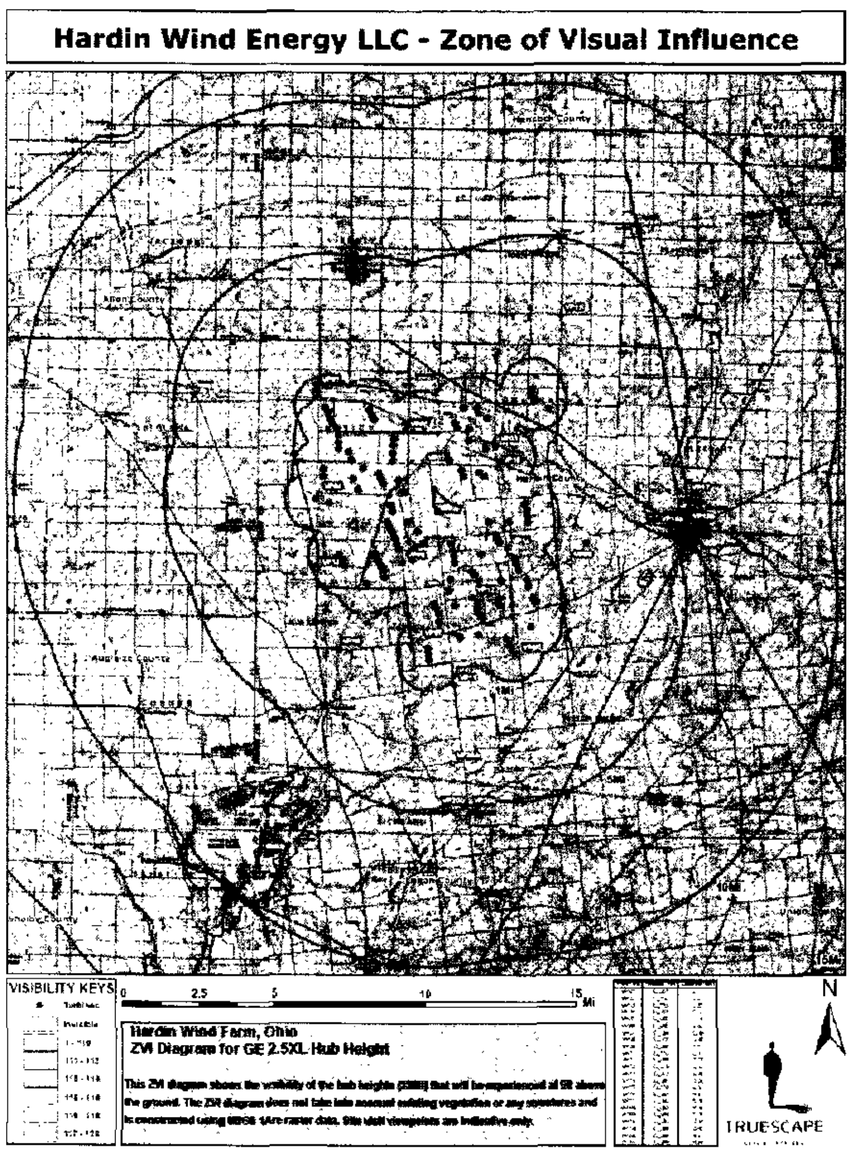
APPENDIX C

ZVI DIAGRAMS

The Zone of Visual Influence (ZVI) diagrams have been created using Arc GIS software and do not account for conditions that may block or diminish turbine visibility. This includes objects such as buildings, structures and vegetation.

The ZVI diagram below shows the visibility of the hub heights that would be experienced at 6ft above ground level.

See full size diagram in the hardcopy booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams".



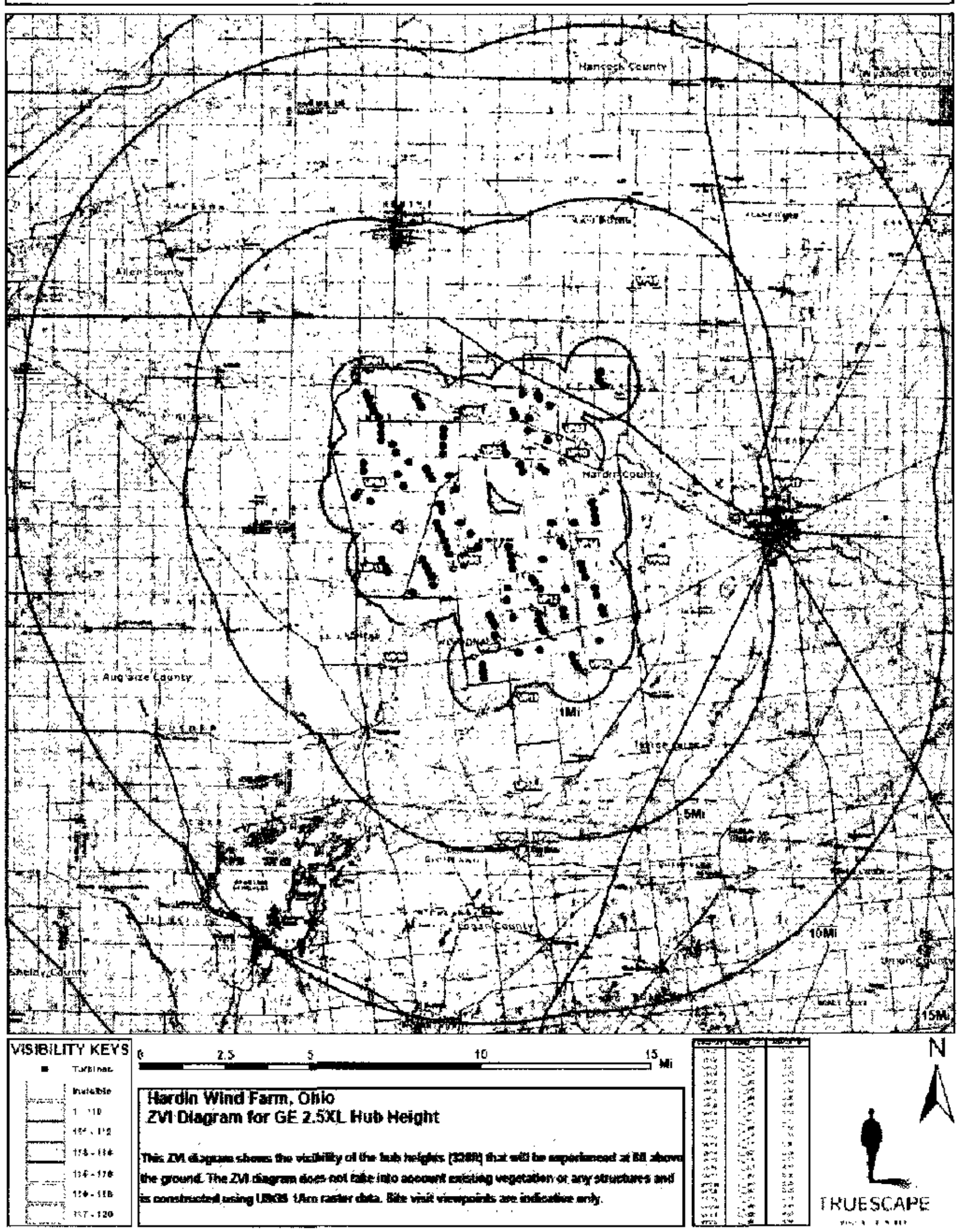
APPENDIX C

ZVI DIAGRAMS

The ZVI diagram below shows the visibility of the blade tips that would be experienced at 6ft above ground level.

See full size diagram in the hardcopy booklet entitled "Reduced Size TrueView™2 Photo Simulations and Zone of Visual Influence Diagrams".

Hardin Wind Energy LLC - Zone of Visual Influence

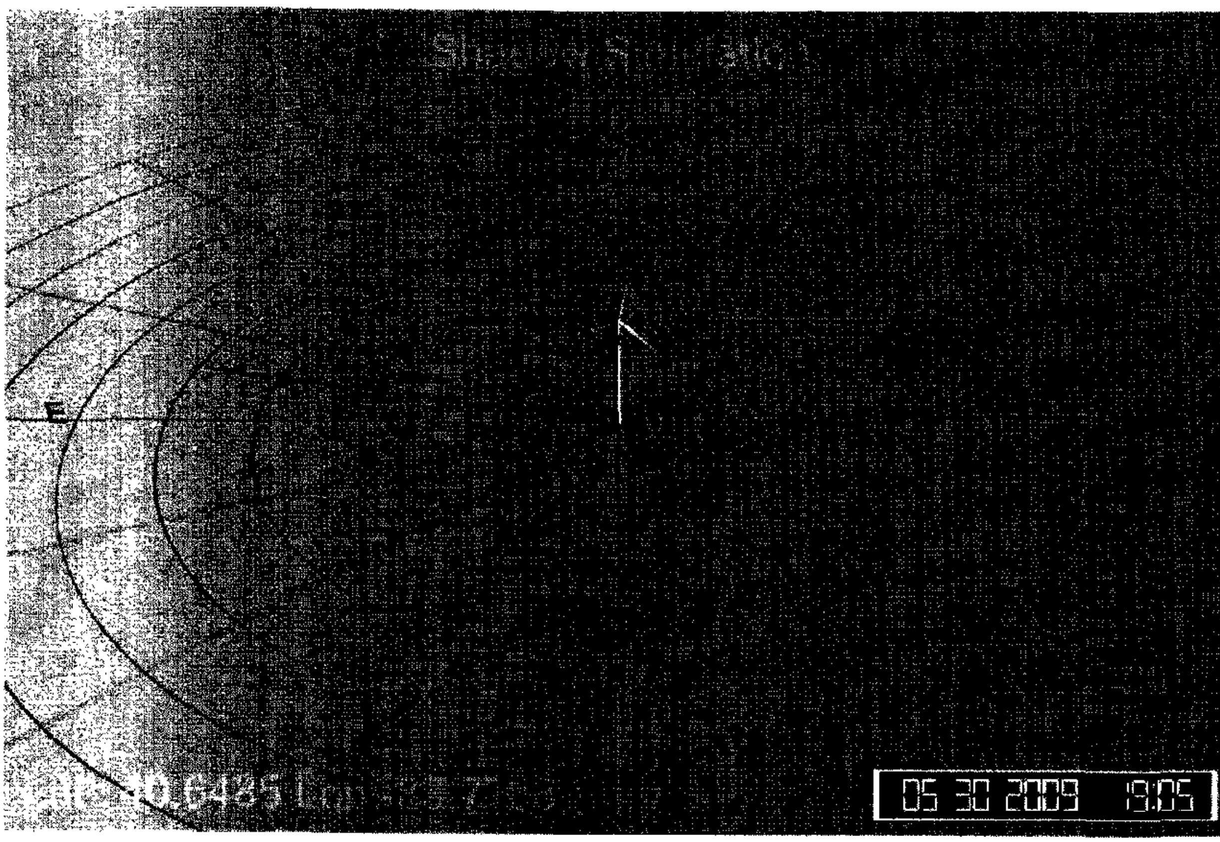


APPENDIX D

ANIMATED SHADOW SIMULATION [redacted]

The animated shadow simulation communicates the length of shadow produced by each turbine during a sunny day. The animation reflects sunlight conditions on the 30th May 2009

The image below depicts a screen shot from the animated shadow simulation. The animation is provided on CD attached to this evidence.

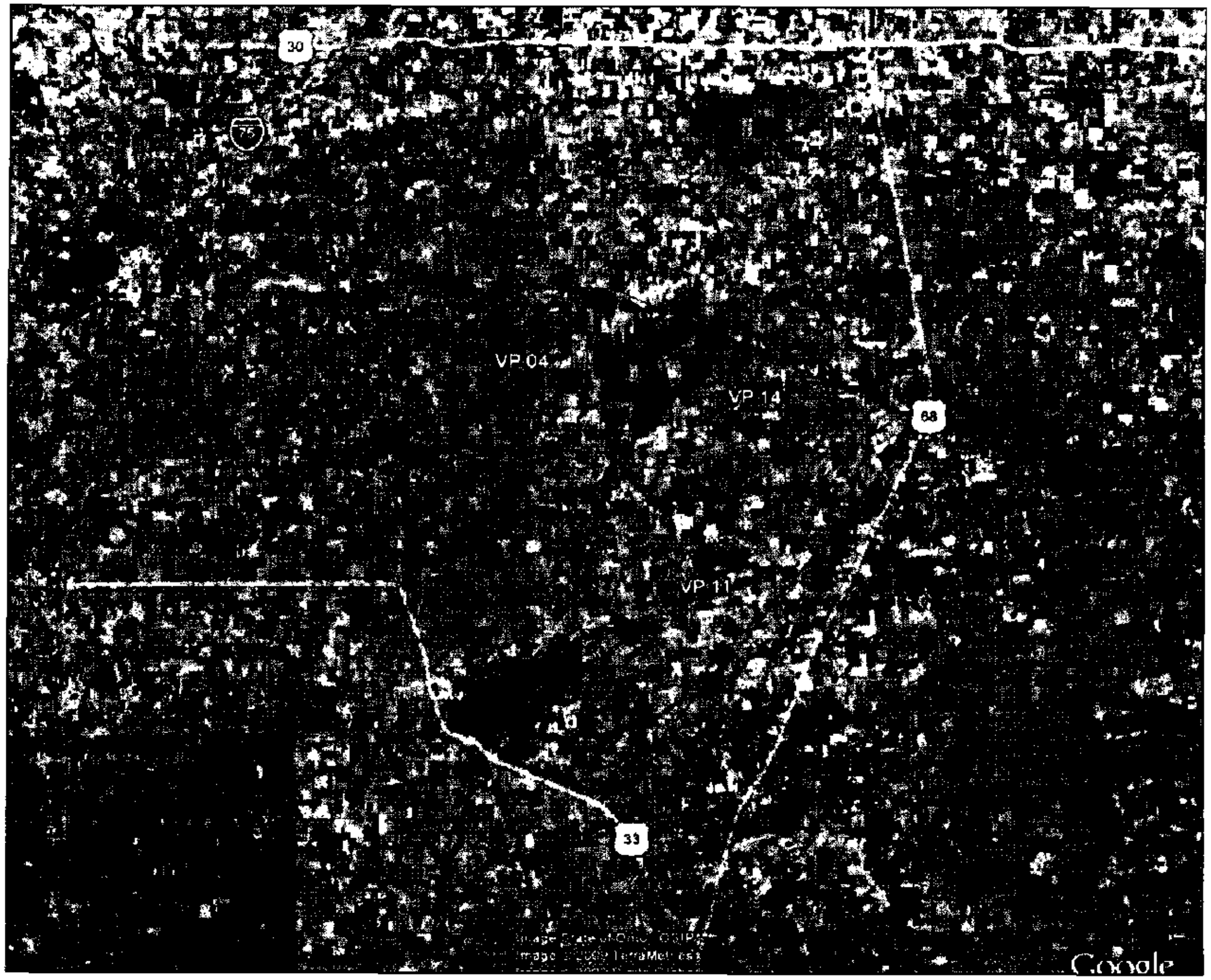


Hardin Wind Energy LLC
Hardin Wind Farm Project, Ohio

TRUESCAPE
VISUAL REALITY

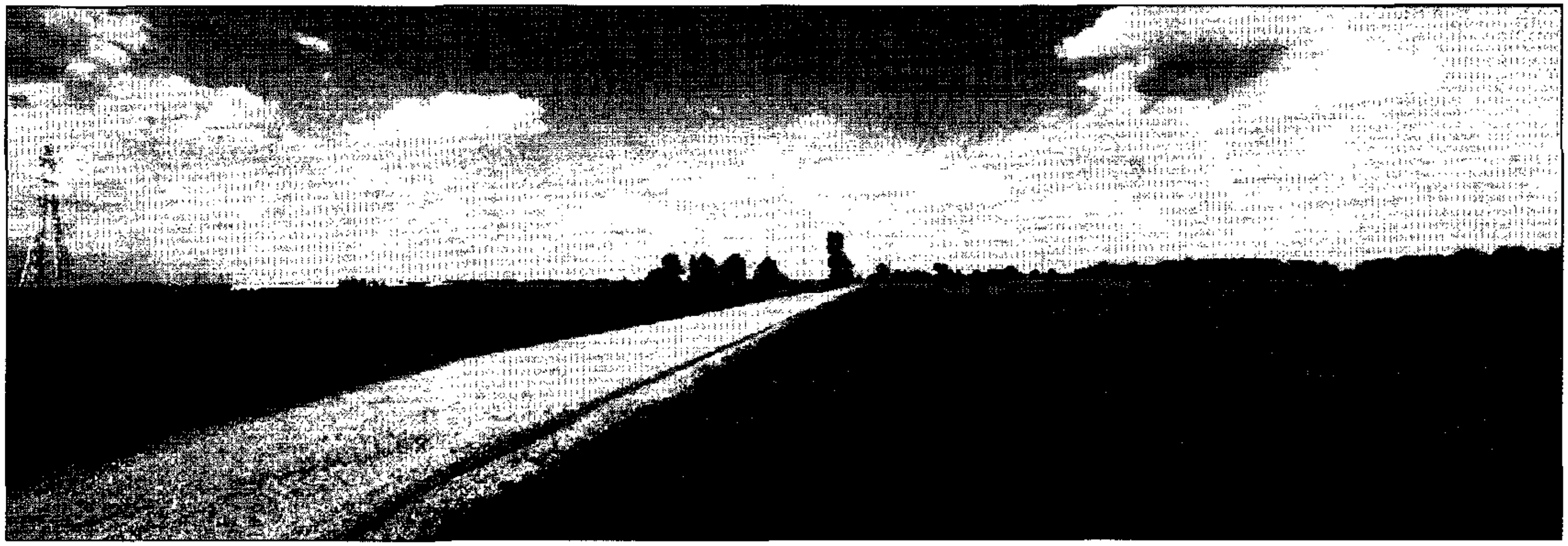
www.truescape.com

Viewpoint Locations



Location

VP 04 - Quickstep Church
VP 11 - Farm Complex, Jct CR 75 and TR 190
VP 14 - Farm Complex, Jct CR 95 South of CR 130



Viewpoint 04 - Quickstep Church - BEFORE

Viewpoint 04 - Quickstep Church - AFTER

Invenergy
Ohio Hardin Project

Viewpoint No.04
Quickstep Church

EASTING POSITION NAD83 (ft):	1596421.8
NORTHING POSITION NAD83 (ft)	344761.9
ELEVATION OF PHOTOPOINT POSITION NAVD88(ft):	984.5
HEIGHT OF CAMERA ABOVE GROUND (ft):	5.41
DATE OF PHOTOGRAPHY	29-MAY-2009 at 05:17 pm
DISTANCE TO NEAREST TURBINE (ft)	1214
ORIENTATION OF VIEW	82°
HORIZONTAL FIELD OF VIEW	124°
VERTICAL FIELD OF VIEW	55°

TURBINE DATA GE Energy 2.5 XL

CORRECT VIEWING OF TRUEVIEW™2 PHOTOSIMULATIONS

NOTES

Photopoint locations have been precision surveyed by
Arnold Hicks
30575 Bainbridge Road, Suite 180, Solon
OH 44139

Heights are above mean sea level

No part of this photosimulation shall be altered in any way

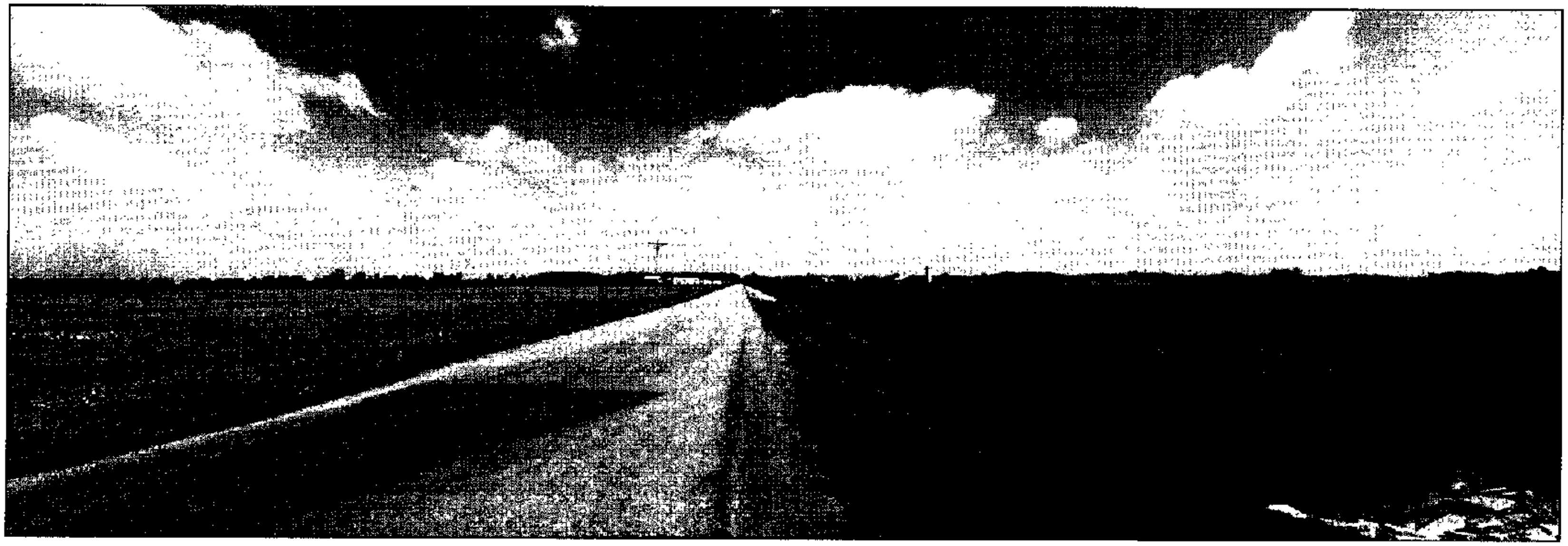
If this photosimulation is to be used for any purpose (other than your own personal use) it is to be reproduced in it's entirety

PHOTOSIMULATION CREATED USING
TrueView™ 2 TECHNOLOGY
PROVIDED BY

TRUESCAPE
VISUAL REALITY

www.truescape.com

DATE PRINTED 19-June-2009



Viewpoint 11 - Farm Complex, Jct CR 75 and TR 190 - BEFORE

Viewpoint 11 - Farm Complex, Jct CR 75 and TR 190 - AFTER

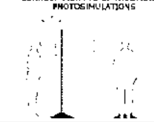
Invenergy
Ohio Hardin Project

Viewpoint No.11
Farm Complex, Jct CR 75 and TR 190

EASTING POSITION NAD83 (ft):	1620452.7
NORTHING POSITION NAD83 (ft):	331407.7
ELEVATION OF PHOTOPOINT POSITION NAVD88(ft):	1065.9
HEIGHT OF CAMERA ABOVE GROUND (ft):	5.41
DATE OF PHOTOGRAPHY:	29-MAY-2009 at 11:55 am
DISTANCE TO NEAREST TURBINE (ft):	6183
ORIENTATION OF VIEW:	268°
HORIZONTAL FIELD OF VIEW:	124°
VERTICAL FIELD OF VIEW:	55°

TURBINE DATA GE Energy 2.5XL

CORRECT VIEWING OF TRUEVIEW™2 PHOTOSIMULATIONS



NOTES:

Photopoint locations have been precision surveyed by
Arcadis/Hicks
30575 Bainbridge Road, Suite 180, Solon
OH 44139

Heights are above mean sea level

No part of this photosimulation shall be altered in any way.

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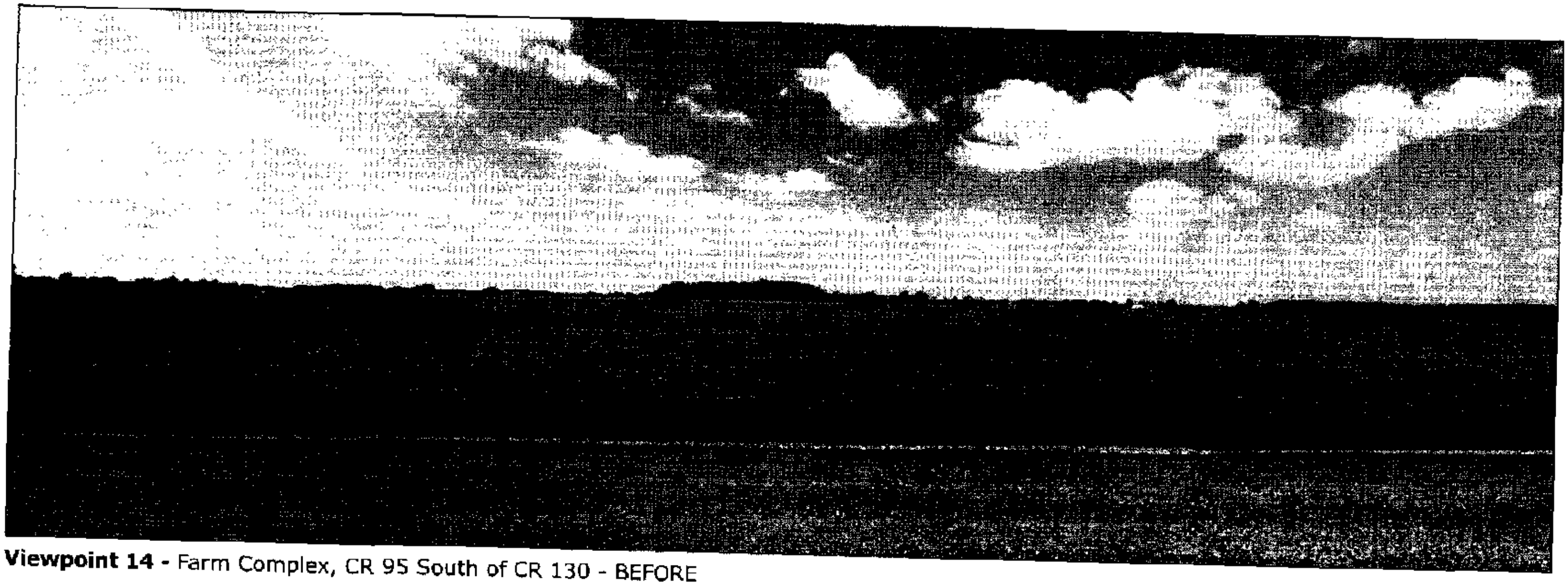
PHOTOSIMULATION CREATED USING
TrueView™ 2 TECHNOLOGY
patent applied for
PROVIDED BY

TRUESCAPE
VISUAL REALITY

www.truescape.com

DATE PRINTED 19-June-2009



Viewpoint 14 - Farm Complex, CR 95 South of CR 130 - BEFORE

Viewpoint 14 - Farm Complex, CR 95 South of CR 130 - AFTER

Invenergy
Ohio Hardin Project

Viewpoint No.14
Farm Complex, CR 95 South of CR 130

EASTING POSITION NAD83 (ft)	1620199.8
NORTHING POSITION NAD83 (ft)	355558.1
ELEVATION OF PHOTOPOINT POSITION NAVD88(ft):	1007.0
HEIGHT OF CAMERA ABOVE GROUND (ft)	5.01
DATE OF PHOTOGRAPHY:	29-MAY-2009 at 12:45 pm
DISTANCE TO NEAREST TURBINE (ft)	1558
ORIENTATION OF VIEW:	162°
HORIZONTAL FIELD OF VIEW	124°
VERTICAL FIELD OF VIEW	55°

TURBINE DATA GE Energy 2 SXL

CORRECT VIEWING OF TRUEVIEW™2 PHOTOSIMULATIONS

NOTES

Photopoint locations have been precision surveyed by Atwell Hicks 30575 Bainbridge Road, Suite 100, Solon OH 44139

Heights are above mean sea level

No part of this photosimulation shall be altered in any way

If this photosimulation is to be used for any purpose (other than your own personal use) it is to be reproduced in it's entirety.

PHOTOSIMULATION CREATED USING TrueView™ 2 TECHNOLOGY

PROVIDED BY

TRUESCAPE
VISUAL REALITY

www.truescape.com

DATE PRINTED 19-June-2009

#U2-041 Delaware-Centerville 138kV
Generation Interconnection

This analysis was completed to assess the reliability impact for the new generation interconnecting to the PJM system as a capacity resource.

Local AEP Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance criteria in accordance with the AEP FERC Form 715. Therefore, this set of criteria was used to assess the impact of the proposed facility on the AEP System. The Invenergy project was studied as a 300 MW net energy injection consistent with the interconnection application. This project was studied with PJM projects #P55, R48, R49, S072, S073, T130, T131, T142, U1-059, U1-060, and U2-026 already in service at 100% output in the vicinity of U2-041. The interconnection project was studied at full capacity. The results are summarized below.

Option #1

(East Lima – Marysville 345 kV)

Normal System (2012 Summer Conditions)

- No problems identified

Single Contingency (2012 Summer Conditions)

- No problems identified

Multiple Contingency (2012 Summer Conditions)

- No problems identified

Short Circuit Analysis

- No problems identified.

Stability Analysis

- Stability studies were not performed as part of this Feasibility Study and are not normally performed as part of a Facility Study effort. The stability assessments are part of the System Impact Study. Based upon the results of this future System Impact Study, the extent of system upgrades could change and the associated costs could be significantly different.

Option #2

(Southwest Lima – Marysville 345 kV)

Normal System (2012 Summer Conditions)

- No problems identified.

Single Contingency (2012 Summer Conditions)

- No problems identified.

Multiple Contingency (2012 Summer Conditions)

- AEP Eastown Road – Rockhill[1] 138 kV line gets overloaded to 103% (190 MVA) of its emergency rating for an outage of the AEP East Lima – Marysville 345 kV line and AEP East Lima – Southwest Lima 345 kV line. Without the addition of U2-041 Project, the same facilities are loaded to 96% (177 MVA) of emergency rating under the same contingency.

Short Circuit Analysis

- No problems identified.

Stability Analysis

- Stability analysis was not performed as part of this Feasibility Study. The stability assessments are part of the System Impact Study. Based upon the results of this future System Impact Study, the extent of system upgrades could change and the associated costs could be significantly different.

Reactive Requirements

PJM requires a power factor correction to 95% lead/lag at the point of interconnection for wind generating facilities. It is expected that Great Lakes will adhere to this standard.

Network Impacts

Option #1

(East Lima – Marysville 345 kV)

[1] The affected facility may appear in additional contingencies that are not mentioned.

The Queue Project U2-041 was studied as a(n) 300MW (Capacity = 39MW) injection at the East Lima – Marysville 345 kV lines in the AEP area. Project U2-041 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability
(Single or N-1 contingencies for the Capacity portion only of the interconnection)

No problems identified

Multiple Facility Contingency
(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

No problems identified

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

No problems identified.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request. **These are not required reliability upgrades.**

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

As a result of the aggregate energy resources in the area, the following potential congestion was identified

1. **(AEP/AEP)** The R60C-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 135.4% to 137.7% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 20.5MW to the thermal congestion.

2. **(AEP/AEP)** The R60C-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 100.1% to 101.7% (DC power flow) of its emergency rating (1301MVA) for the single line contingency outage (AEP21). This project contributes approximately 20.2MW to the thermal congestion.

MISO Impacts

Any impacts on the MISO transmission system will be identified in the Impact Study.

Option #2

(Southwest Lima – Marysville 345 kV)

The Queue Project U2-041 was studied as a(n) 300MW(Capacity = 39MW) injection at the SW Lima- Marysville 345 kV lines in the AEP area. Project U2-041 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

1. **(AEP/AEP)** The Eastown Road-Rock Hill 138kV line (from bus 23137 to bus 23202 ckt 1) loads from 99.50% to 104.84% (DC power flow) of its emergency rating (184MVA) for the tower line outage (AEP_TOWER42). This project contributes approximately 9.8MW to cause this thermal violation.

Short Circuit

No problems identified.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

1. The overload on the Eastown Rd-Rock Hill 138kV circuit can be alleviated by replacing the 138 kV risers at Rockhill station terminal.

   Estimated Cost (2008 dollars): **$75,000**

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request. **These are not required reliability upgrades.**

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

As a result of the aggregate energy resources in the area, the following potential congestion was identified

2. **(AEP/AEP)** The R60C-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 135.4% to 136.9% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 14.0MW to the thermal congestion.

3. **(AEP/AEP)** The R60C-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 100.1% to 101.2% (DC power flow) of its emergency rating (1301MVA) for the single line contingency outage (AEP21). This project contributes approximately 13.8MW to the thermal congestion.

MISO Impacts

Any impacts on the MISO transmission system will be identified in the Impact Study.

#U2-042 East Lima-South Kenton 138kV
Generation Interconnection

This analysis was completed to assess the reliability impact for the new generation interconnecting to the PJM system as a capacity resource.

Network Impacts

Interconnection Option #1 - East Lima-South Kenton 138kV

Local AEP Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. The Invenergy project was studied as a 201 MW net capacity consistent with the interconnection application. The results are summarized below.

Normal System (2012 Summer Conditions)

- A 138 kV 600 A switch at South Kenton is overloaded to 134% of the summer normal rating of 156 MVA and 101% of the winter normal rating of 206 MVA.
- The South Kenton 138/69 transformer #1 is overloaded to 104% of the summer and winter normal rating of 41 MVA.
- The South Kenton 138/69 transformer #2 is overloaded to 118% of the summer and winter normal rating of 39 MVA.
- The entire length of 138 kV line between South Kenton and East Lima, except the portion between U1-060 and U2-042, is overloaded to more than 100% of the conductor summer normal rating of 185 MVA. The winter normal rating is not exceeded for system normal.

- Single Contingency (2012 Summer Conditions)
- The entire length of 138 kV line between South Kenton and East Lima is overloaded to more than 150% of the conductor summer emergency rating of 257 MVA for an outage on the U1-060 – West Newton 138 kV line or on the U2-042 – Lynn 138 kV line.
- A 138 kV 800 A wavetrap and risers at South Kenton station are overloaded to 197% and 162% of their summer emergency ratings of 206 MVA and 250 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch and 800 A wavetrap at South Kenton station are overloaded to 129% and 121% of their summer emergency ratings of 192 MVA and 205 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Nevada – Upper Sandusky 69 kV line is overloaded to 137% of the summer emergency rating of 31 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Nevada – Broken Sword 69 kV line is overloaded to 132% of the summer emergency rating of 31 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Kenton – Rockwell 69 kV line is overloaded to 145% of the summer emergency rating of 50 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch and 800 A wavetrap at North Waldo station are overloaded to 127% and 119% of their summer emergency ratings of 192 MVA and 205 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The North Waldo – Windfall Sw. 138 kV line is overloaded to 102% of the summer emergency rating of 192 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Kenton station are overloaded to 112% and 117% of their summer emergency ratings of 96 MVA and 92 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Kenton – Ashland Pipe 69 kV line is overloaded to 108% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch at Cessna Sw. is overloaded to 110% of the summer emergency rating of 96 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Cessna Sw. – Ashland Pipe 69 kV line is overloaded to 106% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Dunkirk station are overloaded to 109% and 116% of their summer emergency ratings of 96 MVA and 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Cessna Sw. – Dunkirk 69 kV line is overloaded to 104% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Dunkirk station are overloaded to 101% and 108% of their summer emergency ratings of 96 MVA and 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches at Forest station are overloaded to 101% of their summer emergency rating of 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The East Lima 138/69 transformer #3 is overloaded to 100% of the summer emergency rating of 85 MVA for the outage on the U2-042 – Lynn 138 kV line.

Please note that these affected facilities may appear in additional contingencies that are not mentioned.

Also note that there are several contributions to existing overloads that are not listed.

Multiple Contingency (2012 Summer Conditions)

- No problems identified

Short Circuit Analysis

- East Lima 138 kV circuit breakers C2 and D2 are overdutied to 100.4%, and 100.2% for the addition of the new generating facility, and would need to be replaced.

- It should be noted that this new generating facility contributes 2-3% to several 138 kV circuit breakers at East Lima and South Kenton stations.

Stability Analysis

- Stability studies were not performed as part of this Feasibility Study and are not normally performed as part of a Facility Study effort. The stability assessments are part of the System Impact Study. Based upon the results of this future System Impact Study, the extent of system upgrades could change and the associated costs could be significantly different.

Local Upgrades

Upgrades cost have been estimated in bulk because of the quantity of upgrades necessary. More detailed estimates will be provided in the impact study. There are other design alternatives that could be considered. More detailed analysis would need to be completed to determine if another alternative is feasible and also less expensive.

- Reconductor approximately 34 miles of 138 kV line.
  Estimated Cost (2008 Dollars): **$51,000,000**

- Reconductor approximately 28 miles of 69 kV line.

Estimated Cost (2008 Dollars): **$28,000,000**

- Replace station equipment including 3 138/69 kV transformers, switches, wavetraps and risers at various stations.
  Estimated Cost (2008 Dollars): **$6,500,000**

- Replace 138 kV circuit breakers C2 and D2 and associated equipment at East Lima station.
  Estimated Cost (2008 Dollars): **$1,000,000**

*For option 1, analysis was completed with U2-042 operating at 13% of capacity. For that condition, most of the upgrades are not necessary. However, the replacement of the 138 kV circuit breakers at East Lima is still required.

Network Impacts

The Queue Project U2-042 was studied as a 201MW (Capactiy=26MW) injection into the AEP system at a tap of the East Lima-South Kenton 138kV line. Project U2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

No problems identified

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

1. **(AEP/AEP)** The U1-060-West Newton 138kV line loads from 94.03% to 177.05% (DC power flow) of its emergency rating (192MVA) for the tower line outage (AEP_TOWER43_A_T142_U2_041_B). This project contributes approximately 159.4MW to cause this thermal violation.

2. **(AEP/AEP)** The West Newton-East Lima 138kV line loads from 91.93% to 174.95% (DC power flow) of its emergency rating (192MVA) for the tower line outage (AEP_TOWER43_A_T142_U2_041_B). This project contributes approximately 159.4MW to cause this thermal violation.

Short Circuit

No problems identified..

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

1. The overload on the U1-060-West Newton 138kV circuit can be alleviated by replacing two (2) 138kV switches at West Newton and reconductoring approximately 6 miles of 138kV line between U1-060 and West Newton. The estimated cost is **$9,100,000.**

2. The overload on the West Newton-East Lima circuit can be alleviated by replacing a 138 kV 1200 A Switch, wavetrap, and two risers at East Lima and rconductoring approximately 13.4 miles of 138 kV line between West Newton and East Lima. The estimated cost is **$20,200,000.**

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None.

Delivery of Energy Portion of Interconnection Request

(PJM also studied the delivery of the energy portion of this Interconnection Request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with Network Upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

3. **(AEP/AEP)** The U1-060-West Newton 138kV line loads from 102.1% to 205.2% (DC power flow) of its normal rating (156MVA) for non-contingency condition. This project contributes approximately 160.8MW to the thermal congestion.

4. **(AEP/AEP)** The West Newton-East ima 138kV line loads from 99.5% to 202.6% (DC power flow) of its normal rating (156MVA) for non-contingency condition. This project contributes approximately 160.8MW to the thermal congestion.

5. **(AEP/AEP)** The R60-Robison Park 345kV line loads from 137.7% to 139.3% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 14.5MW to the thermal congestion.

6. **(AEP/AEP)** The R60-Robison Park 345kV line loads from 101.7% to 102.8% (DC power flow) of its emergency rating (1301MVA) for the single line contingency outage (AEP21). This project contributes approximately 14.3MW to the thermal congestion.

Interconnection Option #2 - East Lima-Marysville 345kV

Local AEP Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. The Invenergy project was studied as a 201 MW net capacity consistent with the interconnection application. The results are summarized below.

Normal System (2012 Summer Conditions)

- No problems identified.

Single Contingency (2012 Summer Conditions)

- No problems identified.

\

Multiple Contingency (2012 Summer Conditions)

- No problems identified.

Short Circuit Analysis

- No problems identified.

Local/Network Upgrades

- No local upgrades required

Network Impacts

The Queue Project U2-042 was studied as a 201MW (Capacity = 26MW) injection at the East Lima - Marysville 345kV lines in the AEP area. Project U2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

None

Short Circuit

No problems identified..

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

1. **(AEP/AEP)** The Eastown Road-Rock Hill 138kV line (from bus 23137 to bus 23202 ckt 1) loads from 101.72% to 115.69% (DC power flow) of its emergency rating (184MVA) for the tower line outage (AEP_TOWER44_T142B). This project contributes approximately 25.7MW to the thermal violation.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

See list under Local/Network Upgrades.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

1. The overload on the Eastown Rd-Rock Hill 138kV circuit can be alleviated by replacing the 138 kV risers at Rock Hill station terminal.

   Estimated Cost (2008 dollars): **$75,000**

Delivery of Energy Portion of Interconnection Request

(PJM also studied the delivery of the energy portion of this Interconnection Request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with Network Upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

2. **(AEP/AEP)** The R60-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 136.9% to 138.0% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 9.4MW to the thermal congestion. Previous project(s) Y41 contribute(s) to the loading by 14 MW(1.6%).

From: mittaj@pjm.com [mailto:mittaj@pjm.com]
Sent: Tuesday, April 07, 2009 8:32 AM
To: Rodriguez, Carlos
Cc: elmya@pjm.com; fedorkj@pjm.com
Subject: U2-041 - East Lima-Marysville 345kV - System Impact Study Delay Notification

SYSTEM IMPACT STUDY DELAY NOTIFICATION:

This email serves notice, as required by the PJM OAT Tariff §205.3, that the subject queue project's System Impact Study (SIS) is delayed. This delay is due to the backlog of previously queued Impact Studies that must be completed before we can complete the remaining U2 studies.

PJM continues working to address the backlog and has worked with the Stakeholders through the RPPWG to identify additional process enhancements to improve study timing. Wherever possible, PJM applies the approved cluster study methodology to expedite the issuing of the studies and will provide your results as soon as they are available.

PJM anticipates completing all U2-queue Impact Studies on or before the end of the 3rd quarter of 2009.

Please contact Al Elmy at (610) 666-8213 or elmya@pjm.com with any questions you might have.

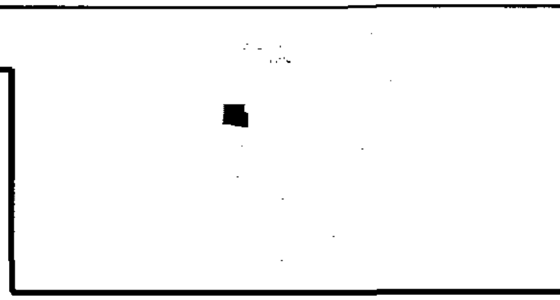
Jeannette Mittan
Interconnection Planning
610-666-3158
mittaj@pjm.com
FOR AL ELMY

Ohio County Profiles

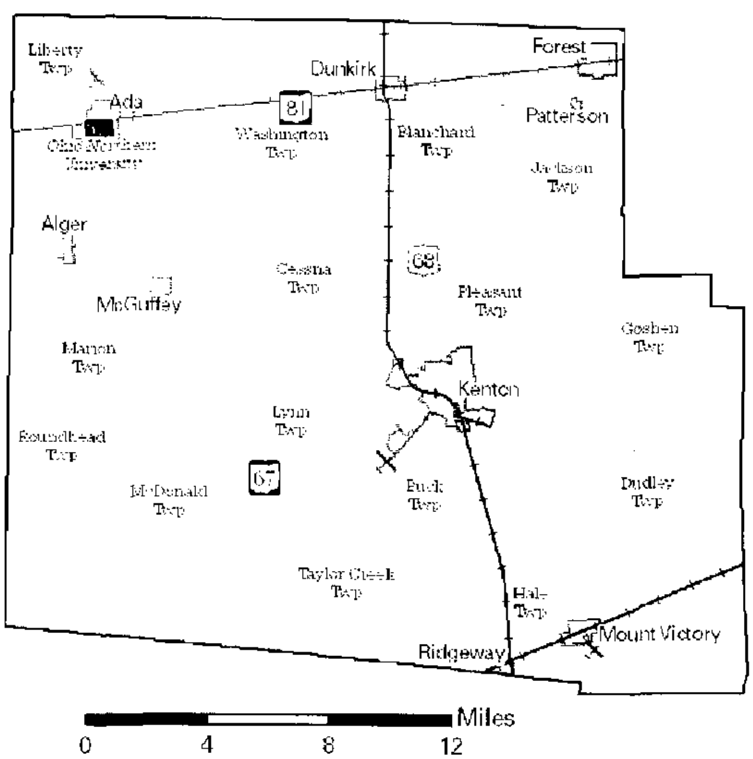
Ohio

Prepared by the Office of Policy, Research and Strategic Planning

Hardin County



Established:	Act - April 1, 1820
2007 Population:	31,650
Land Area:	470.3 square mile
County Seat:	Kenton City
Named for:	Colonel John Hardin Revolutionary War



Taxes

Taxable value of real property	$382,123,810
Residential	$253,409,470
Agriculture	$72,445,900
Industrial	$17,806,040
Commercial	$38,462,400
Mineral	$0
Ohio income tax liability	$13,776,853
Average per return	$1,040.08

Land Use/Land Cover

	Percent
Urban (Residential/Commercial/Industrial/ Transportation and Urban Grasses)	4.32%
Cropland	80.00%
Pasture	6.92%
Forest	6.89%
Open Water	0.26%
Wetlands (Wooded/Herbaceous)	1.59%
Bare/Mines	0.02%

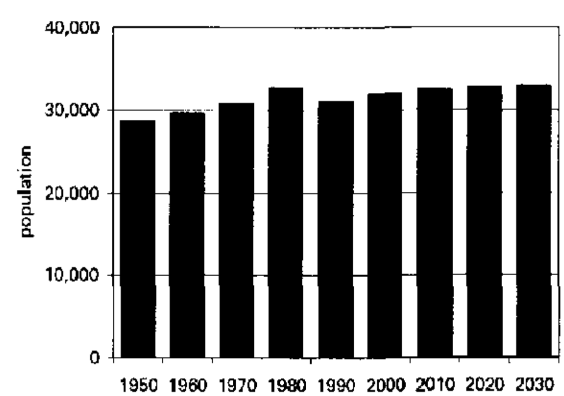
Largest Areas

	Census 2000	Est. 2007
Kenton city	8,336	8,050
Ada village	5,582	5,767
Pleasant twp UB	1,662	1,671
Liberty twp UB	1,567	1,519
Forest village	1,488	1,437
Dudley twp	1,257	1,224
Buck twp UB	1,051	1,093
Marion twp UB	1,039	999
Dunkirk village	952	942
McDonald twp	914	896

UB: Unincorporated Balance

Total Population

Census				Estimated	
1800		**1900**	31,187	**2001**	31,695
1810		**1910**	30,407	**2002**	31,705
1820	22	**1920**	29,167	**2003**	31,564
1830	210	**1930**	27,635	**2004**	31,924
1840	4,598	**1940**	27,061	**2005**	31,739
1850	8,251	**1950**	28,673	**2006**	31,697
1860	13,570	**1960**	29,633	**2007**	31,650
1870	18,714	**1970**	30,813	**Projected**	
1880	27,023	**1980**	32,719	**2010**	32,450
1890	28,939	**1990**	31,111	**2020**	32,720
		2000	31,945	**2030**	32,830



Hardin County

Population by Race

Population by Race	Number	Percent
Total Population	31,945	100.0%
White	31,164	97.6%
African-American	229	0.7%
Native American	102	0.3%
Asian	126	0.4%
Pacific Islander	0	0.0%
Other	55	0.2%
Two or More Races	269	0.8%
Hispanic (may be of any race)	378	1.2%
Total Minority	1,026	3.2%

Educational Attainment

Educational Attainment	Number	Percent
Persons 25 years and over	19,220	100.0%
No high school diploma	3,738	19.4%
High school graduate	9,690	50.4%
Some college, no degree	2,657	13.8%
Associate degree	943	4.9%
Bachelor's degree	1,345	7.0%
Master's degree or higher	847	4.4%

Family Type by Employment Status

Family Type by Employment Status	Number	Percent
Total Families	8,227	100.0%
Married couple, husband and wife in labor force	3,395	41.3%
Married couple, husband in labor force, wife not	1,489	18.1%
Married couple, wife in labor force, husband not	451	5.5%
Married couple, husband and wife not in labor force	1,299	15.8%
Male householder, in labor force	313	3.8%
Male householder, not in labor force	68	0.8%
Female householder, in labor force	813	9.9%
Female householder, not in labor force	399	4.8%

Household Income in 1999

Household Income in 1999	Number	Percent
Total Households	11,995	100.0%
Less than $10,000	1,519	12.7%
$10,000 to $19,999	1,780	14.8%
$20,000 to $29,999	1,842	15.4%
$30,000 to $39,999	1,720	14.3%
$40,000 to $49,999	1,381	11.5%
$50,000 to $59,999	1,206	10.1%
$60,000 to $74,999	1,226	10.2%
$75,000 to $99,999	789	6.6%
$100,000 to $149,999	390	3.3%
$150,000 to $199,999	30	0.3%
$200,000 or more	112	0.9%
Median household income	$34,440	

Population by Age

Population by Age	Number	Percent
Total Population	31,945	100.0%
Under 6 years	2,574	8.1%
6 to 17 years	5,186	16.2%
18 to 24 years	4,965	15.5%
25 to 44 years	8,311	26.0%
45 to 64 years	6,770	21.2%
65 years and more	4,139	13.0%
Median Age	33.3	

Family Type by Presence of Own Children Under 18

Family Type by Presence of Own Children Under 18	Number	Percent
Total Families	8,227	100.0%
Married-couple families with own children	2,890	35.1%
Male householder, no wife present, with own children	236	2.9%
Female householder, no husband present, with own children	706	8.6%
Families with no own children	4,395	53.4%

Poverty Status in 1999 of Families By Family Type by Presence Of Related Children

Poverty Status in 1999 of Families By Family Type by Presence Of Related Children	Number	Percent
Total Families	8,227	100.0%
Family income above poverty level	7,497	91.1%
Family income below poverty level	730	8.9%
Married couple, with related children	232	31.8%
Male householder, no wife present, with related children	48	6.6%
Female householder, no husband present, with related children	267	36.6%
Families with no related children	183	25.1%

Ratio of Income in 1999 To Poverty Level

Ratio of Income in 1999 To Poverty Level	Number	Percent
Population for whom poverty status is determined	29,825	100.0%
Below 50% of poverty level	1,895	6.4%
50% to 99% of poverty level	2,033	6.8%
100% to 149% of poverty level	2,621	8.8%
150% to 199% of poverty level	2,954	9.9%
200% of poverty level or more	20,322	68.1%

Residence in 1995

Residence in 1995	Number	Percent
Population 5 years and over	29,860	100.0%
Same house in 1995	17,169	57.5%
Different house, same county	7,173	24.0%
Different county, same state	4,218	14.1%
Different state	1,169	3.9%
Puerto Rico or U.S. islands	0	0.0%
Foreign country	131	0.4%

Travel Time To Work

	Number	Percent
Workers 16 years and over	14,390	100.0%
Less than 15 minutes	5,618	39.0%
15 to 29 minutes	3,878	26.9%
30 to 44 minutes	2,780	19.3%
45 to 59 minutes	914	6.4%
60 minutes or more	578	4.0%
Worked at home	622	4.3%
Mean travel time	21.8 minutes	

Housing Units

	Number	Percent
Total housing units	12,907	100.0%
Occupied housing units	11,963	92.7%
Owner occupied	8,730	67.6%
Renter occupied	3,233	25.0%
Vacant housing units	944	7.3%

Year Structure Built

	Number	Percent
Total housing units	12,907	100.0%
Built 1995 to March 2000	1,069	8.3%
Built 1990 to 1994	735	5.7%
Built 1980 to 1989	893	6.9%
Built 1970 to 1979	1,720	13.3%
Built 1960 to 1969	1,455	11.3%
Built 1950 to 1959	1,316	10.2%
Built 1940 to 1949	1,110	8.6%
Built 1939 or earlier	4,609	35.7%
Median year built	1956	

Value for Specified Owner-Occupied Housing Units

	Number	Percent
Specified owner-occupied housing units	6,576	100.0%
Less than $20,000	145	2.2%
$20,000 to $39,999	660	10.0%
$40,000 to $59,999	1,312	20.0%
$60,000 to $79,999	1,719	26.1%
$80,000 to $99,999	1,274	19.4%
$100,000 to $124,999	678	10.3%
$125,000 to $149,999	339	5.2%
$150,000 to $199,999	295	4.5%
$200,000 to $249,999	84	1.3%
$250,000 to $499,999	47	0.7%
$500,000 to $999,999	16	0.2%
$1,000,000 or more	7	0.1%
Median value	$73,800	

House Heating Fuel

	Number	Percent
Occupied housing units	11,963	100.0%
Utility gas	5,929	49.6%
Bottled, tank or LP gas	2,775	23.2%
Electricity	2,468	20.6%
Fuel oil, kerosene, etc	338	2.8%
Coal, coke or wood	402	3.4%
Solar energy or other fuel	30	0.3%
No fuel used	21	0.2%

Gross Rent

	Number	Percent
Specified renter-occupied housing units	3,091	100.0%
Less than $100	17	0.5%
$100 to $199	257	8.3%
$200 to $299	366	11.8%
$300 to $399	729	23.6%
$400 to $499	709	22.9%
$500 to $599	388	12.6%
$600 to $699	187	6.0%
$700 to $799	72	2.3%
$800 to $899	37	1.2%
$900 to $999	17	0.5%
$1,000 to $1,499	27	0.9%
$1,500 or more	11	0.4%
No cash rent	274	8.9%
Median gross rent	$405	
Median gross rent as a percentage of household income in 1999	23.6	

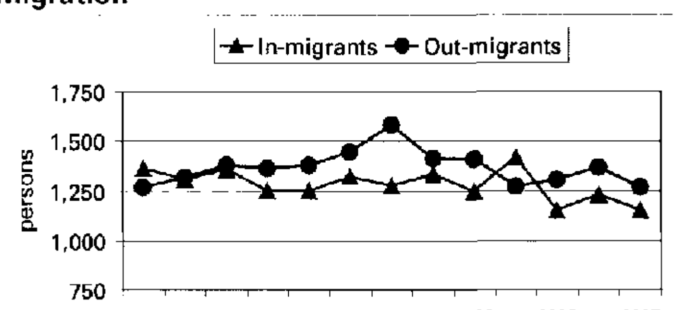
Selected Monthly Owner Costs for Specified Owner-Occupied Housing Units

	Number	Percent
Specified owner-occupied housing units with a mortgage	4,245	100.0%
Less than $400	298	7.0%
$400 to $599	1,011	23.8%
$600 to $799	1,158	27.3%
$800 to $999	917	21.6%
$1,000 to $1,249	597	14.1%
$1,250 to $1,499	140	3.3%
$1,500 to $1,999	116	2.7%
$2,000 to $2,999	8	0.2%
$3,000 or more	0	0.0%
Median monthly owners cost	$744	
Median monthly owners cost as a percentage of household income	19.3	

Vital Statistics

	Number	Rate
Births / rate per 1,000 women	377	53.3
Teen births / rate per 1,000 females 15-17	10	16.3
Deaths / rate per 100,000 population	329	1,029.2
Marriages / rate per 1,000 population	220	6.9
Divorces / rate per 1,000 population	142	4.4

Migration



Hardin County

Agriculture

Land in farms (acres)	242,000
Number of farms	820
Average size (acres)	295
Total cash receipts	$119,627,000
Per farm	$144,129

Education

Public schools	21
Students (Average Daily Membership)	5,651
Expenditures per student	$8,313
Student-teacher ratio	16.0
Graduation rate	91.6
Teachers (Full Time Equivalent)	379.8
Non-public schools	0
Students	0
4-year public universites	0
Branches	0
2-year public colleges	0
Private universities and colleges	1
Public libraries (Main / Branches)	6 / 1

Transportation

Registered motor vehicles	34,590
Passenger cars	20,103
Noncommercial trucks	7,060
Total license revenue	$955,084.83
Interstate highway miles	0.00
Turnpike miles	0.00
U.S. highway miles	21.81
State highway miles	154.18
County, township, and municipal road miles	828.49
Commercial airports	3

Voting

Number of precincts	38
Number of registered voters	17,604
Voted in 2006 election	10,005
Percent turnout	56.8%

Health Care

Physicians (MDs & DOs)	12
Registered hospitals	1
Number of beds	25
Licensed nursing homes	2
Number of beds	200
Licensed residential care	3
Number of beds	123
Adults with employer-based insurance	59.6%
Children with employer-based insurance	65.2%

State Parks, Forests, Nature Preserves, And Wildlife Areas

Facilities	2
Acreage	1,058.93

Communications

Television stations	0
Radio stations	2
Daily newspapers	1
Circulation	7,200

Crime

Total crimes reported in Uniform Crime Report	1,012

Finance

FDIC insured financial institutions (HQs)	4
Assets	$357,713
Branch offices	14
Institutions represented	9

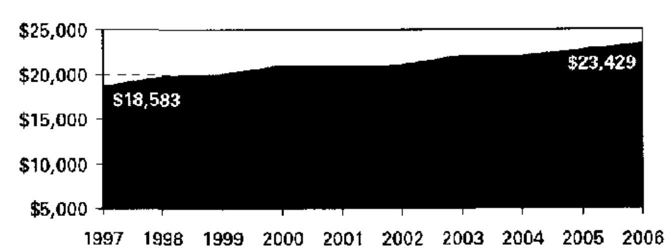
Transfer Payments

Total transfer payments	$159,441,000
Payments to individuals	$150,873,000
Retirement and disability	$67,656,000
Medical payments	$63,376,000
Income maintenance (Supplemental SSI, family assistance, food stamps, etc)	$12,391,000
Unemployment benefits	$2,639,000
Veterans benefits	$2,718,000
Federal education and training assistance	$2,013,000
Other payments to individuals	$80,000
Total personal income	$742,641,000
Depedency ratio	21.5%

Federal Expenditures

Direct expenditures or obligations	$146,450,492
Retirement and disability	$46,699,751
Other direct payments	$58,606,386
Grant awards	$27,614,502
Highway planning and construction	$1,123,561
Temporary assistance to needy families	$2,048,321
Medical assistance program	$14,403,794
Procurement contract awards	$7,801,516
Dept. of Defense	$6,448,394
Salary and wages	$5,728,337
Dept. of Defense	$231,000
Other federal assistance	$54,974,414
Direct loans	$1,230,040
Guaranteed loans	$8,749,101
Insurance	$44,995,273

Per Capita Personal Income



Hardin County

Civilian Labor Force

Civilian Labor Force	2003	2004	2005	2006	2007
Civilian labor force	15,500	15,800	16,200	15,900	15,800
Employed	14,600	14,800	15,300	15,000	14,900
Unemployed	1,000	1,000	900	900	900
Unemployment rate	6.2	6.2	5.9	5.5	6.0

Establishments, Employment, and Wages by Sector: 2006

Industrial Sector	Number of Establishments	Average Employment	Total Wages	Average Weekly Wage
Private Sector	459	6,905	$205,049,408	$571
Goods-Producing	87	2,557	$93,883,130	$706
Natural Resources and Mining	13	87	$2,334,702	$516
Constuction	36	140	$3,804,383	$522
Manufacturing	38	2,330	$87,744,045	$724
Service-Providing	372	4,348	$111,166,278	$491
Trade, Transportation and Utilities	126	1,386	$36,601,267	$507
Information	9	87	$2,188,547	$483
Financial Services	42	275	$7,717,382	$539
Professional and Business Services	43	193	$3,821,786	$380
Education and Health Services	38	1,327	$48,326,230	$700
Leisure and Hospitality	54	817	$8,698,948	$204
Other Services	60	260	$3,705,672	$274
Unclassified	1	4	$106,446	$511
Federal Government		85	$3,397,400	$768
State Government		37	$1,331,038	$691
Local Government		1,590	$41,962,276	$507
Change Since 2001				
Private Sector	-5.2%	-0.5%	12.2%	12.8%
Goods-Producing	-12.1%	1.0%	5.7%	4.7%
Natural Resources and Mining	62.5%	70.6%	101.4%	18.1%
Construction	-30.8%	-37.8%	-22.1%	25.2%
Manufacturing	-5.0%	3.3%	6.0%	2.7%
Service-Producing	-3.4%	-1.4%	18.4%	20.0%
Trade, Transportation and Utilities	-8.7%	-4.4%	13.6%	18.7%
Information	0.0%	14.5%	2.1%	-10.9%
Financial Services	0.0%	26.7%	48.5%	17.2%
Professional and Business Services	7.5%	1.0%	-9.0%	-10.0%
Education and Health Services	-9.5%	2.5%	23.8%	20.9%
Leisure and Hospitality	5.9%	-11.7%	11.7%	26.7%
Other Services	-6.3%	3.6%	11.9%	8.3%
Federal Government		-3.4%	9.1%	12.9%
State Government		-5.1%	-1.3%	3.9%
Local Government		1.5%	9.8%	8.1%

Business Numbers

Business Numbers	2003	2004	2005	2006	2007
Business starts	54	47	26	39	23
Active businesses	534	527	525	508	466

Residential Construction

Residential Construction	2003	2004	2005	2006	2007
Total units	38	53	39	67	36
Total valuation (000)	$3,730	$6,320	$4,598	$9,526	$5,130
Total single-unit bldgs	36	49	39	67	34
Average cost per unit	$102,372	$121,703	$117,894	$142,178	$144,276
Total multi-unit bldg units	2	4	0	0	2
Average cost per unit	$22,500	$89,250	$0	$0	$112,500

Major Employers

Ada Technologies	Mfg
Amer Grp plc/Wilson Sporting Goods	Mfg
Hardin County Government	Govt
Hardin Memorial Hospital	Serv
International Paper Co	Mfg
Kenton City Bd of Ed	Govt
Ohio Northern University	Serv
Reliance Steel&Alum/Precision Strip Inc	Mfg
Sumitomo Chemical/Durez Corp	Mfg
Sypris Solutions Inc	Mfg
Triumph Group Inc	Mfg

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Acentech
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29 June 2009

Hardin Wind Energy LLC
7564 Standish Place, Suite 123
Rockville, MD 20855

Attention: Nazre G. Adum, P.E. *** via email (nadum@invenergyllc.com) ***

Subject: Phase 1 - Acoustical Study for
Proposed Hardin Wind Farm
Hardin County, Ohio
Acentech Project No. 620456

Dear Mr. Adum:

At Hardin Wind Energy's request, Acentech developed an initial sound model to support the environmental study of the proposed 300 MW Hardin Wind Farm. Two potential plans under development for this wind farm consist of 120 GE Model 2.5xl wind turbine generators (WTGs) and 200 GE Model 1.5xle WTGs. The project area is mostly agricultural land that includes about 1250 residences located over the site and within one mile of the site boundary. This letter outlines the State of Ohio noise requirements for wind turbine projects, presents the initial sound level estimates based on model runs for the two project layout options and equipment information, and discusses community sound level criterion. Additional acoustical analysis may be conducted as part of further design work for Hardin Wind Farm.

State Noise Requirements
The Ohio Power Siting Board (OPSB) has adopted rules that implement certification requirements for wind-powered electric generation facilities. Subsection (A) Health and safety of Sec. 4906-17-08 Social and ecological data, of the rules specifically require the wind power applicant to:
(a) Describe the construction noise levels expected at the nearest property boundary. The description shall address:

- Dynamiting activities
- Operation of earth moving equipment
- Driving of piles
- Erection of structures
- Truck traffic
- Installation of equipment

(b) For each turbine, evaluate and describe the operational noise levels expected at the property boundary closest to that turbine, under both day and nighttime conditions. Evaluate and describe the cumulative operational noise levels for the wind facility at each property boundary for each property adjacent to the project area, under both day and nighttime operations. The applicant shall use generally accepted computer modeling software (developed for wind turbine noise measurement) or similar wind turbine noise methodology, including consideration of broadband, tonal, and low-frequency noise levels.

(c) Indicate the location of any noise-sensitive areas within one mile of the proposed facility.

(d) Describe equipment and procedures to mitigate the effects of noise emissions from the proposed facility during construction and operation.

Construction Sound Estimates and Mitigation Measures
Construction of the Hardin Wind Farm is scheduled to start in early spring and continue into late fall. Initial activities (Construction Phase I) will include improvements and new construction of facility access roads; then clearing where needed, excavation, foundation, and backfill work at the WTGs and the substation. Concrete for the project will be made at temporary on-site batch plants using trucked-in materials or will be directly trucked-in from an offsite plant. Phase I activities will be followed by Phase II activities, which are comprised of erection of the WTG towers and installation of the WTGs; trenching and installation of the electrical collection system; and installation of substation equipment. Finally, prior to commercial operation, the individual equipment items and the entire facility will be tested and commissioned during Phase III.

A majority of the construction activities associated with the proposed project will be conducted during daylight hours. At times over the planned construction schedule, the construction activities will be audible to nearby residents. Any construction at the facility in the evening and nighttime is expected to be limited to relatively quiet activities and to be less noticeable than in the daytime.

The following mitigation measures will be employed during the construction phase of the project:

- Effective exhaust mufflers in proper working condition will be installed on all engine-powered construction equipment at the site. Mufflers found to be defective will be replaced promptly.
- Contractors will be required to comply with federal limits on truck noise.
- Contractors will be required to ensure that their employee and delivery vehicles are driven responsibly.
- Nighttime construction work that does occur will generally be limited to relatively quiet activities, such as welding and installing equipment, cabling, and instrumentation.
- Contractors will be required to notify the community in advance of any blasting activity.

Construction sound that may be heard off-site will vary from hour-to-hour and day-to-day in accordance with the equipment in use and the operations being performed at the site. Since the construction activity at the site will be temporary, will occur mostly in the daytime hours, and will produce sounds that are already familiar to the community, including sounds from home construction, its overall noise impact on the community beyond 1000 ft. of the nearest turbine is not expected to be significant.

Typical on-site equipment used to construct the wind farm project will include trucks, cranes, dozers, excavators, trenchers, graders, and batch plants. Representative average sound levels (equivalent sound levels, Leq) associated with this construction equipment during the workday are listed in Table 1. For example, with 2 trucks, 1 dozer, and 1 excavator operating at a WTG, the calculated equivalent sound level during the workday is 59 dBA at 1050 ft. (approximate minimum distance from a 2.5MW turbine site to nearest residence) and 61 dBA at 930 ft. (minimum distance from a 1.5MW turbine site to nearest residence). The construction sound level at the nearest property boundary will be greater than these values, depending on the actual distances from the construction activity to the boundary. Table 1 also lists the sound estimates at 600 ft. and 740 ft. from the construction equipment, which are the shortest distances from the 1.5MW and 2.5MW turbines, respectively, to the facility's property line and the sound estimates at one-half mile and one mile from the equipment. These reported sound levels are based on the results of extensive previous acoustical studies of engine-powered construction equipment.

Operation Sound Estimates and Mitigation Measures

The sound levels from the wind turbine generators at the 1253 residential locations and parcel boundaries in the community within one mile of the project site have been predicted. The project is addressing facility sound by considering the location of each turbine on the project site and by purchasing the GE 2.5xl or 1.5xle wind turbine generators, two models that incorporate the following noise control treatments into their designs:

- Noise insulation of the gearbox and generator
- Reduced-noise gearbox
- Reduced-noise nacelle
- Vibration isolation mounts
- Quieted-design rotor blades

In addition, the project will specify and purchase high-efficiency, reduced-noise transformers.

Tonal and Low-Frequency Sound

Modern turbines such as the models proposed for the Hardin site, are designed to avoid prominent tonal sound that were present in some earlier models due to the design and construction of the gearbox and nacelle. Some earlier wind turbine designs also used downwind rotors (rotors downwind of the support tower), which could produce higher levels of low frequency sound. When low frequency sound is substantially greater than the background ambient sound, it may be noticed in the community and can cause annoyance. The most significant concern of low frequency sound is that it can induce vibration in a building structure, which may result in rattling china or moving mirrors and windows. Fortunately, modern wind turbines, including the GE 2.5xl and GE 1.5xle units, incorporate the upwind rotor design, which has greatly decreased the generation of low frequency sound. Note that the slowly modulating mid-frequency broadband sound ("swish") from the rotating turbine blades should not be confused with low frequency sound.

Sound Model Description

The estimated sound levels and contours, which apply to both daytime and nighttime hours for the operating phase, were developed with the computer noise modeling program, Cadna/A. This commercial software program, which was developed by DataKustik GmbH (www.datakustik.de), is widely-accepted by the international acoustics community for the calculation of community sound levels due to industrial sources. The calculations are performed for industrial sources according to the following international standards:

- ISO 9613-1: Acoustics - Attenuation of sound during propagation outdoors, Part 1: Calculation of the absorption of sound by the atmosphere, and

- ISO 9613-2: Acoustics - Attenuation of sound during propagation outdoors, Part 2: General method of calculation.

Inputs to the program include: source locations and associated sound power emissions, receptor locations, land topography, and meteorological conditions. The calculations account for spreading losses, atmospheric attenuation, ground effects, terrain and other barrier shielding, and reflections for the sound between each source and each receptor. For this study, the sound propagation routines and barrier calculations in the Cadna/A model are based on octave band sound pressure levels and on downwind conditions with a moderate temperature inversion. The following describes significant parameters used in the sound model:

- Turbine, project boundary, 1-mile boundary, and residence locations – the shape files with these data were owner-provided.

- Land elevation contours – the shape files with these data were owner-provided.

- GE 2.5xl Turbine data – Model GE 2.5xl with maximum A-weighted sound power level (LwA) of 104.2 dBA and hub height at 100 meters (turbine input as point source at 100m height above local terrain). Spectral values in the sound model for the GE 2.5xl unit were based on available GE 1.5sl/sle data and normalized to the overall LwA value for the GE 2.5xl unit. The turbine LwA sound levels vs. the normalized wind speeds at the standard 10m elevation are:
    - 4 m/s – 95.7 dBA
    - 5 m/s – 98.6 dBA
    - 6 m/s – 102.1 dBA
    - 7 m/s – 104.1 dBA
    - 8 m/s – 104.2 dBA
    - 9 m/s – 103.0 dBA

- GE 1.5xle Turbine data – Model GE 1.5xle with maximum A-weighted sound power level (LwA) of 104.1 dBA and hub height at 80 meters (turbine input as point source at 80m height above local terrain). Spectral values based on available GE 1.5xle data. The turbine LwA sound levels vs. the normalized wind speeds at the standard 10m elevation are:
    - 3 m/s – <96
    - 4 m/s – 97.2 dBA
    - 5 m/s – 101.5 dBA
    - 6 m/s to cut out – ≤104.1 dBA

- Meteorological conditions are 10°C (50°F) and 70%RH, moderate inversion, and all receptors downwind from turbines.

- Ground conditions – moderate soft ground with parameter G = 0.5 and spectral calculations for all sources.

- Receptor heights – 1.5m above local ground elevation.

Sound Model Results

Figures 1 through 9 present the proposed wind farm layout with the 120 GE 2.5xl turbines, project boundary, one-mile boundary from the project, the residences within the one-mile boundary, and the estimated sound level contours in 5 dBA increments. The computer shape files of the sound level contours (1 dBA increments) and an Excel file with the estimated facility sound level at each of the 1253 residences within one-mile boundary of the project site are provided in a separate transmittal. The estimates are based on the greatest sound output condition for each turbine (e.g., LwA=104.2 dBA at 8 m/s wind speed at the standard 10m elevation). Under conditions of wind speeds greater or less than 8 m/s, the estimated sound levels in the community will be lower than these reported values. Specifically, the sound will be less than the displayed values by 2 dBA for wind conditions of 6 m/s, about 5 dBA less for 5 m/s, and 8 dBA less for 4 m/s.

Figure 10 is a scatter plot that displays the estimated sound levels at the residences vs. their respective distances from the nearest turbine. Note that the level represents the sound of the entire facility and that more than just the one nearest turbine may contribute significantly to the overall sound level at a specific receptor.

Figures 11 to 20 are identical in format to Figs. 1 to 10, but present the sound estimates for the alternative project layout with 200 GE 1.5xle turbines. The estimates are based on the greatest sound output condition for each turbine (e.g., LwA=104.1 dBA at 6 m/s wind speed at the standard 10m elevation). Under conditions of wind speeds less than 6 m/s, the estimated sound levels in the community will be lower than these reported values. Specifically, the sound will be less than the displayed values by 2 dBA for wind conditions of 5 m/s, about 7 dBA less for 4 m/s, and 8 dBA less for 3 m/s.

The estimated sound levels produced only by the wind farm range at the residences within the one-mile boundary of the project from 20 dBA to 46 dBA for the GE 2.5xl layout site and from 23 dBA to 47 dBA with the GE 1.5xle layout. These levels apply to both daytime and nighttime hours. Although the turbines will be heard at community locations at times during turbine operation and quieter ambient sound levels, the WTG sound emissions will be less under conditions of reduced wind speeds, including the times below the minimum cut-off wind speed when the turbine does not operate.

Noise Impact Assessment

Turbine Construction

The majority of the construction activities associated with the project will be conducted during the daylight hours, and the sound levels will vary over time, depending on the equipment in use and the operations being performed at the site. The temporary noise associated with construction of the project will be similar to the noise produced during farming operations, and during excavation, grading, and steel erection activities at many other mid-size and home building projects. To minimize construction noise, it is suggested that the project employ best management practices such as turning off engines when not in use, maintaining equipment in good working order with effective exhaust mufflers on all engine-powered construction equipment, and minimizing the use of heavy equipment to daytime hours at the site.

Turbine Operation
The project will be available to operate 24-hours per day and seven days per week. The findings of our study indicate that routine operation of the wind farm will produce from 20 dBA to 47 dBA at the community residences within one mile-boundary from the project site. No State or local noise standards are available for comparison to the project levels. However, the estimated project levels of 20 dBA to 47 dBA are less than the steady 48 dBA sound level that is associated with the USEPA Noise Guideline and FERC Criterion with an Ldn sound level of 55 dBA.

The project levels are also compared to an average ambient sound level (Leq) of 45 dBA, which the New York State Department of Environmental Conservation (NYDEC) Policy has identified as representative of rural agricultural areas. The NYDEC policy seeks to limit increases in the community sound levels due to a project to 6 dBA above the existing ambient levels, which results in a total level of 51 dBA for an ambient level 45 dBA. Based on an average ambient sound level (Leq) of 45 dBA for a rural agricultural area such as Hardin County, and an upper turbine sound level of 47 dBA at the nearest residences, the project would result in an average sound level (Leq) to 49 dBA (total of ambient and turbine sound) at the nearest community residences, which is an increase of 4 dBA over the ambient level.

To address turbine operation sound, the project could consider adopting the 48 dBA sound level associated with the USEPA Noise Guideline as an upper level goal for the turbine sound at the nearest residences during this initial phase of project planning.

****

Sincerely,

James D. Barnes
Acentech Incorporated

Figures 1-20
Table 3
Appendix A
Data files with sound contours (provided separately)
Data file with sound levels at residences (provided separately)

Figure 1.
Aerial Photograph Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+), Site Boundary (black line) and 1-mile Boundary (red line).

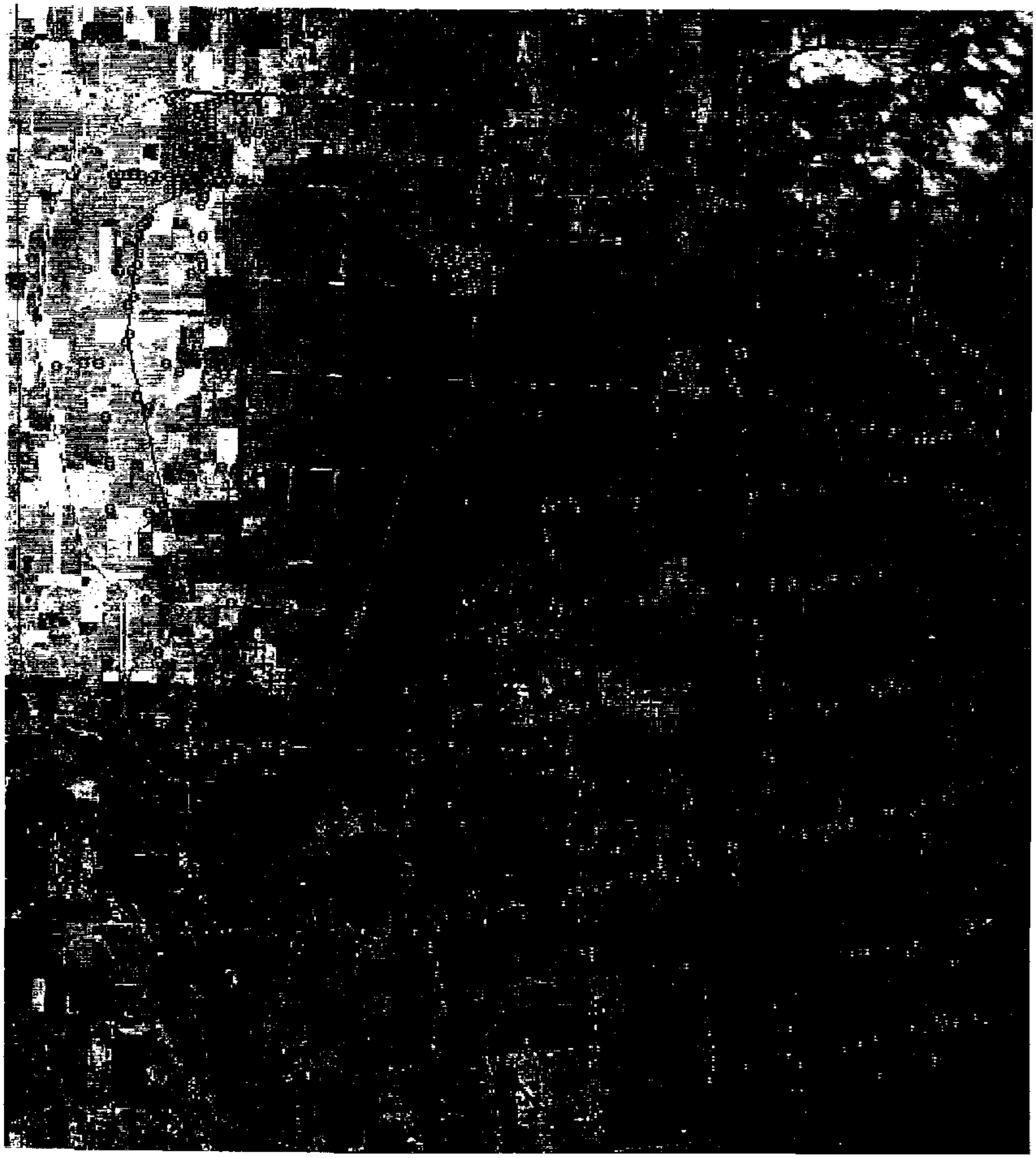

Figure 2.
Map Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+), Site Boundary (black line), and 1-mile Boundary (red line).

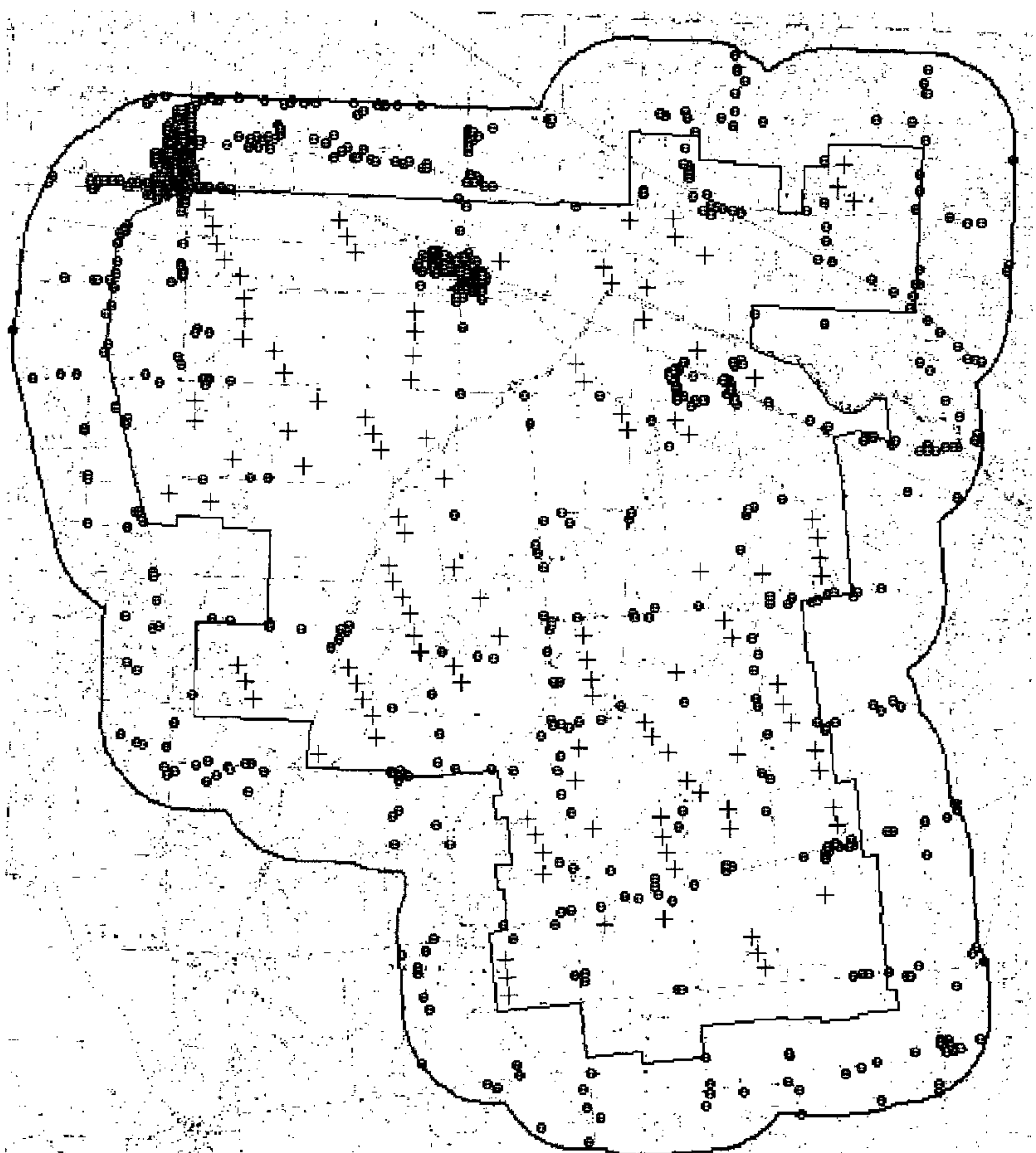

Figure 3.
Map Showing Residences (O) and Project Site with
Potential Turbine GE 2.5xl Locations (+) and Turbine Sound Level Contours.

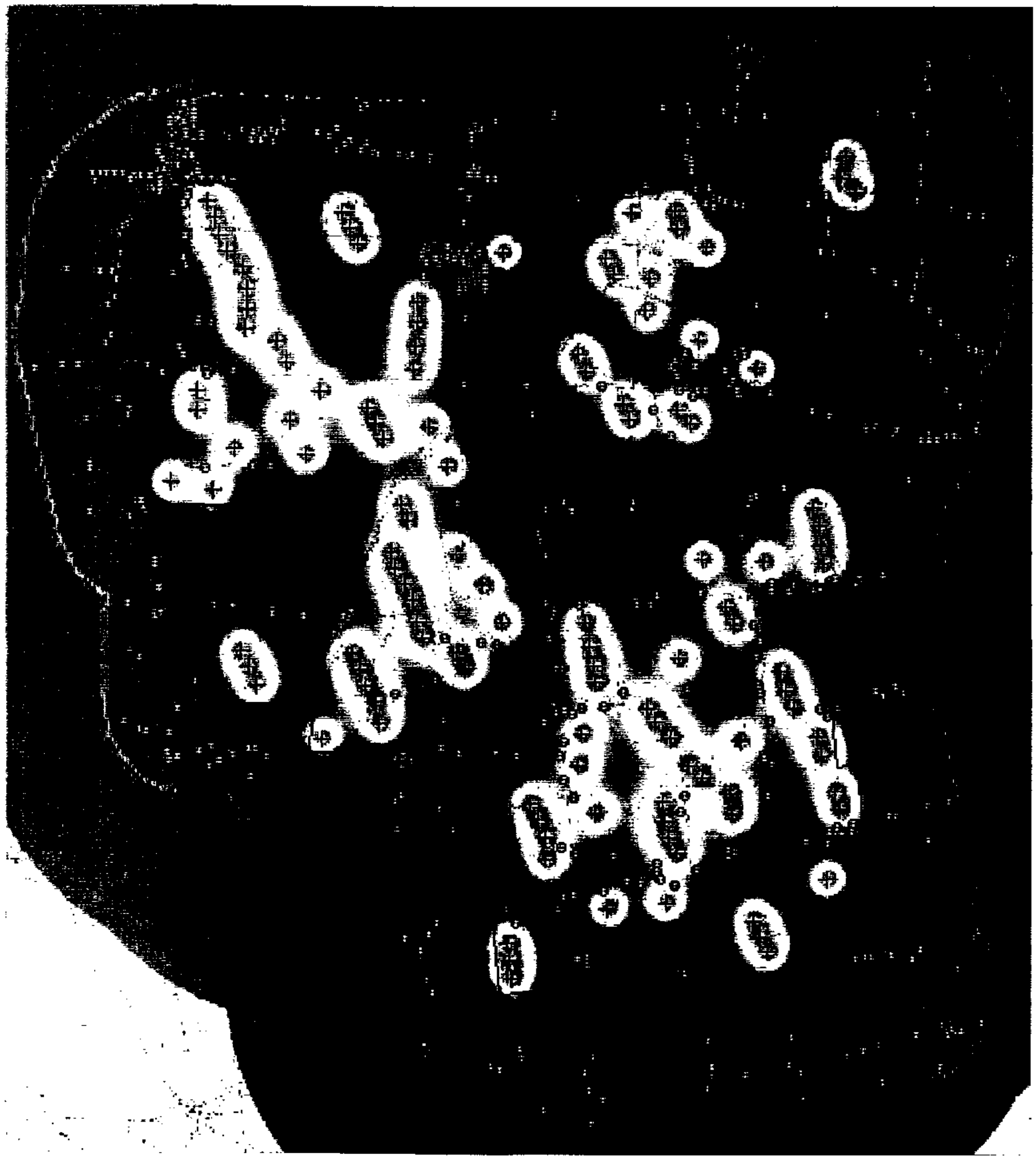

Figure 4.
Map Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level Contours.

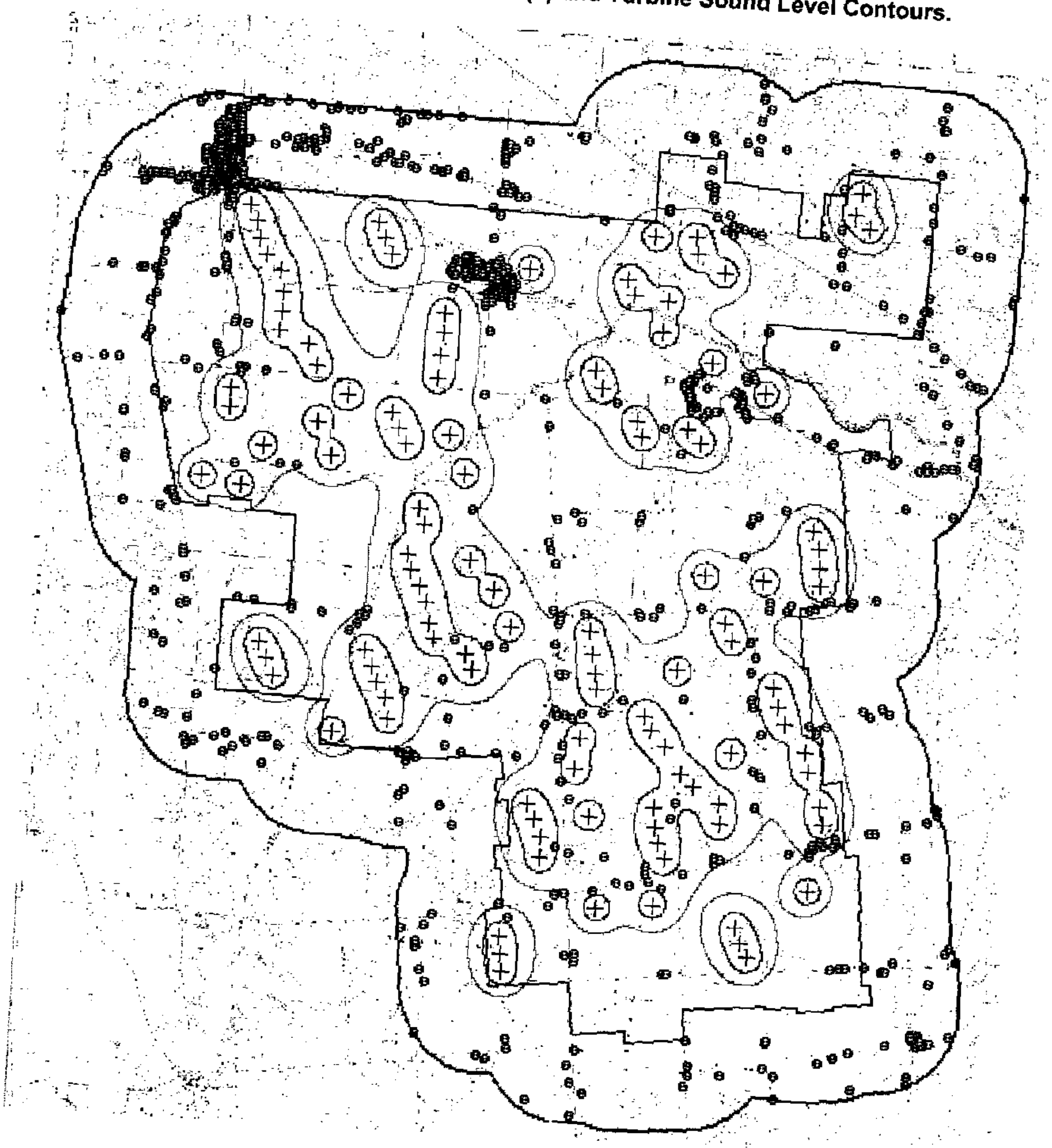

Figure 5.
Project Layout Showing Residences (O) and Project Site with
Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

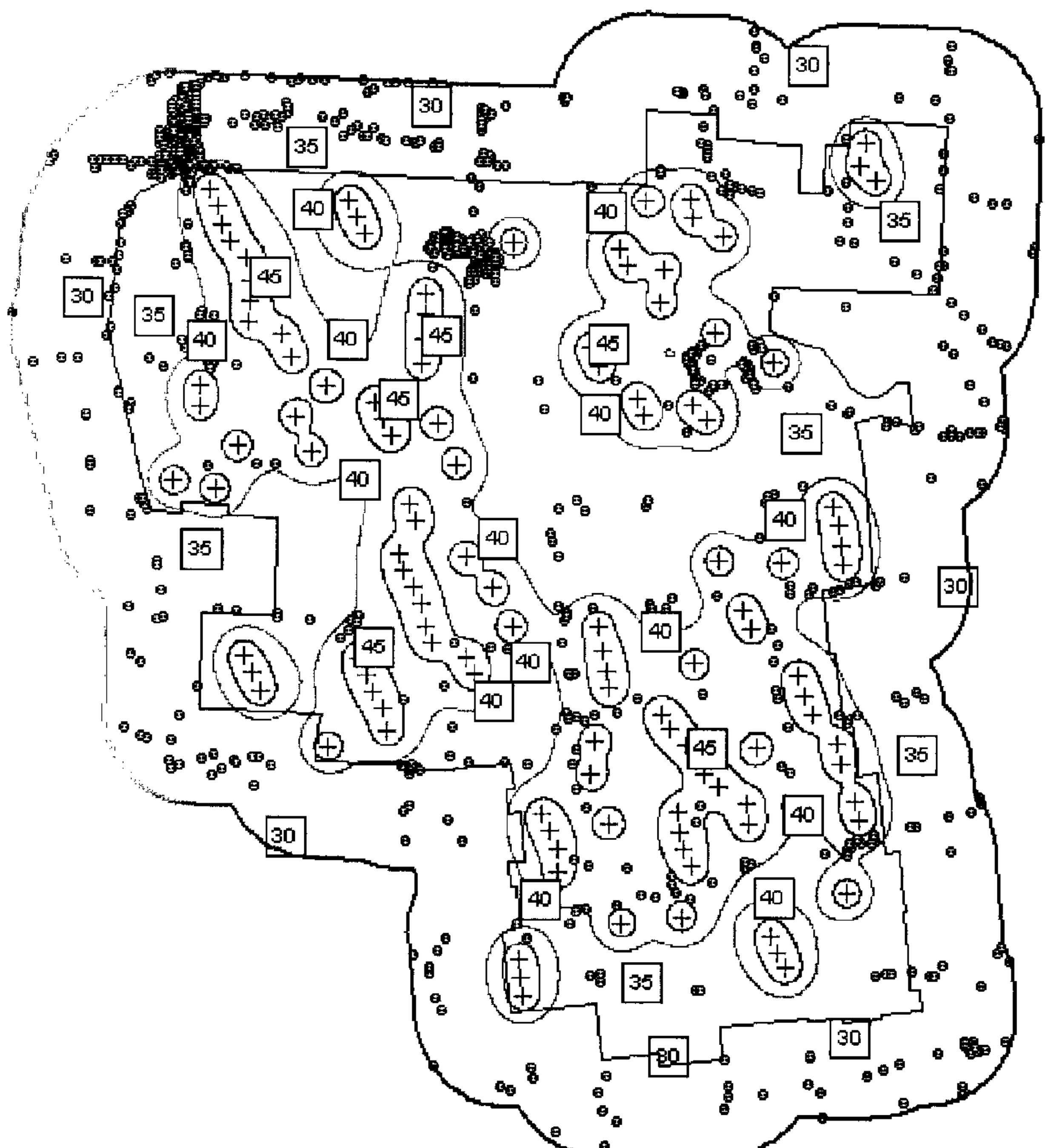

Figure 6.
NE Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

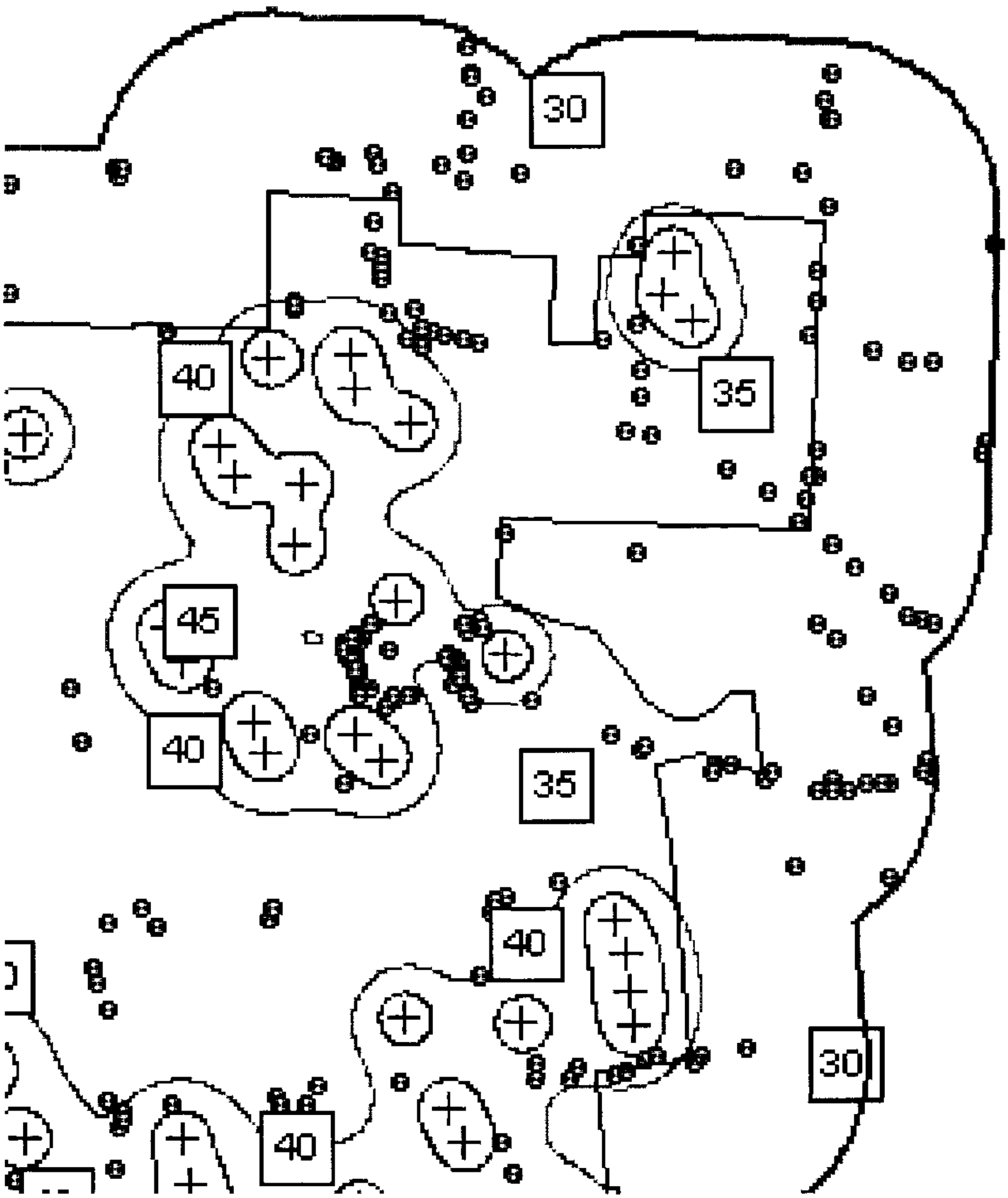

Figure 7.
NW Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

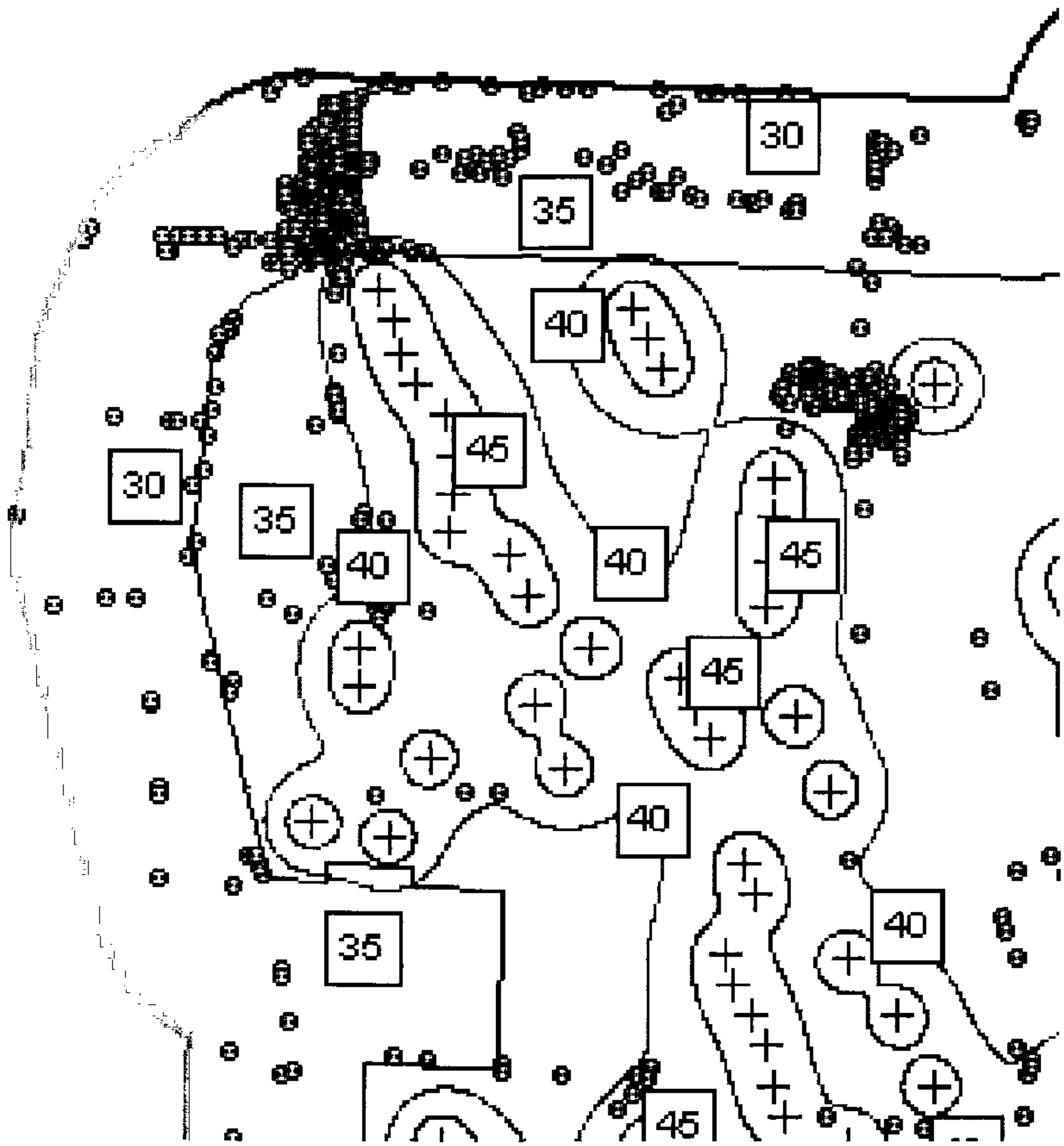

Figure 8.
SW Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

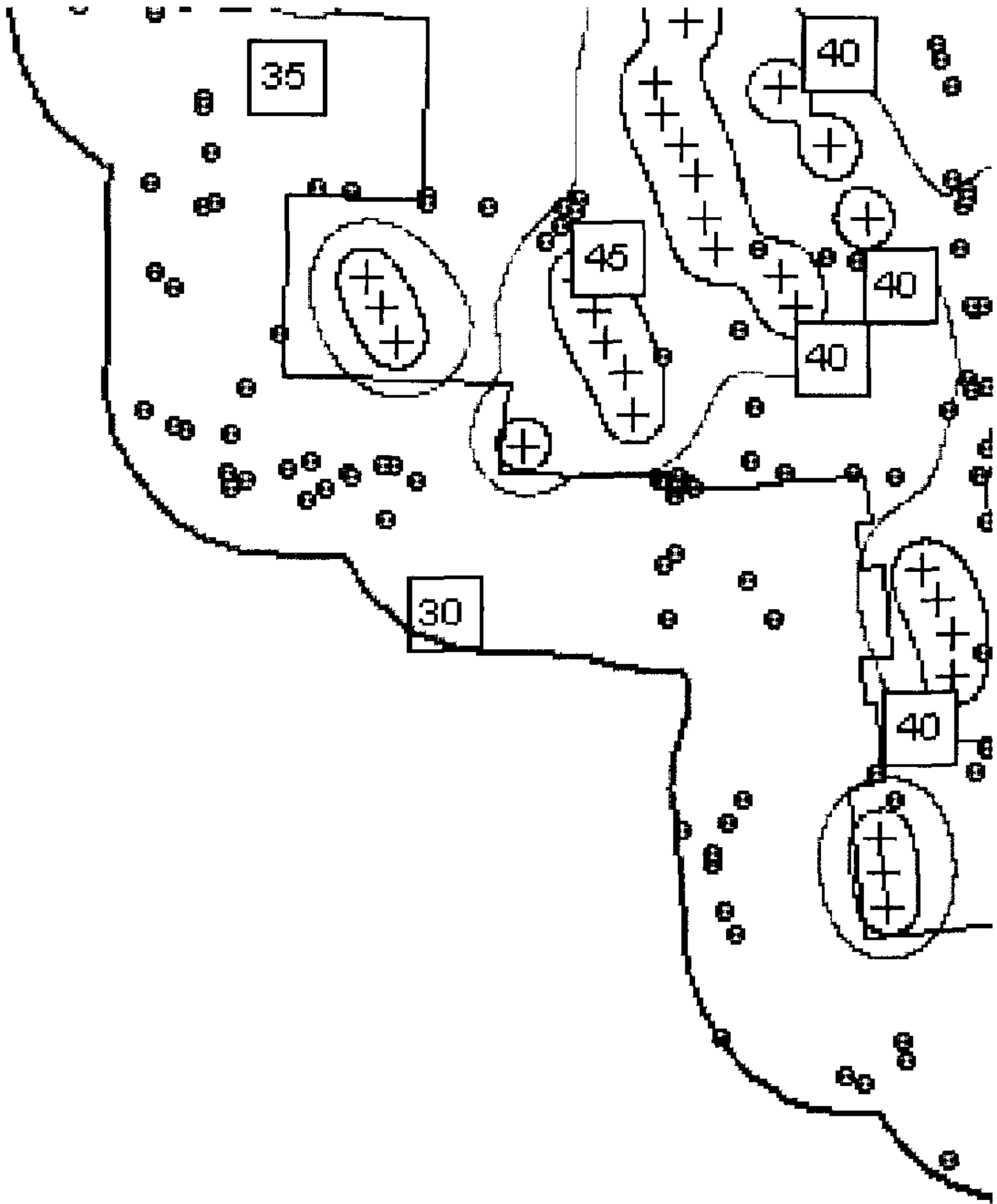

Figure 9.
SE Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 2.5xl Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

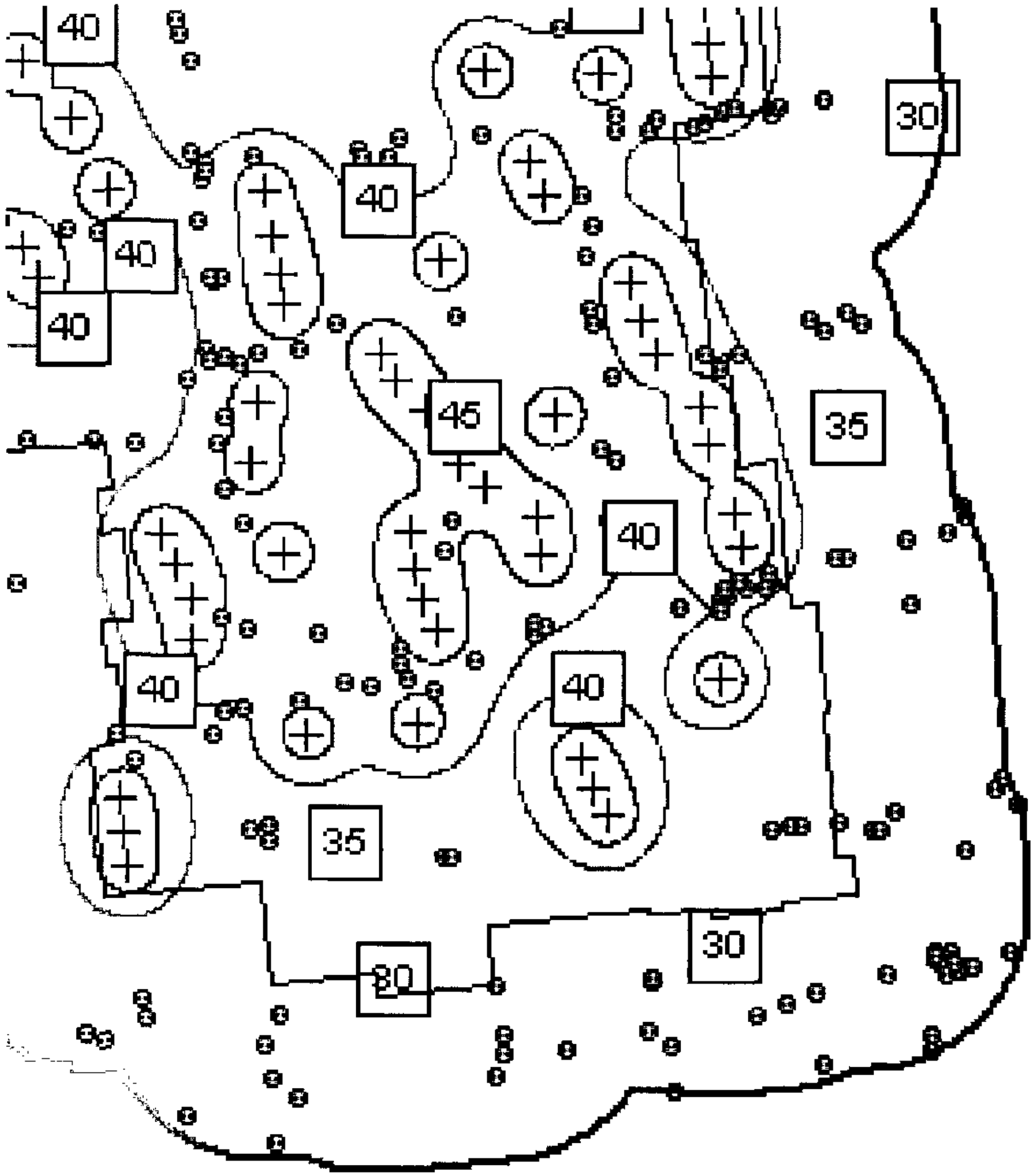

Figure 10.
Scatter Plot of Estimated Overall Turbine Facility Sound Levels (dBA) vs. Distances (ft) to Nearest Turbine for Residences within One Mile Boundary of Project Site. (operating condition at maximum sound output for each GE 2.5xl turbine, i.e., A-Weighted sound power level of 104.2 dBA with 8 m/s wind speed at 10m height)

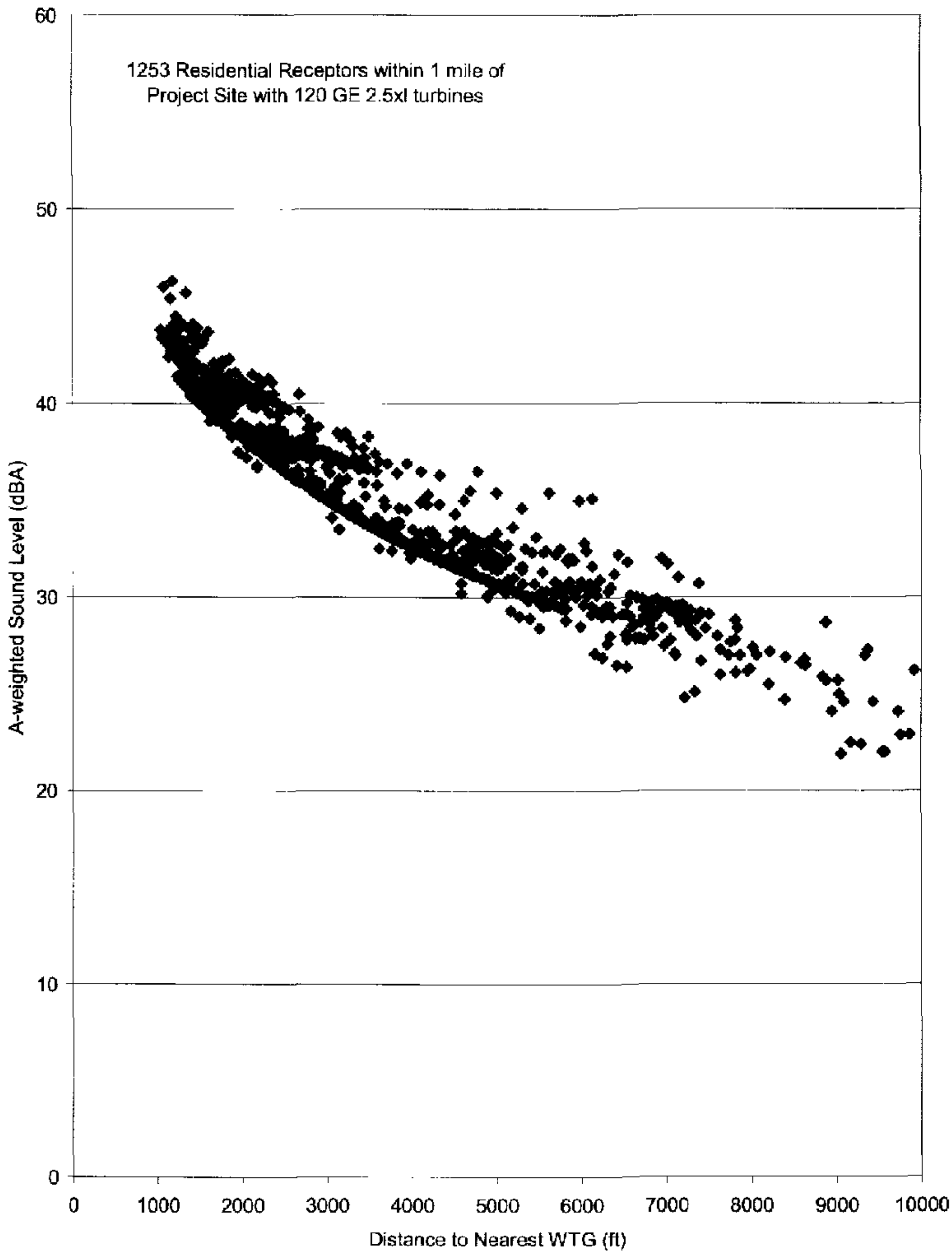

Figure 11.
Aerial Photograph Showing Residences (O) and Project Site with Potential GE 1.5xle Turbine Locations (+), Site Boundary (black line) and 1-mile Boundary (red line).

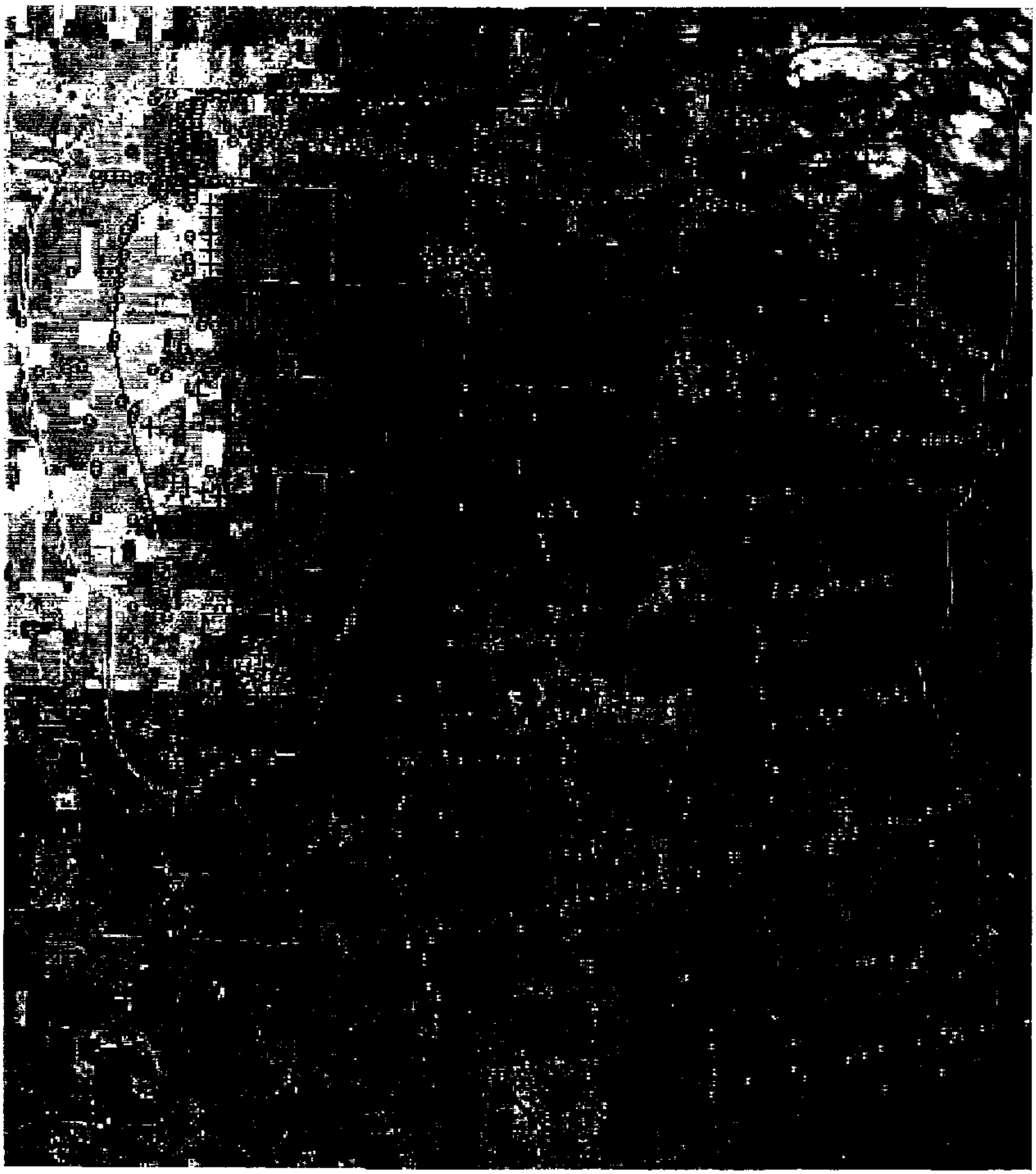

Figure 12.
Map Showing Residences (O) and Project Site with
Potential GE 1.5xle Turbine Locations (+), Site Boundary (black line), and
1-mile Boundary (red line).

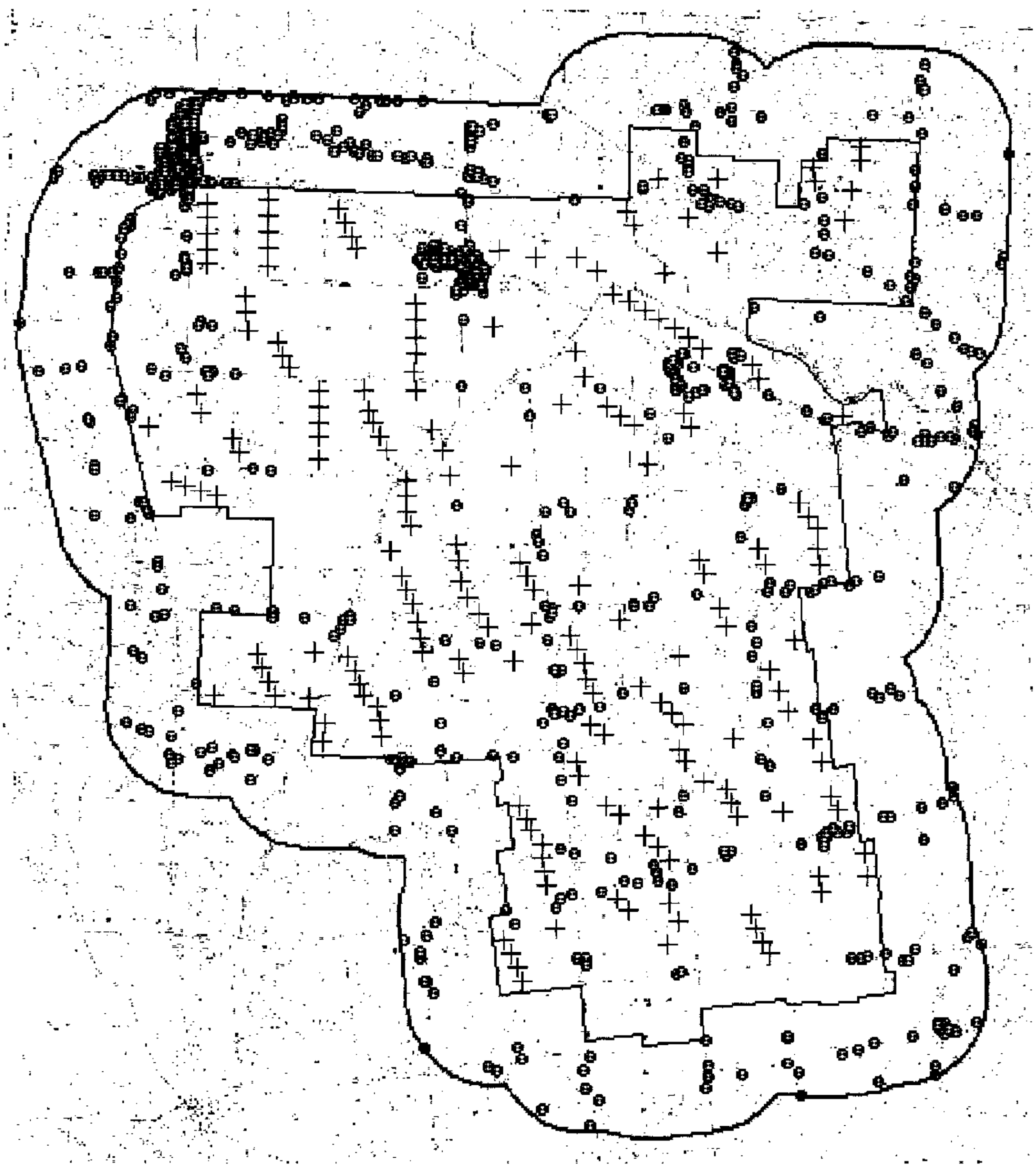

Figure 13.
Map Showing Residences (O) and Project Site with
Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level Contours.

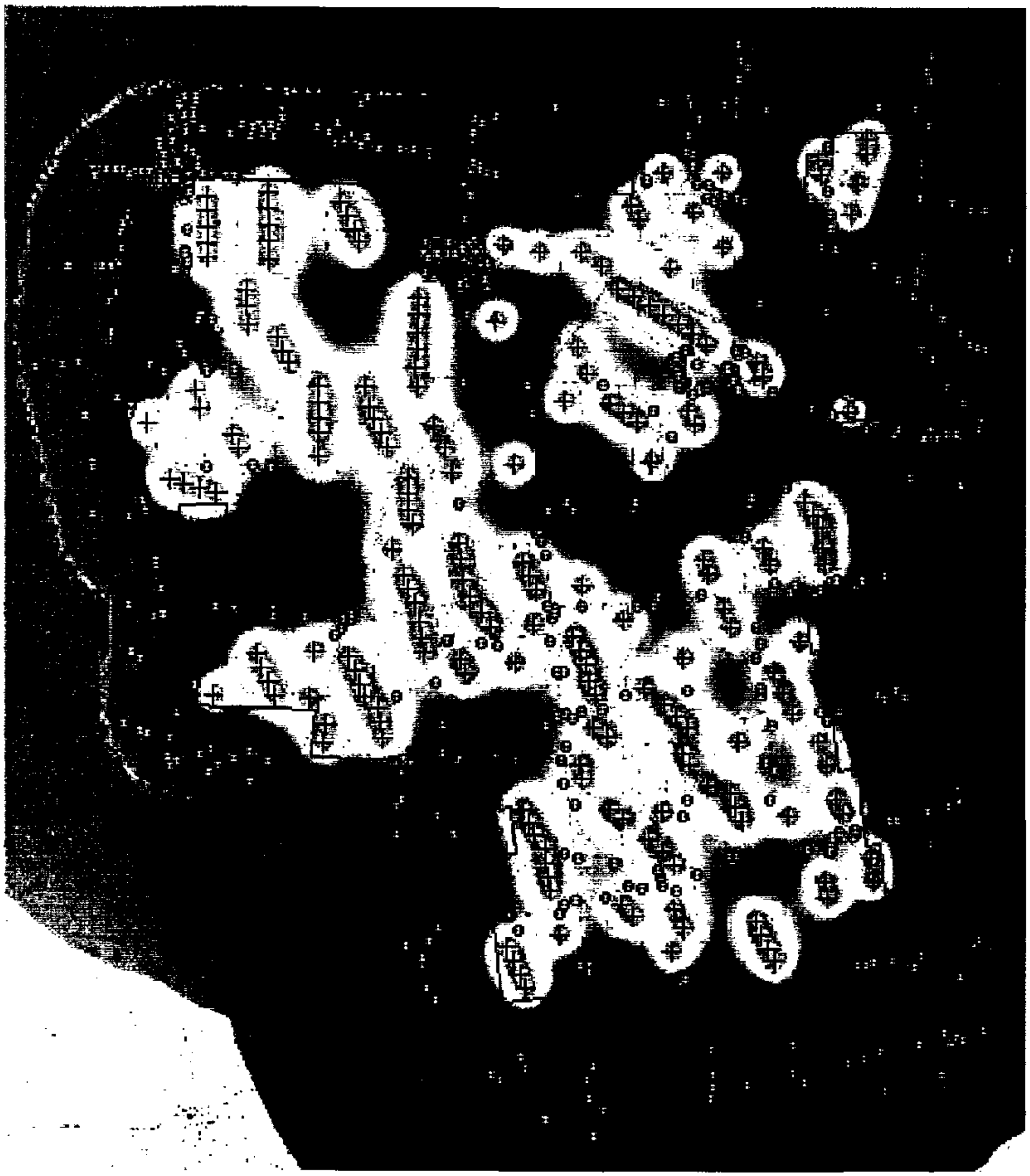

Figure 14.
Map Showing Residences (O) and Project Site with
Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level Contours.

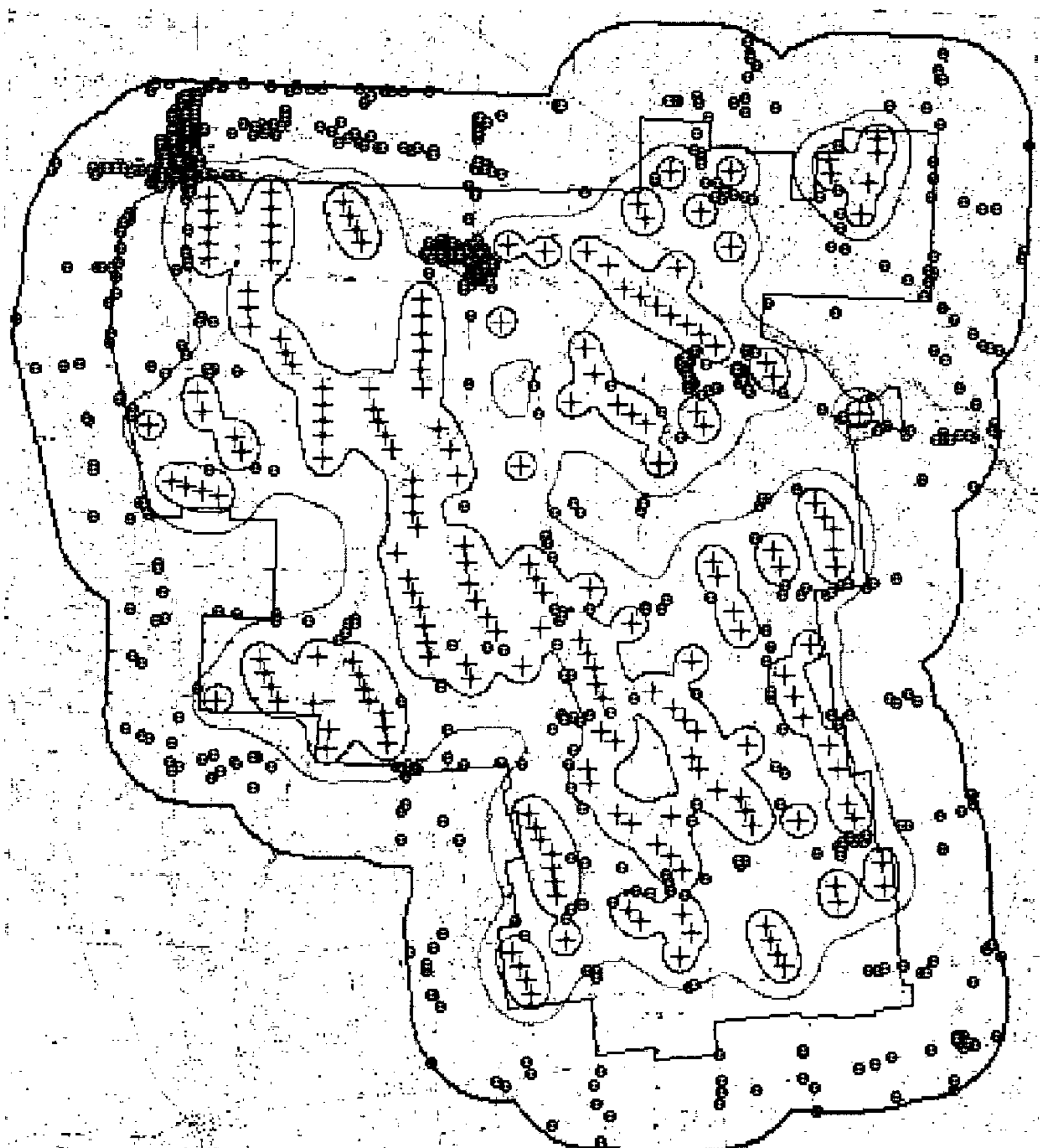

Figure 15.
Project Layout Showing Residences (O) and Project Site with Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

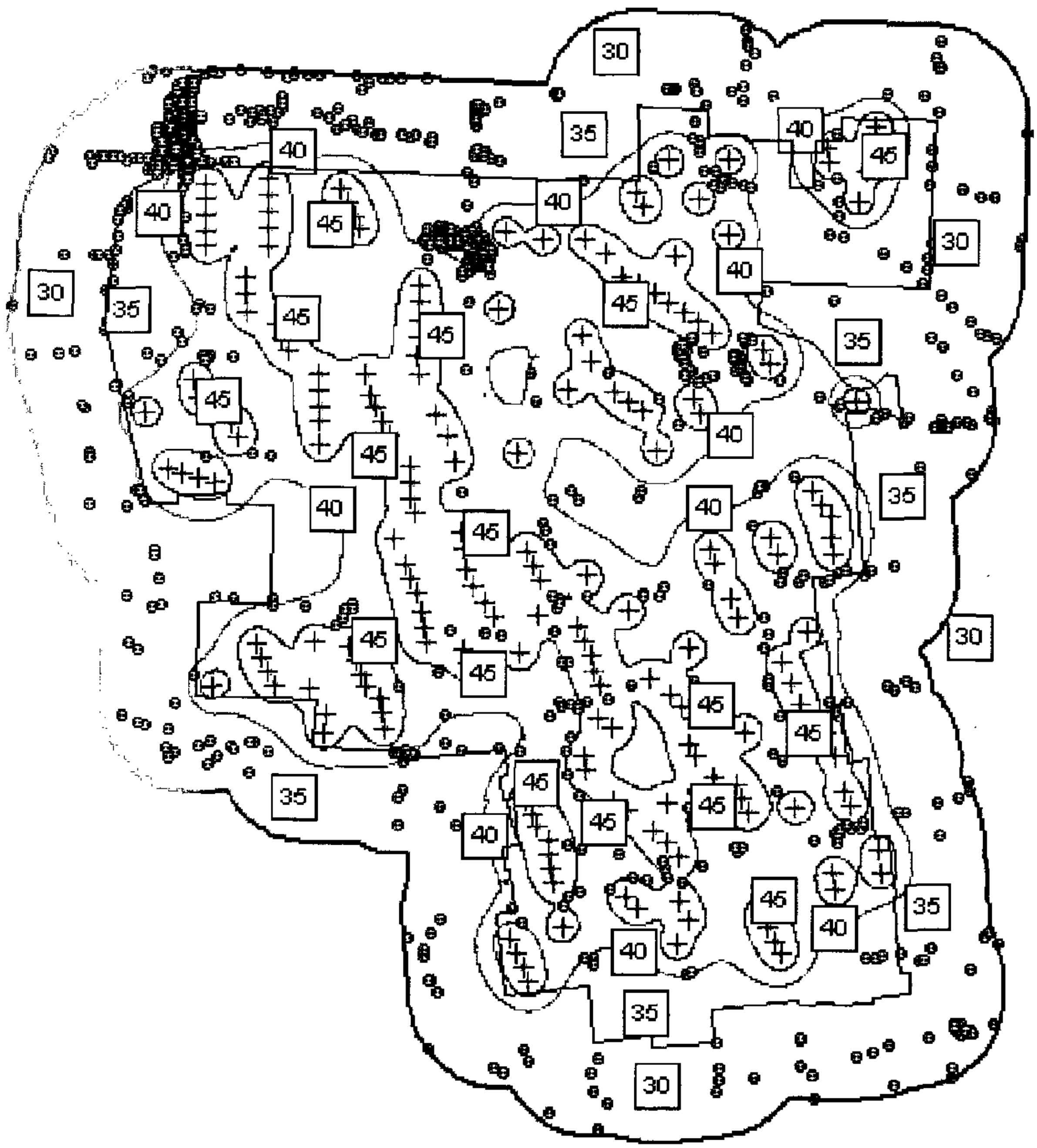

Figure 16.
NE Quadrant of Project Layout Showing *Residences* (O) and Project Site with Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

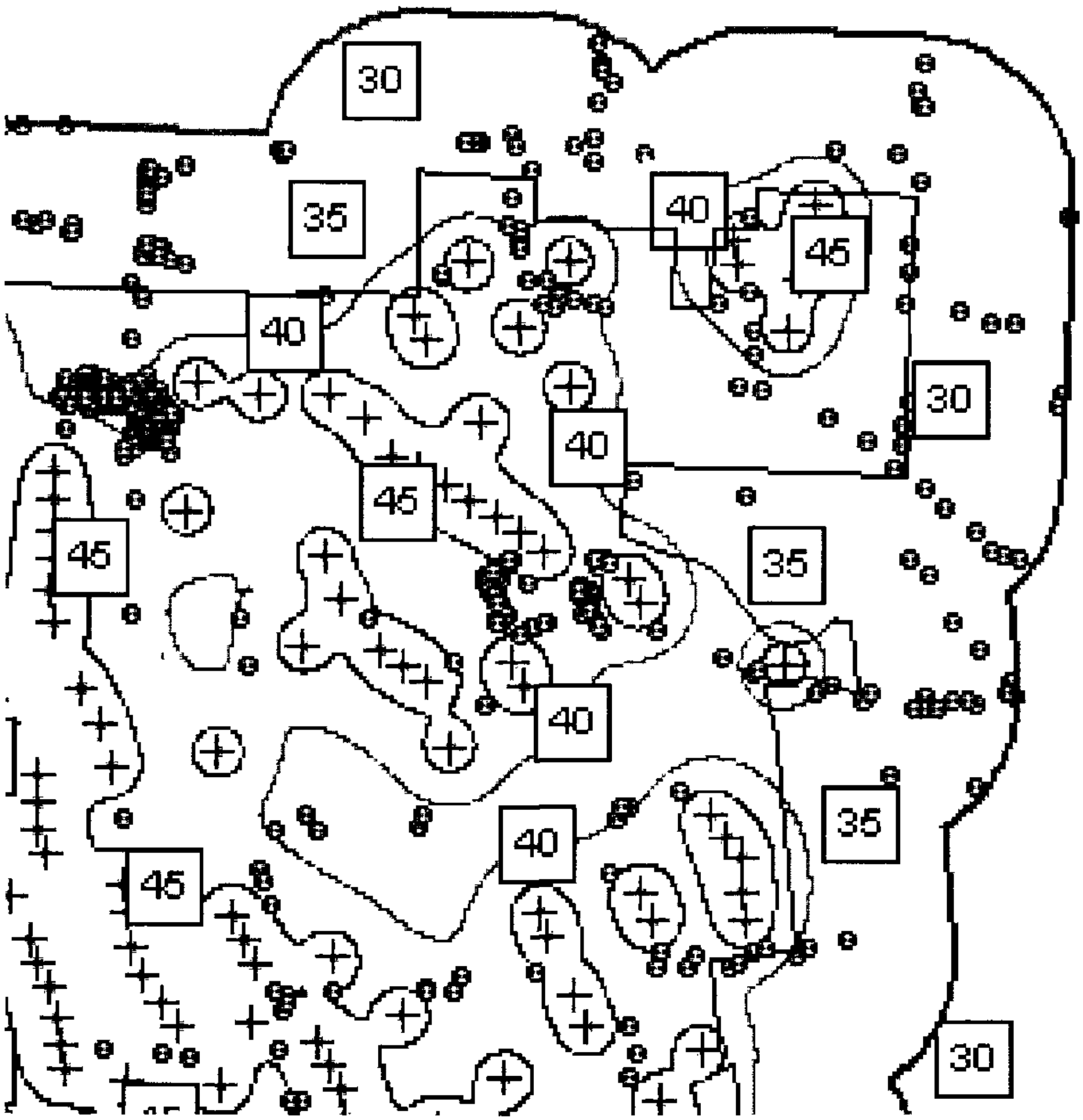

Figure 17.
NW Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

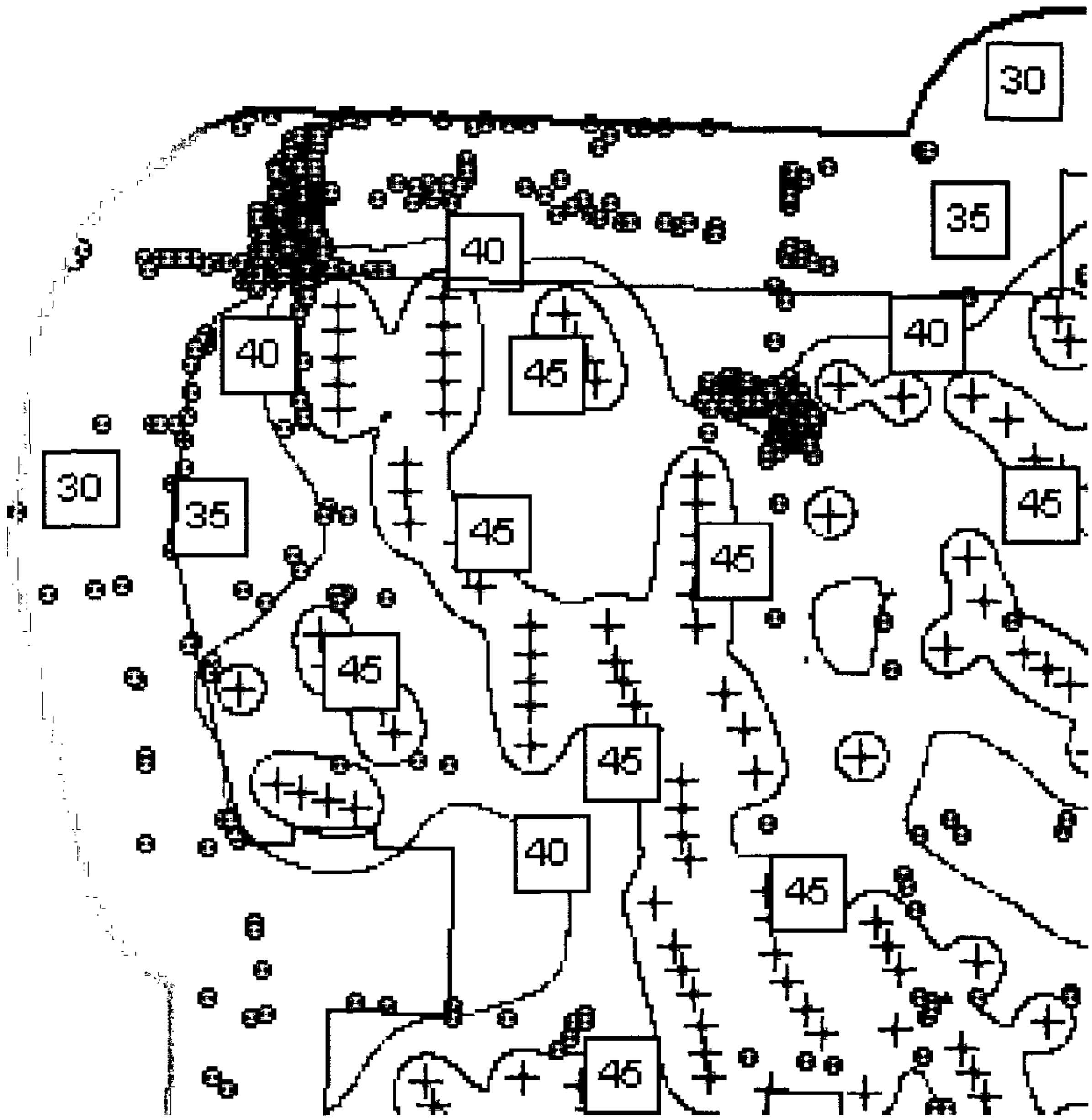

Figure 18.
SW Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

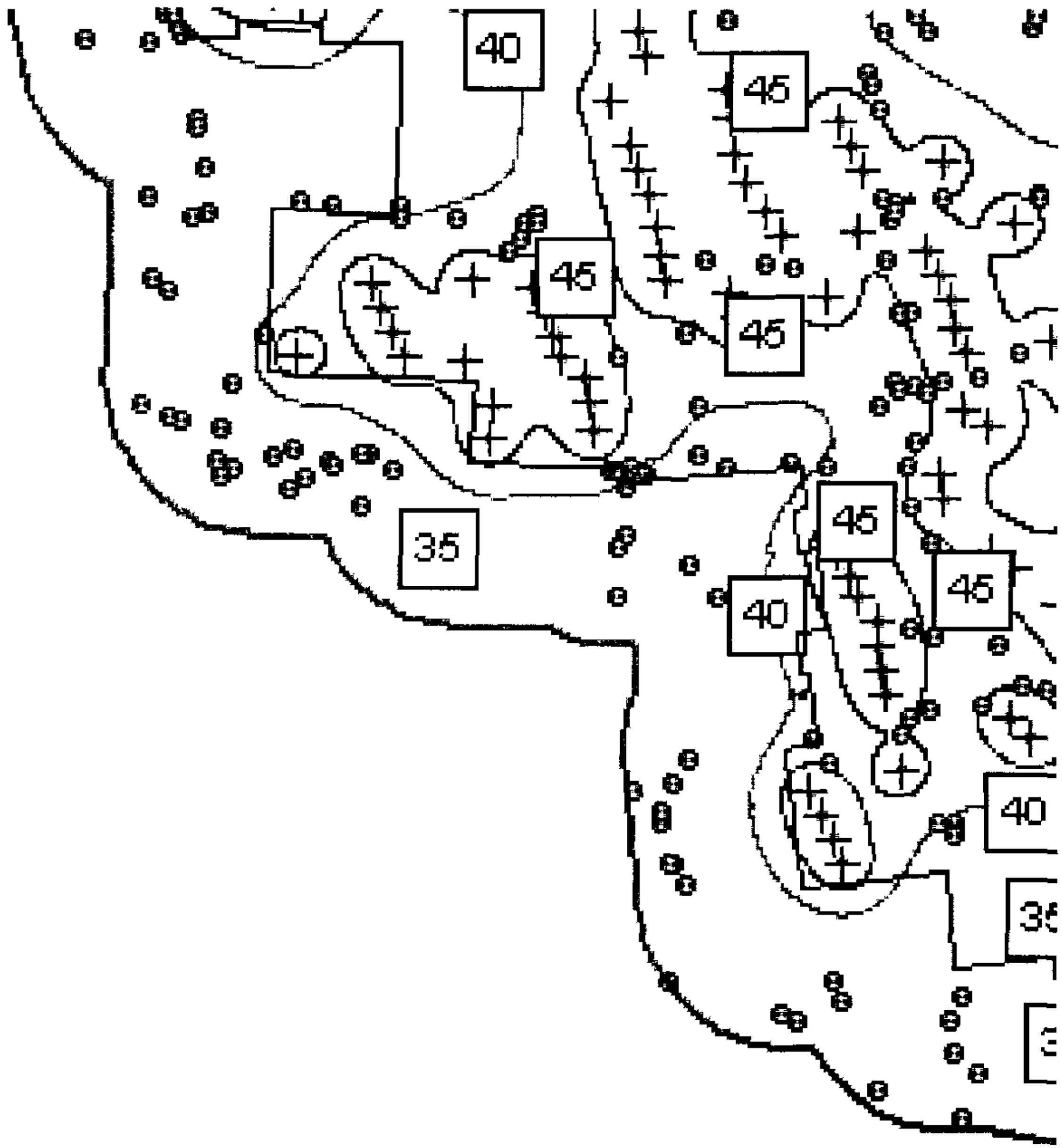

Figure 19.
SE Quadrant of Project Layout Showing Residences (O) and Project Site with Potential GE 1.5xle Turbine Locations (+) and Turbine Sound Level (dBA) Contours.

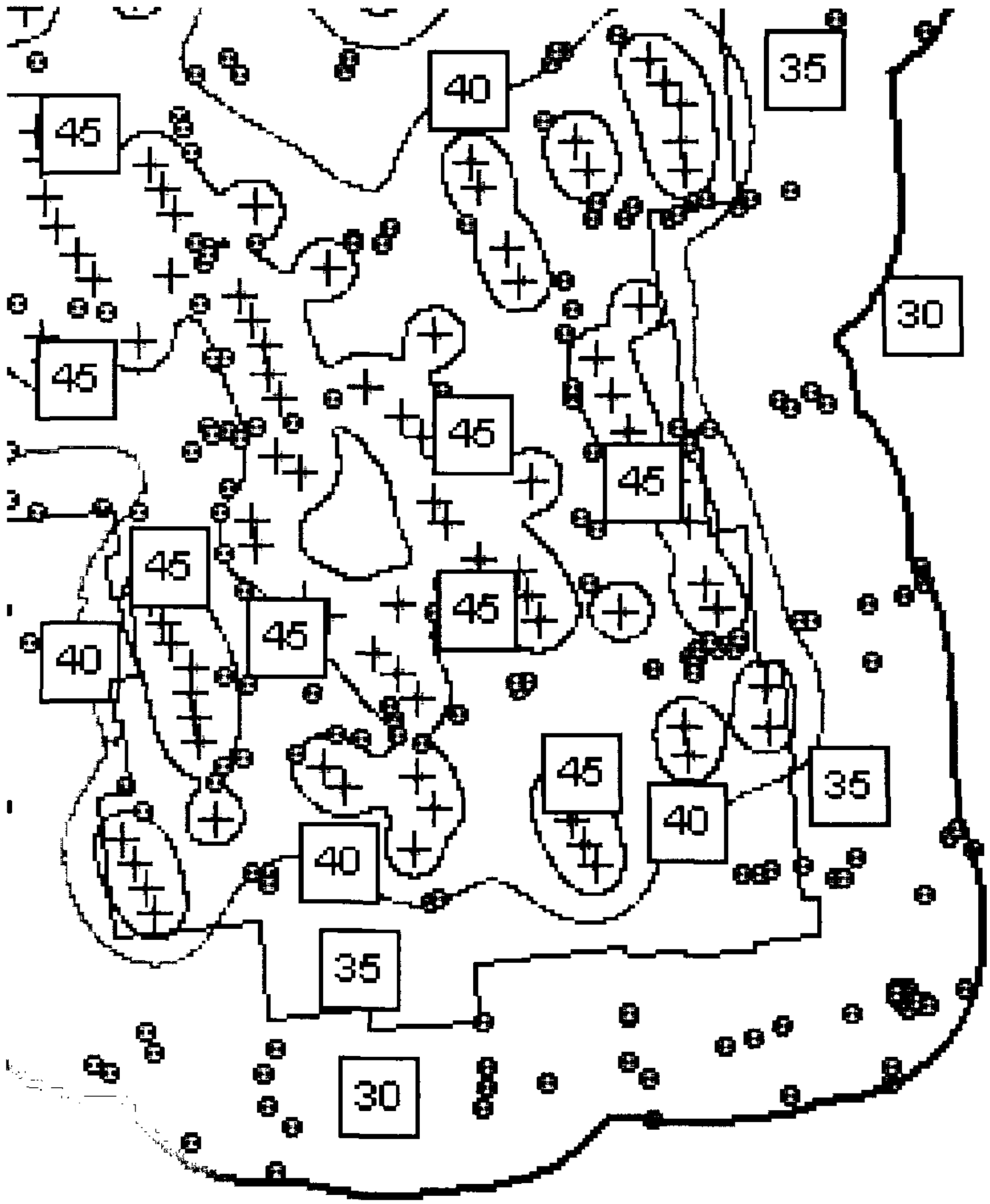

Figure 20.
Scatter Plot of Estimated Overall Turbine Facility Sound Levels (dBA) vs. Distances (ft) to Nearest Turbine for Residences within One Mile Boundary of Project Site. (operating condition at maximum sound output for each GE 1.5xle turbine, i.e., A-Weighted sound power level of 104.1 dBA with 8 m/s wind speed at 10m height)

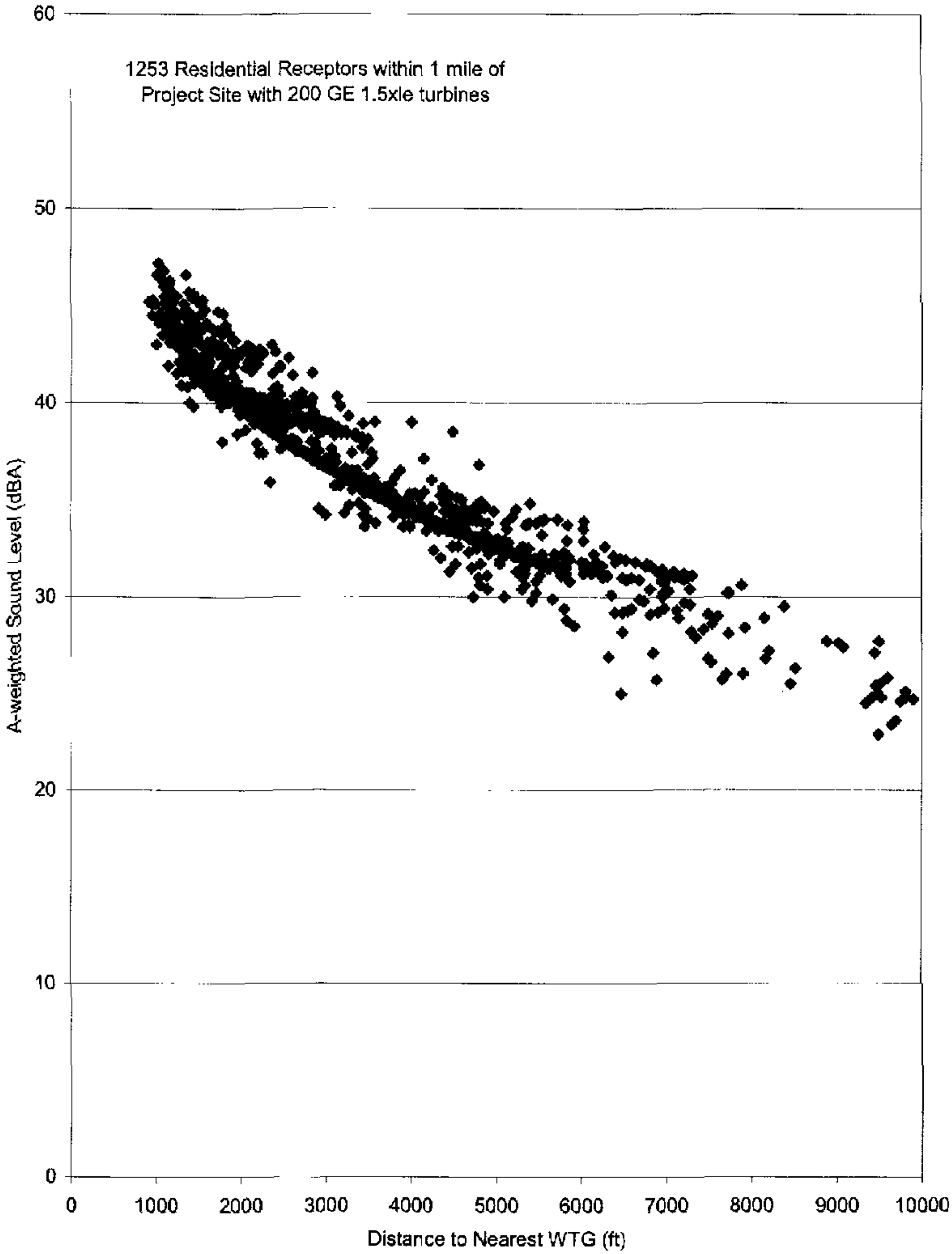

Table 1.
Estimated Equivalent Sound Levels (Leq*) of Representative Construction Equipment at Various Distances.

Equipment	Energy Average Sound Levels (Leq, dBA)*					
	600 ft. [1]	740 ft. [2]	930 ft. [3]	1050 ft. [4]	½ mile	1 mile
Phase I – Preparation & Foundation						
Blasting	71†	70†	67†	65†	54†	43†
Pile Driving	70†	69†	66†	64†	53†	42†
Dozer	60	59	56	54	43	32
Excavator	61	60	57	55	44	33
Trencher	61	60	57	55	44	33
Grader	59	58	55	53	42	31
Roller	56	55	52	50	39	28
Trucks	55	54	51	49	38	27
Batch Plant	52	51	48	46	35	24
Phase II – Erection & Installation						
Trucks	55	54	51	49	38	27
Crane	61	60	57	55	44	33
Phase III – Test & Commission						
Trucks	55	54	51	49	38	27

* Estimated Leq sound levels over a 10-hour daytime shift. 24-hr Ldn would be 4 dBA less than each Leq.
[1] Estimated sound levels at nearest non-participating landowner's property line to proposed GE 1.5xle turbines.
[2] Estimated sound levels at nearest non-participating landowner's property line to proposed GE 2.5xl turbines.
[3] Estimated sound levels at nearest community residence to proposed GE 1.5xle turbines.
[4] Estimated sound levels at nearest community residence to proposed GE 2.5xl turbines.
† Estimated values for blasting and pile driving are maximum (Lmax) sound levels, not Leq.

Reference: ESEERCO Power Plant Construction Noise Guide, BBN Report No. 3321, May 1977.

Table 2.
Township IDs for 49 Residences with Estimated Overall Turbine Facility Sound Levels (dBA) at or above 43 dBA for Proposed 120 GE 2.5xl Turbine Layout. (operating condition at maximum sound output for each turbine, i.e., A-weighted sound power level of 104.2 dBA with 8 m/s wind speed at 10m height)

Residence ID	Sound Level dBA
10000207132	46
10000207152	46
10000206061	46
10000207137	45
10000207157	45
10000207108	44
10000207169	44
10000207123	44
10000207151	44
10000205995	44
10000207106	44
10000207124	44
10000207168	44
10000206060	44
10000207136	44
10000207139	44
10000205998	44
10000206439	44
10000206020	43
10000207127	43
10000207131	43
10000207165	43
10000207167	43
10000205955	43
10000205957	43
10000206052	43
10000206055	43
10000207143	43
10000207164	43
10000201745	43
10000205954	43
10000206018	43
10000207129	43
10000206000	43
10000207118	43
10000206014	43
10000206051	43
10000206115	43
10000206395	43
10000205996	43
10000206469	43
10000207229	43
10000205987	43
10000206054	43
10000206282	43
10000206110	43
10000206382	43
10000205946	43
10000206105	43

Table 3.
Township IDs for 52 Residences with Estimated Overall Turbine Facility Sound Levels (dBA) at or above 45 dBA for Proposed 200 GE 1.5xle Turbine Layout. (operating condition at maximum sound output for each turbine, i.e., A-weighted sound power level of 104.1 dBA with 8 m/s wind speed at 10m height)

Residence ID	Sound Level dBA
10000207124	47
10000207137	47
10000207152	47
10000207169	47
10000206052	46
10000207145	46
10000207151	46
10000207127	46
10000207143	46
10000206054	46
10000207106	46
10000207126	46
10000206401	46
10000207144	46
10000206469	46
10000207125	46
10000206060	46
10000207157	46
10000207164	46
10000207168	46
10000207130	45
10000201742	45
10000207114	45
10000207139	45
10000205918	45
10000206061	45
10000207118	45
10000207132	45
10000207226	45
10000201745	45
10000207165	45
10000207167	45
10000207224	45
10000207163	45
10000206059	45
10000207108	45
10000206395	45
10000207122	45
10000207129	45
10000207136	45
10000205943	45
10000205955	45
10000206055	45
10000206391	45
10000206392	45
10000207128	45
10000207166	45
10000201741	45
10000206384	45
10000207115	45
10000207131	45
10000207229	45

Appendix A. Sound in Lay Terms

Sounds we hear come from small pressure oscillations, or sound waves, that travel through the air and actuate our hearing mechanism. These airborne pressure oscillations cause the eardrum and small bones of the middle ear to vibrate. These vibrations are transmitted to the fluid-filled cochlea of the inner ear's sensory organ. Sensory hair cells then transduce these vibrations into nerve impulses that are transmitted to the brain where they are perceived and interpreted.

Noise is often defined as unwanted sound and the degree of disturbance or annoyance of an intruding noise depends on various factors including the magnitude and nature of the intruding noise, the magnitude of the background or pre-development ambient sound present without the intruding noise, and the nature of the activity of people in the area where the noise is heard. For example, people relaxing at home generally prefer a quiet environment, while factory employees may be accustomed to relatively high noise levels when at work.

The magnitude, or loudness, of sound waves (pressure oscillations) is described quantitatively by the terms sound pressure level, sound level, or simply noise level. The magnitude of a sound is measured in decibels, abbreviated dB. Decibels are used to quantify sound pressure levels just as degrees are used to quantify temperature and inches are used to quantify distance. The faintest sound level that can be heard by a young healthy ear is about 0 dB, a moderate sound level is about 50 dB, and a loud sound level is about 100 dB.

Sound level meters are usually equipped with electronic filters or weighting circuits, as specified in ANSI S1.4 - 1983, for the purpose of simulating the frequency response characteristics of the human ear. The A-weighting filter included with essentially all sound level meters is most commonly employed for this purpose because the measured sound level data correlate well with subjective response to sounds. Sound levels measured using the A-weighting network are designated by dBA.

Sound energy spreads as it travels away from its source causing the sound level to diminish. Other factors that reduce sound levels include absorption in the atmosphere, diffraction and refraction in the atmosphere, terrain, and forests.

The frequency of a sound is analogous to its tonal quality or pitch. The unit for frequency is hertz, abbreviated Hz (formerly cycles per second or cps). Thus, if a sound wave oscillates 500 times per second, its frequency is 500 Hz. The fundamental frequency of Middle C on a piano keyboard, for example, is 262 Hz. However, most sounds include a composite of many frequencies and are characterized as broadband or random. The normal frequency range of human hearing extends from a low frequency of about 20 to 50 Hz (a rumbling sound) up to a high frequency of about 10,000 to 15,000 Hz (a hissing sound) or even higher for some people. People have different hearing sensitivity to different frequencies and generally hear best in the mid-frequency region that is common to human speech, about 500 to 4000 Hz.

The background or ambient acoustical environment in most communities varies from place to place and varies with time at any given location due to the composite of many nearby and distant sound sources. The ambient environment includes high sound level single-events such as the passby of an airplane or nearby car, the barking of a dog, thunder, or a siren. The ambient acoustical environment also includes relatively steady residual or background sounds caused by sources such as distant traffic and ventilation equipment. The quantity of the single-event sounds and the amplitude of the background sounds are usually least during the late night hours from about midnight to 5:00 am. Indeed, the pre-development ambient sound level at a location is typically related to the amount of human activity in its vicinity. The amplitude statistics of this rather complex acoustical environment include the presence of a relatively-steady lower-level background and diurnal and seasonal variations.

At any location, a complete physical description of the ambient acoustical environment might include its sound level at various frequencies, as a function of time. As a first step towards simplifying this multi-dimensional description, it has become common practice to eliminate the frequency variable by measuring the A-weighted sound level (dBA), as observed on a standard sound level meter. The A-weighting filter emphasizes the mid-frequency components of sounds to approximate the frequency response of the human ear. A-weighted sound levels correlate well with our perception of the loudness of most sounds.

An increase or decrease of the outdoor ambient sound level in a community by 1 or 2 dB is generally not noticeable. Whereas a change of the ambient sound level by 5 or 6 dB is generally noticeable and an increase or decrease of the ambient sound level by 10 dB is generally considered to represent a doubling or halving of the perceived sound.

To evaluate noise impacts and report time-varying ambient sound levels it is common practice, using the A-weighted scale, to measure the equivalent sound level and the day-night sound level. The equivalent sound level is the level of a steady-state sound that has the same total (equivalent) energy as the time-varying sound of interest, taken over a specified time period. Thus, the equivalent sound level is a single-valued level that expresses the time-averaged total energy of the entire ambient sound energy. It includes both the high sound level single-event ambient sounds and the relatively steady background sounds. The day-night sound level is simply the average equivalent sound for 24-hours after 10 dBA has been added to the nighttime sound levels from 10 pm to 7 am. Adding 10 dBA to the nighttime sound levels accounts for people's expectation that nighttime be a quiet period. The day-night sound level is calculated in accordance with the following relationship

$$\text{Day-night sound level} = 10\log\{[15(10^{0.1L_d}) + 9(10^{0.1L_n+10})]/24\}$$

where L_d is the equivalent sound level during daytime hours (7 a.m. - 10 p.m.) and L_n is the equivalent sound level during nighttime hours (10 p.m. - 7 a.m.).

The annual day-night sound level has been selected by the U.S. Environmental Protection Agency as the best descriptor to use for the purpose of identifying and evaluating levels of environmental sound. Both the equivalent sound level and the day-night sound levels have been selected by the U.S. Environmental Protection Agency (USEPA) as the best descriptors to use for the purpose of identifying and evaluating levels of environmental noise. The USEPA has identified an Ldn level of 55 dBA as protective of the health and welfare of humans. In addition, the Federal Energy Regulatory Commission (FERC) employs an Ldn level of 55 dBA as its criterion during review of proposed projects. Note that a steady sound level of 48 dBA at a receptor location during the daytime and nighttime hours of a 24-hour period will result in an Ldn level of about 55 dBA; this difference between the steady sound level and the Ldn sound level is due to the required adjustment of the nighttime sound levels in calculating Ldn.

Shadow Flicker Impact Analysis for the Hardin Wind Farm

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July 2009

complex world

CLEAR SOLUTIONS™

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TABLES

FIGURES

ATTACHMENT

1.0 OVERVIEW

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker, and can be a temporary phenomena experienced by people at nearby residences or public gathering places. The impact area depends on the time of year and day (which determines the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker generally occurs during low angle sunlight conditions, typical during sunrise and sunset times of the day. However, when the sun angle gets very low (less than 3 degrees), the light has to pass through more atmosphere and becomes too diffuse to form a coherent shadow. Shadow flicker will not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 1,500 meters is very low and generally considered imperceptible. Shadow flicker intensity for receptor-to-turbine distances between 1,000 and 1,500 meters (between 3,281 and 4,921 feet) is also low and considered barely noticeable. At this distance shadow flicker intensity would only tend to be noticed under conditions that would enhance the intensity difference, such as observing from a dark room with a single window directly facing the turbine casting the shadow. At distances less than 1,000 meters (3,281 feet), shadow flicker may be more noticeable. In general, the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurs nearest the wind turbines.

Shadow flicker intensity is also affected by the relative percentage of the solar disk which is masked (covered) by the turbine rotor. Studies suggest that when less than 20% of the solar disk is masked, the shadow will be too diffuse to cause a significant impact.

Ashtabula II Wind LLC is proposing to build 212 wind turbines as part of the Hardin Wind Farm (Project) in Hardin County, Ohio. Since the Project uses a minimum turbine siting setback requirement (to any residence) which ranges from 750 feet (228.6 meters) to 1000 feet (304.8 meters), depending on the resident's project participant status, sensitive receptors (homes) are generally not located in the worst case potential shadow flicker impact zones, which ensures that shadow flicker impacts are minimized.

The wind turbine being considered for the Project, and evaluated for potential shadow flicker impacts, has the following characteristics:

- **GE Wind Energy GE 1.5xle** – 3-blade 82.5-meter-diameter rotor, with a hub height of 80 meters. The GE 1.5xle has a nominal rotor speed of 18.0 rpm which translates to a blade pass frequency of 0.90 Hz (less than 1 alternation per second).

Shadow flicker frequency is related to the wind turbine's rotor blade speed and the number of blades on the rotor. From a health standpoint, such low frequencies are harmless. For comparison, strobe lights used in discotheques have frequencies which range from about 3 Hertz (Hz) to 10 Hz (1 Hz = 1 flash per second). As a result, public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy are unfounded. The Epilepsy Action (working name for the British Epilepsy Foundation), states that there is no evidence that wind turbines can cause seizures. However, they recommend that wind turbine flicker frequency be limited to 3 Hz (http://www.epilepsy.org.uk/info/photo_other.html). Since the proposed Project's wind turbine blade pass frequency is approximately 0.90 Hz (less than 1 alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

2.0 WINDPRO SHADOW FLICKER ANALYSIS

An analysis of potential shadow flicker impacts from the Project was conducted using the WindPro software package. The WindPro analysis was conducted to determine shadow flicker impacts under realistic impact conditions (actual expected shadow). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker could occur at receptors out to 1,500 meters (4,921.3 feet). The realistic impact condition scenario is based on the following assumptions:

- The elevation and position geometries of the wind turbines and surrounding receptors (houses). Elevations were determined using USGS digital elevation model (DEM) data. Positions geometries were determined using GIS and referenced to UTM Zone 14 (NAD83).
- The position of the sun and the incident sunlight relative to the wind turbine and receptors on a minute by minute basis over the course of a year.
- Historical sunshine hours availability (percent of total available). Historical sunshine rates for the area (as listed by the www.City-Data.com for nearby Kenton, OH) used in this analysis are as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
36%	42%	44%	51%	56%	60%	60%	60%	61%	56%	37%	31%

- Estimated wind turbine operations and orientation (based on approximately 1 year of data from 5/21/08 to 6/22/09 of on-site measured wind data (wind speed / wind direction frequency distribution)). The WindPro calculated wind direction frequency distribution for operating hour winds is as follows:

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW
4.1%	5.5%	7.7%	6.7%	4.9%	6.3%	8.7%	15.1%	13.1%	13.0%	9.1%	5.8%

- Receptor viewpoint (i.e., house windows) are assumed to always be directly facing turbine to sun line of sight ("greenhouse mode").

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. The sun's path with respect to each turbine location is calculated by the software to determine the cast shadow paths every minute over a full year. Sun angles less than 3 degrees above the horizon were excluded, for the reasons identified earlier in this section.

A total of 988 sensitive receptor locations were identified in the vicinity of the project area. These locations correspond to houses or other structures in the Project Area. A receptor in the model is defined as a 1 m^2 area (approximate size of a typical window), 1 meter (3.28 feet) aboveground level. Approximate eye level is set at 1.5 meters (4.94 feet). Figure 1 shows the sensitive receptor locations considered.

3.0 WINDPRO SHADOW FLICKER ANALYSIS RESULTS

WindPro predicts that shadow flicker impacts will primarily occur near the wind turbines. Figure 2 describes the WindPro predicted expected shadow flicker impact areas. A detailed WindPro shadow flicker analysis results summary, for each of the modeled receptor locations, is provided in Attachment A. Table 1 presents the WindPro predicted shadow flicker impacts for the top 10 most affected receptors for WindPro predicted expected shadow flicker impact. Only 4 of the 988 receptors modeled had shadow flicker impact predicted more than 50 hours per year.

Table 1. WindPro Predicted Shadow Flicker Impacts for Receptors with Maximum Impacts

Receptor ID	Shadow Hours per Year (expected) [hh:mm / year]
1737	55:28
888	53:41
636	52:36
627	52:16
826	49:53
943	47:46
695	47:44
645	47:20
647	44:21
660	44:11

The maximum predicted shadow flicker impact at any receptor, for the range of potential wind turbine options, is 55 hours, 28 minutes per year, which is only approximately 1.2 percent of the potential available daylight hours. As shown in the Tables in Attachment B, the shadow flicker impacts for this receptor occur during the morning hours for certain days of the year.

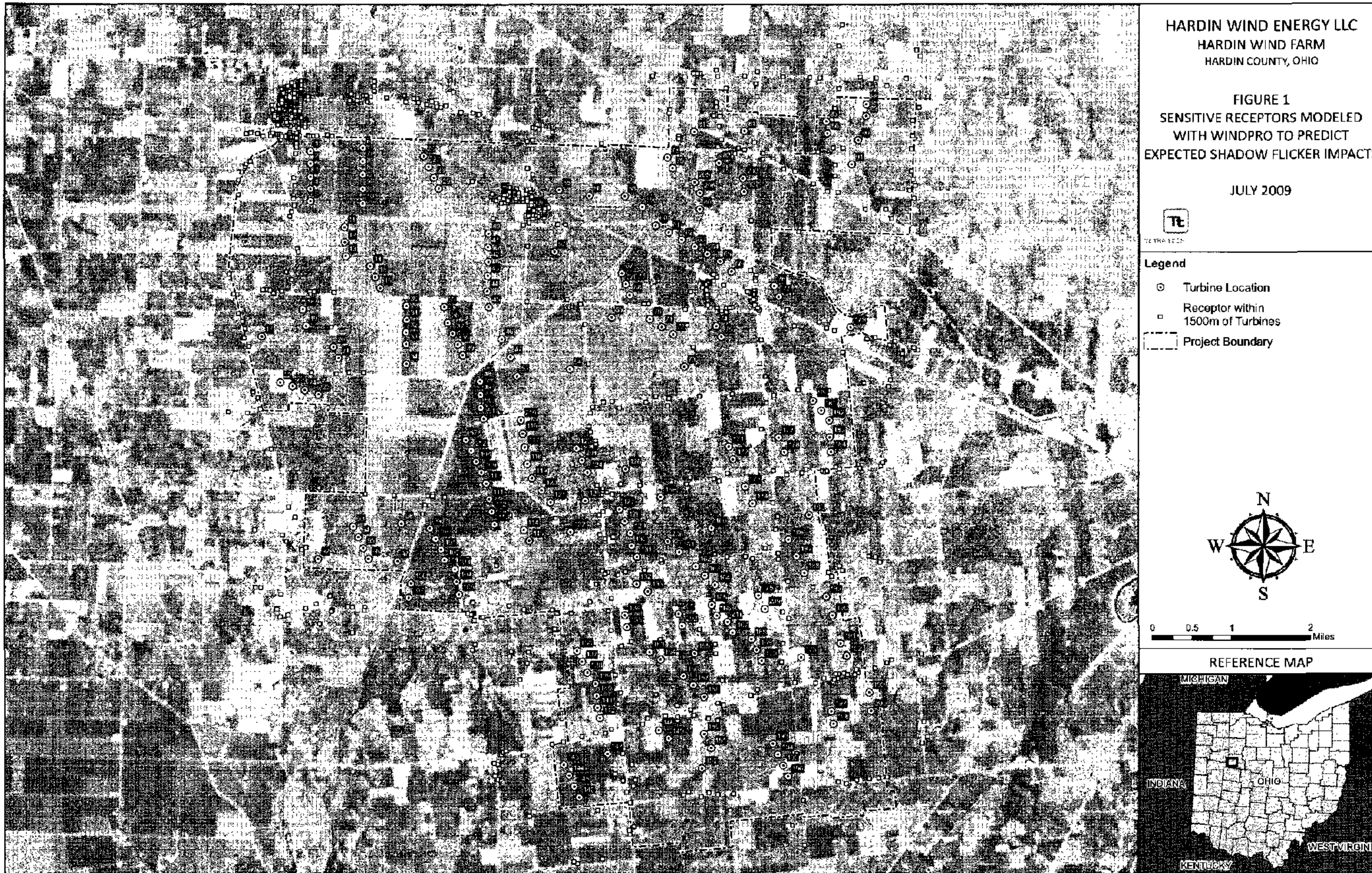
The overwhelming majority of the receptor locations evaluated have less than 50 hours per year of predicted shadow flicker impact. The shadow flicker impact prediction statistics are as summarized in Table 2.

Table 2. Statistical Summary of WindPro Predicted Shadow Flicker Impacts at Modeled Sensitive Receptor Locations

Cumulative Shadow Flicker Time (Expected)	Number of Receptors
Total	988
= 0 Hours	343
> 0 and < 10 Hours	466
≥ 10 and < 20 Hours	105
≥ 20 and < 30 Hours	44
≥ 30 and < 40 Hours	15
≥40 and < 50 hours	11
≥ 50 and < 60 hours	4
> 60 hours	0

4.0 CONCLUSION

The analysis of potential shadow flicker impacts from the Project on nearby houses (receptors) shows that shadow flicker impacts within the area of study are expected to be minor. The analysis assumes that the houses all have a direct in line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions which may block sunlight. In reality, the windows of many houses will not face the sun directly for the key shadow flicker impact times. In addition, potential shadow flicker impacts for wind turbines up to 1,500 meters (4,921 feet) away were determined. In reality, the shadow flicker impacts for turbines beyond 1,000 meters (3,281 feet) will be very low intensity. In addition, shadow flicker has been predicted for all periods when any portion the turbine rotor masks (covers) the sun's disc. Typically, periods when the solar disc is masked less than 20%, will not cause a significant shadow flicker impact. For these reasons, shadow flicker impacts are expected to be less than estimated with this conservative analysis, and shadow flicker is not expected to be a significant environmental impact.



HARDIN WIND ENERGY LLC
HARDIN WIND FARM
HARDIN COUNTY, OHIO

FIGURE 1
SENSITIVE RECEPTORS MODELED WITH WINDPRO TO PREDICT EXPECTED SHADOW FLICKER IMPACTS

JULY 2009


HARDIN WIND ENERGY LLC
HARDIN WIND FARM
HARDIN COUNTY, OHIO
FIGURE 2
WINDPRO PREDICTED EXPECTED
SHADOW FLICKER IMPACT AREAS
JULY 2009
Legend
Turbine Location
Receptor within 1500m of Turbines
Project Boundary
Shadow Flicker Iso Line
10 hrs/yr
25 hrs/yr
50 hrs/yr
100 hrs/yr
200 hrs/yr
N
W
E
S
0
0.5
1
2
Miles
REFERENCE MAP
MICHIGAN
INDIANA
OHIO
WEST VIRGINIA
KENTUCKY

ATTACHMENT A

Detailed Summary of WindPro Shadow Flicker Analysis Results

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
104	270342	4495032	0:00:00
164	271206	4496319	1:42:00
174	268882	4496101	2:06:00
175	268811	4495761	0:00:00
176	270090	4495448	0:00:00
177	270321	4495969	0:00:00
284	259844	4501856	1:26:00
309	259589	4501484	3:42:00
313	259142	4500384	1:29:00
314	259555	4500247	0:00:00
317	259033	4500393	3:06:00
318	259012	4501596	0:25:00
324	259665	4501356	4:24:00
325	259979	4501182	19:15:00
326	260568	4500214	0:00:00
327	261029	4499985	2:10:00
328	260067	4501226	25:03:00
329	260928	4499998	1:25:00
330	260283	4500056	0:00:00
331	261288	4499985	4:23:00
332	261272	4499919	2:35:00
334	259696	4499819	0:00:00
335	260069	4499958	0:00:00
336	260615	4499929	0:00:00
341	261036	4499457	0:00:00
342	260595	4499895	0:00:00
343	260348	4499638	0:00:00
346	259475	4499945	0:00:00
347	259538	4499782	0:00:00
413	262936	4502285	12:07:00
414	262589	4502300	7:53:00
415	262473	4501925	15:56:00
416	262529	4502116	9:23:00
417	261889	4502306	0:52:00
418	262684	4502339	9:38:00
419	262679	4502295	7:17:00
420	261297	4502340	1:59:00
421	259715	4502071	0:31:00
422	260605	4502426	0:00:00
423	260340	4502469	0:00:00
515	266844	4495419	3:30:00
582	266193	4494742	0:00:00
583	266763	4495259	0:00:00
584	266750	4495345	0:00:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
623	266312	4500701	6:21:00
624	266254	4501346	32:30:00
625	266386	4500161	8:27:00
626	267074	4500744	4:59:00
627	266417	4501440	52:16:00
628	266679	4500710	22:14:00
629	266256	4501399	24:50:00
630	266514	4500646	13:24:00
631	266787	4499261	19:46:00
632	268197	4499520	39:15:00
633	267376	4499311	23:45:00
634	267733	4499021	43:28:00
635	266586	4499174	15:40:00
636	268398	4498915	52:36:00
637	267294	4498162	10:53:00
638	266559	4498205	33:54:00
639	265262	4499855	1:08:00
640	265208	4499527	3:04:00
641	266457	4498571	27:48:00
642	264486	4498483	4:28:00
643	264655	4499042	4:07:00
644	266319	4499900	26:15:00
645	266383	4498285	47:20:00
646	265544	4499855	3:57:00
647	266375	4499494	44:21:00
648	264632	4498805	5:26:00
649	266147	4501491	18:43:00
650	266202	4500729	16:43:00
651	265936	4500088	10:56:00
652	266257	4500672	6:10:00
653	266074	4500452	4:20:00
654	264143	4501198	20:28:00
655	264008	4500850	8:47:00
656	263699	4499774	0:00:00
657	263732	4499778	0:00:00
658	263529	4499861	1:14:00
659	263513	4500084	4:22:00
660	263417	4500996	44:11:00
661	263260	4499914	4:52:00
662	264579	4499924	1:39:00
663	264261	4500013	3:41:00
664	264262	4500497	4:41:00
665	265171	4499920	0:28:00
666	266863	4497499	22:33:00

Attachment A

Hardin Wind Farm

WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
667	267115	4497675	23:28:00
668	267490	4497728	12:04:00
669	268568	4497983	24:03:00
670	268561	4497627	14:40:00
671	268014	4497848	5:45:00
672	268076	4497739	3:20:00
673	267735	4497696	18:12:00
674	267017	4497547	26:35:00
675	268370	4497676	4:26:00
676	267718	4497944	12:31:00
677	266801	4496711	19:44:00
678	267855	4496072	0:00:00
679	268383	4496119	0:00:00
680	267964	4496135	0:00:00
681	266871	4496383	3:03:00
682	266830	4496258	3:22:00
683	266766	4495908	3:41:00
684	268228	4496042	0:00:00
685	268566	4496087	3:39:00
686	266089	4495754	0:00:00
688	265674	4494645	0:00:00
689	265596	4494675	0:00:00
692	265145	4497127	1:04:00
693	265767	4497288	5:15:00
694	266059	4497367	1:18:00
695	266510	4497961	47:44:00
696	266249	4497358	2:12:00
697	266457	4496513	10:02:00
698	266691	4496128	4:51:00
699	266383	4497438	2:55:00
700	265381	4497184	1:49:00
701	266616	4496375	5:31:00
702	266611	4496935	27:32:00
703	265555	4496999	3:24:00
704	263544	4499702	0:32:00
706	264270	4498963	1:23:00
707	264301	4499056	1:26:00
708	264320	4499496	0:39:00
709	263551	4499210	0:00:00
710	263494	4499089	0:00:00
711	263416	4499860	2:25:00
719	263487	4499829	1:41:00
776	264686	4495627	3:31:00
779	263947	4496735	0:36:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
780	264095	4496917	1:20:00
781	264557	4496908	6:20:00
783	264025	4496399	1:34:00
789	263963	4496475	0:45:00
790	264027	4496715	1:15:00
795	264142	4496972	1:25:00
796	264192	4496997	1:35:00
801	267141	4506298	21:00:00
802	267042	4506300	4:07:00
803	265901	4505040	12:20:00
804	265829	4505858	12:17:00
805	267898	4506181	20:23:00
806	267930	4505850	43:15:00
807	266219	4504255	0:00:00
808	265992	4504141	0:00:00
809	266402	4504263	0:00:00
810	267095	4504256	0:00:00
811	267303	4504366	0:00:00
812	267541	4504180	0:00:00
813	267572	4504326	0:00:00
814	266551	4504130	0:00:00
815	266067	4503335	25:17:00
816	266205	4502438	18:13:00
817	266975	4502509	11:21:00
818	266057	4503439	12:17:00
819	266065	4503370	17:08:00
820	267623	4502576	7:43:00
821	267992	4502680	16:44:00
822	266578	4502539	12:23:00
823	267931	4502545	10:20:00
824	267654	4502499	27:25:00
825	266399	4502334	8:38:00
826	266213	4501971	49:53:00
827	266175	4502315	29:21:00
828	266285	4502368	13:17:00
829	265221	4501830	20:44:00
830	266130	4501891	43:42:00
831	266078	4502424	28:37:00
832	266083	4502522	4:03:00
833	265943	4504023	0:58:00
834	265458	4506382	7:15:00
835	265920	4503736	2:35:00
836	265734	4506288	12:42:00
837	265949	4503628	2:24:00

Attachment A

Hardin Wind Farm

WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
838	264964	4501872	27:14:00
839	264292	4501903	43:54:00
845	269754	4501604	28:18:00
846	269809	4500974	28:51:00
847	269281	4500989	10:24:00
848	269133	4501035	13:21:00
849	268761	4501028	13:53:00
850	269542	4501204	26:20:00
851	269806	4501101	19:40:00
852	270010	4500511	11:03:00
853	272791	4497599	4:11:00
854	272867	4497285	1:48:00
865	272718	4498459	4:04:00
883	270145	4498417	4:32:00
884	270566	4498409	5:19:00
885	269243	4498152	3:15:00
886	268677	4497948	23:51:00
887	269377	4498274	3:00:00
888	269865	4498845	53:41:00
889	269902	4499882	28:42:00
890	268652	4498462	18:06:00
891	270023	4499750	27:13:00
892	269899	4499232	33:03:00
893	271070	4500841	9:58:00
894	270843	4500704	17:16:00
895	271813	4501029	0:00:00
897	271685	4501046	0:38:00
898	270525	4500404	18:52:00
899	270737	4498513	4:19:00
900	272510	4498895	1:15:00
901	271794	4498717	12:39:00
902	271026	4498503	6:49:00
904	271441	4498634	0:56:00
905	271418	4498688	1:00:00
906	271374	4498582	3:51:00
907	270956	4498481	4:15:00
908	271226	4498579	10:02:00
909	271042	4498599	9:12:00
910	270992	4498596	11:48:00
911	272129	4498898	3:51:00
912	270911	4500625	11:02:00
913	271139	4500746	7:12:00
914	271149	4498622	9:17:00
915	271908	4500917	1:53:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
916	272033	4498830	5:41:00
917	272762	4497151	0:00:00
918	271876	4496437	0:00:00
919	271042	4496355	3:59:00
920	271681	4496422	0:00:00
921	272039	4496456	0:00:00
922	271418	4496391	0:29:00
933	272745	4499003	0:11:00
943	270182	4496933	47:46:00
944	267427	4500909	25:01:00
945	268508	4501082	19:07:00
946	268394	4500996	33:07:00
947	267408	4500967	41:32:00
948	268515	4499009	32:37:00
949	268503	4499204	23:23:00
950	269327	4506811	38:09:00
951	269336	4506774	39:24:00
952	271569	4504655	4:33:00
953	272113	4504720	0:00:00
954	271132	4505293	0:00:00
955	270129	4505837	1:07:00
956	270800	4505793	9:22:00
957	269980	4506172	1:31:00
958	271793	4505596	15:41:00
959	270962	4505744	36:39:00
960	271634	4505572	0:00:00
961	269342	4506891	27:50:00
962	270218	4504511	15:56:00
963	270649	4505913	4:19:00
964	272672	4505330	0:31:00
974	272589	4505372	0:42:00
976	272100	4505443	5:16:00
977	272198	4505514	2:28:00
978	272362	4505263	3:05:00
979	269705	4502826	15:18:00
980	268765	4502761	13:03:00
981	269563	4504240	4:22:00
982	269461	4503692	18:55:00
988	269794	4501876	15:55:00
989	272076	4504585	1:25:00
990	270854	4504494	15:17:00
991	271957	4502996	3:42:00
992	271527	4502939	11:17:00
993	270997	4502900	3:30:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
994	268596	4502612	11:57:00
995	269980	4502747	7:20:00
996	269693	4502156	18:28:00
997	271917	4502922	3:49:00
998	271071	4502854	2:46:00
999	271490	4502886	6:27:00
1000	270719	4502820	7:28:00
1001	270765	4502801	6:35:00
1002	270815	4502822	3:31:00
1003	270290	4502777	3:39:00
1004	270375	4502848	2:30:00
1005	269452	4505552	5:17:00
1006	269409	4506166	4:50:00
1007	268852	4506222	5:43:00
1008	268738	4506203	8:20:00
1009	268549	4506209	7:26:00
1010	268001	4506542	8:49:00
1011	268060	4505389	15:24:00
1012	268730	4506122	6:36:00
1013	268470	4506769	1:24:00
1014	268538	4506848	24:55:00
1015	268803	4506209	6:49:00
1016	268467	4506893	25:34:00
1017	269231	4506996	28:39:00
1018	268647	4506140	7:07:00
1019	268681	4506675	2:36:00
1020	269719	4504395	6:13:00
1021	269543	4504786	2:03:00
1022	268867	4504413	2:06:00
1023	268195	4504376	0:00:00
1024	268493	4502656	7:29:00
1025	268402	4506745	7:17:00
1026	268407	4506723	2:13:00
1027	268382	4506710	2:14:00
1028	268361	4506761	16:37:00
1029	268361	4506748	13:44:00
1030	268354	4506721	7:30:00
1031	268291	4506712	11:59:00
1032	268322	4506683	2:00:00
1033	268307	4506617	1:45:00
1034	268331	4506556	2:00:00
1035	268330	4506532	1:59:00
1036	268252	4506640	2:16:00
1037	269309	4506568	31:26:00

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Hardin Wind Farm

WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1038	269314	4506504	25:05:00
1039	269283	4506490	23:30:00
1040	269233	4506511	25:54:00
1041	269190	4506533	16:33:00
1042	269161	4506546	13:34:00
1043	269259	4506365	11:09:00
1044	269321	4506403	12:10:00
1045	269264	4506331	13:53:00
1046	269297	4506379	12:25:00
1047	269322	4506267	21:44:00
1048	269380	4506203	2:14:00
1049	268402	4506218	6:42:00
1050	268360	4506287	4:00:00
1051	268360	4506266	4:01:00
1052	268354	4506494	3:24:00
1053	268351	4506435	4:48:00
1054	268346	4506472	4:00:00
1055	268331	4506579	2:00:00
1140	272710	4511448	1:36:00
1143	271118	4512105	0:00:00
1145	271490	4511017	0:00:00
1146	271815	4510996	3:57:00
1147	272430	4510981	6:39:00
1148	272636	4511570	0:00:00
1152	271049	4511671	0:00:00
1159	268524	4511157	0:00:00
1160	269371	4511128	0:00:00
1165	269319	4509660	4:52:00
1166	269112	4509495	10:05:00
1167	268601	4510194	13:17:00
1168	268983	4509538	13:54:00
1169	268558	4511031	0:00:00
1170	268592	4509997	15:07:00
1171	268641	4509708	27:39:00
1172	268472	4510212	11:16:00
1173	269338	4510874	0:00:00
1174	269363	4510613	0:36:00
1175	268727	4510780	0:00:00
1176	268527	4510394	2:58:00
1177	269110	4511037	0:00:00
1178	268528	4510490	0:00:00
1179	270451	4511010	2:27:00
1180	270657	4511001	3:07:00
1181	270932	4509541	25:57:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1182	269888	4511029	0:00:00
1183	270617	4509458	7:42:00
1184	270960	4510366	17:41:00
1185	271053	4510774	10:02:00
1186	271137	4509536	0:00:00
1187	272035	4510845	14:45:00
1188	272567	4509787	5:20:00
1189	272541	4509512	2:30:00
1190	272569	4510103	5:39:00
1193	272690	4510377	5:10:00
1195	272677	4510677	3:56:00
1203	269484	4509425	5:04:00
1204	267223	4511040	0:00:00
1205	267566	4510261	6:48:00
1206	267577	4510339	2:52:00
1207	267763	4509787	36:30:00
1208	267764	4509731	11:56:00
1209	268187	4511090	0:00:00
1210	268135	4511094	0:00:00
1211	268058	4511095	0:00:00
1212	268917	4509416	23:41:00
1213	268835	4509448	26:17:00
1214	266621	4509557	3:41:00
1218	269698	4507821	1:55:00
1219	270227	4507803	0:00:00
1220	270855	4507773	0:00:00
1278	269253	4508023	6:20:00
1285	272588	4508485	2:00:00
1286	271034	4508607	0:00:00
1287	271597	4508268	0:00:00
1288	272136	4508078	0:00:00
1290	270972	4508954	0:00:00
1291	272023	4508267	0:00:00
1292	268566	4509562	2:56:00
1298	272580	4508871	0:55:00
1299	272622	4508754	0:53:00
1302	272537	4509052	2:06:00
1303	272509	4508647	1:35:00
1304	270972	4509188	19:18:00
1305	269484	4509310	4:33:00
1306	269919	4509096	6:38:00
1307	270148	4509058	5:57:00
1308	270530	4508792	2:51:00
1309	270822	4508646	0:00:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1440	261323	4510507	0:00:00
1442	261475	4510932	0:00:00
1445	261250	4510636	0:00:00
1447	261471	4510726	0:00:00
1448	261477	4510836	0:00:00
1449	261399	4510607	0:00:00
1450	261163	4510604	0:00:00
1452	261304	4510634	0:00:00
1453	261731	4510589	0:00:00
1456	262287	4510574	0:00:00
1457	262363	4510568	0:00:00
1460	262944	4510427	0:00:00
1461	262743	4510475	0:00:00
1462	262118	4510507	0:00:00
1463	262378	4510489	0:00:00
1464	262660	4510514	0:00:00
1465	263112	4510707	0:00:00
1466	262089	4510632	0:00:00
1467	262756	4510399	0:00:00
1469	262847	4510386	0:00:00
1475	262558	4510451	0:00:00
1480	263266	4510286	0:00:00
1481	263635	4510245	0:00:00
1489	263518	4510271	0:00:00
1491	264636	4509666	0:00:00
1495	264736	4509694	0:00:00
1496	264811	4510026	0:00:00
1497	264938	4510015	0:00:00
1498	264876	4510016	0:00:00
1499	264840	4510020	0:00:00
1502	264759	4509957	0:00:00
1503	264815	4509950	0:00:00
1506	265160	4509870	0:00:00
1511	264884	4509924	0:00:00
1513	264735	4509512	0:00:00
1520	259909	4510931	0:00:00
1521	259907	4510915	0:00:00
1522	259907	4510894	0:00:00
1523	259802	4510884	0:00:00
1524	259762	4510896	0:00:00
1543	259537	4510808	0:00:00
1544	259525	4510772	0:00:00
1545	259532	4510754	0:00:00
1546	259562	4510623	0:00:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1547	259565	4510666	0:00:00
1548	259559	4510693	0:00:00
1549	259564	4510741	0:00:00
1550	259567	4510757	0:00:00
1551	259634	4510800	0:00:00
1552	259643	4510772	0:00:00
1553	259628	4510736	0:00:00
1554	259637	4510723	0:00:00
1555	259642	4510694	0:00:00
1556	259644	4510662	0:00:00
1557	259684	4510728	0:00:00
1558	259680	4510786	0:00:00
1559	259681	4510804	0:00:00
1560	259685	4510834	0:00:00
1561	259759	4510797	0:00:00
1562	259758	4510772	0:00:00
1563	259731	4510724	0:00:00
1564	259817	4510782	0:00:00
1565	259847	4510836	0:00:00
1566	259904	4510859	0:00:00
1567	259903	4510825	0:00:00
1568	259900	4510796	0:00:00
1569	259895	4510780	0:00:00
1570	259901	4510767	0:00:00
1571	259838	4510731	0:00:00
1572	259902	4510744	0:00:00
1573	259896	4510720	0:00:00
1574	259897	4510684	0:00:00
1575	259893	4510657	0:00:00
1576	259845	4510677	0:00:00
1577	259789	4510682	0:00:00
1578	259838	4510628	0:00:00
1579	259889	4510639	0:00:00
1580	259593	4510692	0:00:00
1581	259819	4510621	0:00:00
1582	259815	4510679	0:00:00
1583	259954	4510742	0:00:00
1584	259957	4510874	0:00:00
1585	259955	4510791	0:00:00
1587	259951	4510666	0:00:00
1588	259951	4510688	0:00:00
1589	259953	4510720	0:00:00
1590	259958	4510906	0:00:00
1592	259956	4510826	0:00:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1594	259960	4510937	0:00:00
1596	259955	4510767	0:00:00
1597	259961	4510849	0:00:00
1599	261130	4510605	0:00:00
1600	260965	4510522	0:00:00
1601	259987	4510565	0:00:00
1602	260058	4510562	0:00:00
1603	260499	4509815	10:23:00
1604	260601	4509787	17:59:00
1605	260570	4510547	0:00:00
1606	260792	4510606	0:00:00
1607	261116	4510526	0:00:00
1608	260108	4510556	0:00:00
1609	260999	4510660	0:00:00
1610	259492	4510422	0:00:00
1611	259710	4510193	0:00:00
1612	259529	4510626	0:00:00
1613	259675	4510515	0:00:00
1614	259671	4510500	0:00:00
1615	259683	4510470	0:00:00
1616	259671	4510438	0:00:00
1617	259671	4510421	0:00:00
1618	259672	4510356	0:00:00
1619	259668	4510312	0:00:00
1620	259674	4510274	0:00:00
1621	259667	4510259	0:00:00
1622	259674	4510227	0:00:00
1623	259631	4510225	0:00:00
1624	259620	4510241	0:00:00
1625	259630	4510274	0:00:00
1626	259631	4510305	0:00:00
1627	259632	4510322	0:00:00
1628	259616	4510340	0:00:00
1629	259634	4510387	0:00:00
1630	259639	4510420	0:00:00
1631	259637	4510434	0:00:00
1632	259638	4510481	0:00:00
1633	259637	4510518	0:00:00
1634	259639	4510547	0:00:00
1635	259642	4510565	0:00:00
1636	259642	4510582	0:00:00
1637	259642	4510597	0:00:00
1638	259521	4510596	0:00:00
1639	259521	4510587	0:00:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1640	259520	4510576	0:00:00
1641	259517	4510555	0:00:00
1642	259528	4510554	0:00:00
1643	259538	4510553	0:00:00
1644	259587	4510585	0:00:00
1645	259585	4510593	0:00:00
1646	259529	4510471	0:00:00
1647	259583	4510438	0:00:00
1648	259558	4510421	0:00:00
1649	259555	4510387	0:00:00
1650	259561	4510356	0:00:00
1651	259557	4510279	0:00:00
1652	259556	4510258	0:00:00
1653	259556	4510230	0:00:00
1654	259580	4510233	0:00:00
1655	259521	4510394	0:00:00
1656	259526	4510427	0:00:00
1657	259525	4510441	0:00:00
1658	259582	4510551	0:00:00
1659	259592	4510551	0:00:00
1660	259587	4510574	0:00:00
1661	259562	4510555	0:00:00
1662	259572	4510552	0:00:00
1663	259564	4510467	0:00:00
1664	259565	4510194	0:00:00
1665	259627	4510181	0:00:00
1666	259627	4510196	0:00:00
1667	259668	4510195	0:00:00
1668	259670	4510174	0:00:00
1669	259880	4510505	0:00:00
1670	259813	4510507	0:00:00
1671	259746	4510502	0:00:00
1672	259744	4510481	0:00:00
1673	259742	4510463	0:00:00
1674	259809	4510463	0:00:00
1675	259883	4510462	0:00:00
1676	259881	4510433	0:00:00
1677	259882	4510414	0:00:00
1678	259786	4510418	0:00:00
1679	259789	4510434	0:00:00
1680	259746	4510437	0:00:00
1681	259742	4510418	0:00:00
1682	259746	4510400	0:00:00
1683	259746	4510381	0:00:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1684	259781	4510380	0:00:00
1685	259779	4510401	0:00:00
1686	259828	4510386	0:00:00
1687	259893	4510395	0:00:00
1688	259886	4510377	0:00:00
1689	259849	4510346	0:00:00
1690	259869	4510309	0:00:00
1691	259785	4510299	0:00:00
1692	259780	4510317	0:00:00
1693	259784	4510339	0:00:00
1694	259727	4510359	0:00:00
1695	259746	4510337	0:00:00
1696	259747	4510318	0:00:00
1697	259743	4510239	0:00:00
1698	259741	4510221	0:00:00
1699	259780	4510255	0:00:00
1700	259782	4510270	0:00:00
1701	259846	4510271	0:00:00
1702	259892	4510268	0:00:00
1703	259887	4510252	0:00:00
1704	259881	4510218	0:00:00
1705	259780	4510239	0:00:00
1706	259828	4510236	0:00:00
1707	259815	4510582	0:00:00
1708	259842	4510303	0:00:00
1709	259945	4510552	0:00:00
1710	259949	4510503	0:00:00
1711	259948	4510467	0:00:00
1712	259946	4510429	0:00:00
1713	259944	4510388	0:00:00
1714	259946	4510348	0:00:00
1715	259935	4510282	0:00:00
1716	259925	4510252	0:21:00
1717	259935	4510231	0:23:00
1718	259937	4510302	0:00:00
1719	259950	4510617	0:00:00
1720	259950	4510641	0:00:00
1721	259990	4510620	0:00:00
1722	260017	4510619	0:00:00
1723	260041	4510618	0:00:00
1724	260067	4510618	0:00:00
1725	260120	4510615	0:00:00
1726	260096	4510616	0:00:00
1727	264757	4508974	5:37:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1728	263948	4508535	3:29:00
1729	263957	4508470	2:47:00
1730	263499	4508844	14:04:00
1731	263888	4508531	4:09:00
1732	263912	4508579	3:39:00
1733	263941	4508069	4:56:00
1734	263991	4508441	2:43:00
1735	264065	4508506	2:29:00
1736	264640	4509113	4:48:00
1737	259859	4509416	55:28:00
1738	259837	4508759	25:05:00
1739	259825	4508369	37:06:00
1740	259769	4508212	2:22:00
1741	259830	4508334	36:04:00
1743	258747	4509039	2:12:00
1744	259814	4508540	32:18:00
1745	259810	4508491	16:00:00
1746	258813	4509150	2:25:00
1747	258838	4509202	2:35:00
1748	258924	4509257	3:40:00
1749	258677	4508868	0:50:00
1750	259816	4508921	32:00:00
1753	258668	4508562	0:48:00
1770	258479	4506913	0:00:00
1771	259271	4506592	2:30:00
1772	259567	4506562	6:39:00
1774	259743	4508114	3:00:00
1776	259655	4506955	2:29:00
1777	259181	4506584	2:33:00
1779	259770	4506801	3:30:00
1781	259322	4506582	2:57:00
1783	260190	4506543	4:23:00
1784	260634	4506535	11:53:00
1785	260263	4506566	6:10:00
1786	260226	4506541	5:34:00
1787	259891	4507434	8:54:00
1788	259908	4507363	4:12:00
1789	260141	4506544	3:10:00
1790	264646	4507479	17:10:00
1791	264627	4506330	6:05:00
1792	260589	4505814	8:06:00
1793	260959	4504873	11:52:00
1794	261262	4504866	11:32:00
1795	260153	4506493	4:26:00

Attachment A
Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1796	258641	4506486	0:30:00
1797	258788	4505585	21:38:00
1798	258893	4505413	2:13:00
1799	258766	4505926	11:46:00
1800	258572	4506501	0:24:00
1801	258670	4506094	2:40:00
1802	258811	4505777	14:23:00
1803	259398	4506519	3:53:00
1808	258106	4505676	1:24:00
1823	258190	4504917	0:30:00
1824	259083	4504340	10:43:00
1825	258984	4504459	21:55:00
1826	258467	4504053	0:56:00
1827	259135	4504111	8:02:00
1828	258205	4504854	0:33:00
1829	259355	4503274	0:00:00
1831	258864	4504030	1:49:00
1832	260690	4504842	8:08:00
1833	260184	4504864	17:24:00
1834	264209	4508767	1:45:00
1835	264209	4508644	1:56:00
1836	264313	4508635	1:53:00
1837	264339	4508634	2:06:00
1838	264333	4508586	2:09:00
1839	264336	4508513	2:16:00
1840	264308	4508512	2:06:00
1841	264339	4508473	2:24:00
1842	264319	4508436	2:22:00
1843	264229	4508512	2:14:00
1844	264189	4508438	2:09:00
1845	264182	4508404	2:10:00
1846	264246	4508402	2:28:00
1847	264106	4508389	2:03:00
1848	264665	4508023	7:50:00
1849	264705	4508632	7:11:00
1850	264605	4508063	5:01:00
1851	264194	4508479	2:08:00
1852	264634	4508655	5:32:00
1853	264618	4508106	3:57:00
1854	264261	4508442	2:24:00
1855	264287	4508438	2:08:00
1856	264204	4508536	2:07:00
1857	264275	4508476	2:26:00
1858	264289	4508510	2:25:00

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Hardin Wind Farm

WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1859	264256	4508479	2:19:00
1860	264274	4508516	2:21:00
1861	264613	4508138	3:54:00
1862	264210	4508670	1:53:00
1863	264697	4508672	6:32:00
1864	264208	4508620	1:58:00
1865	264208	4508590	2:02:00
1866	264240	4508446	2:19:00
1867	264270	4508627	2:10:00
1868	264674	4507973	8:53:00
1869	265046	4508344	3:57:00
1870	264563	4507920	12:26:00
1871	264209	4508561	2:04:00
1872	264679	4508535	7:58:00
1873	264679	4508501	8:55:00
1874	264677	4508476	9:57:00
1875	264677	4508416	14:54:00
1876	264723	4508416	15:18:00
1877	264723	4508450	16:56:00
1878	264725	4508487	12:27:00
1879	264728	4508513	10:45:00
1880	264802	4508412	10:01:00
1881	264802	4508446	16:51:00
1882	264829	4508447	15:26:00
1883	264830	4508432	11:41:00
1884	264833	4508423	8:43:00
1885	264829	4508411	5:52:00
1886	264865	4508409	3:54:00
1887	264911	4508444	3:52:00
1888	264911	4508432	3:51:00
1889	264917	4508419	3:43:00
1890	264963	4508421	3:29:00
1891	264988	4508405	3:32:00
1892	265009	4508402	3:34:00
1893	264680	4508377	12:38:00
1894	264676	4508365	11:34:00
1895	264671	4508306	4:42:00
1896	264745	4508360	4:53:00
1897	264748	4508388	10:24:00
1898	264780	4508385	6:06:00
1899	264784	4508359	4:09:00
1900	264777	4508332	4:01:00
1901	264860	4508328	3:21:00
1902	264860	4508370	3:35:00

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Hardin Wind Farm

WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1903	264860	4508386	3:49:00
1904	264891	4508385	3:32:00
1905	264918	4508385	3:26:00
1906	264891	4508328	3:19:00
1907	264967	4508382	3:27:00
1908	264998	4508381	3:30:00
1909	265000	4508368	3:31:00
1910	264998	4508350	3:37:00
1911	264999	4508321	3:42:00
1912	264736	4508284	3:44:00
1913	264667	4508285	4:50:00
1914	264719	4508319	4:26:00
1915	264722	4508385	11:51:00
1916	264285	4508716	2:00:00
1917	264265	4508718	1:54:00
1918	264203	4508700	1:47:00
1919	264172	4508767	2:07:00
1920	264151	4508741	2:06:00
1921	264168	4508725	2:09:00
1922	264169	4508672	2:13:00
1923	264167	4508654	2:14:00
1924	264162	4508641	2:18:00
1925	264163	4508625	2:17:00
1926	264166	4508590	1:58:00
1927	264166	4508571	1:58:00
1928	264167	4508556	2:01:00
1929	264156	4508492	1:59:00
1930	264416	4508680	2:23:00
1931	264365	4508627	2:13:00
1932	264413	4508555	2:47:00
1933	264372	4508590	2:21:00
1934	264376	4508558	2:29:00
1935	264374	4508511	2:32:00
1936	264413	4508536	2:48:00
1937	264413	4508520	2:50:00
1938	264413	4508508	2:51:00
1939	264359	4508462	2:35:00
1940	264368	4508429	2:50:00
1941	264442	4508427	4:12:00
1942	264454	4508427	4:25:00
1943	264482	4508426	4:57:00
1944	264478	4508461	4:30:00
1945	264454	4508531	3:43:00
1946	264452	4508592	3:28:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
1947	264530	4508473	5:18:00
1948	264526	4508439	5:43:00
1949	264563	4508424	7:07:00
1950	264562	4508469	6:02:00
1951	264637	4508470	8:18:00
1952	264637	4508424	12:00:00
1953	264442	4508468	3:53:00
1954	264413	4508430	3:21:00
1955	264398	4508473	2:53:00
1956	264615	4508569	5:52:00
1970	259451	4509823	4:28:00
1971	259073	4509833	1:47:00
1972	258927	4509860	1:10:00
1973	258836	4509836	0:55:00
1977	259415	4509825	4:53:00
1978	259479	4509822	4:01:00
1979	259337	4509827	4:50:00
1984	259379	4509839	4:44:00
1985	260107	4509803	2:48:00
1986	260124	4509787	2:56:00
1987	260168	4509789	3:16:00
1988	260222	4509789	3:20:00
1989	260286	4509794	2:43:00
1990	266176	4509621	0:34:00
1991	259178	4509787	2:29:00
1992	259525	4509702	8:30:00
1993	259549	4509729	7:38:00
1994	259868	4509716	16:00:00
1995	259865	4509674	15:02:00
1996	259866	4509591	18:11:00
1997	259866	4509631	15:58:00
1998	259865	4509554	23:59:00
1999	259343	4509784	4:36:00
2003	265265	4507946	0:29:00
2004	265438	4507940	2:42:00
2005	259432	4510120	0:13:00
2006	259365	4510201	0:00:00
2007	259497	4510225	0:00:00
2008	259484	4510281	0:00:00
2009	259419	4510283	0:00:00
2010	259412	4510239	0:00:00
2011	259356	4510430	0:00:00
2012	259491	4510068	0:51:00
2013	259380	4510329	0:00:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
2014	259912	4509867	0:57:00
2015	259913	4509827	0:59:00
2016	259910	4509797	4:53:00
2017	259933	4509796	3:26:00
2018	259915	4509887	0:54:00
2019	259740	4510157	0:00:00
2020	259738	4509983	0:00:00
2021	259801	4510028	0:00:00
2022	259832	4510173	0:00:00
2023	259820	4510138	0:00:00
2024	259845	4510110	0:00:00
2025	259845	4510091	0:23:00
2026	259883	4509972	0:26:00
2027	259883	4509992	0:26:00
2028	259886	4510057	0:26:00
2029	259888	4510073	0:25:00
2030	259886	4510088	0:25:00
2031	259923	4510192	0:23:00
2032	259924	4510173	0:22:00
2033	259922	4510153	0:25:00
2034	259932	4510137	0:26:00
2035	259919	4510107	0:27:00
2036	259926	4510091	0:29:00
2037	259922	4510052	0:28:00
2038	259919	4510027	0:28:00
2039	259913	4509971	0:29:00
2040	259921	4509950	0:53:00
2041	259977	4510023	1:01:00
2042	259998	4510052	1:07:00
2043	259976	4510104	0:32:00
2044	260002	4510103	1:09:00
2045	259998	4510133	0:29:00
2046	259970	4510169	0:26:00
2047	259739	4509998	0:00:00
2048	260035	4510142	1:25:00
2049	260063	4510111	1:34:00
2050	260047	4510081	1:22:00
2051	260047	4510058	1:20:00
2052	260047	4510031	1:19:00
2053	260044	4509974	1:18:00
2054	259520	4510246	0:00:00
2055	259519	4510263	0:00:00
2056	259524	4510281	0:00:00
2057	259524	4510308	0:00:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
2058	259524	4510326	0:00:00
2059	259521	4510351	0:00:00
2060	259569	4510150	0:00:00
2061	259558	4510164	0:00:00
2062	259550	4510148	0:00:00
2063	259530	4510146	0:00:00
2064	259511	4510147	0:00:00
2065	259512	4510196	0:00:00
2066	259628	4510144	0:00:00
2067	259625	4510162	0:00:00
2068	259666	4510159	0:00:00
2069	259672	4510114	0:00:00
2070	259665	4510095	0:00:00
2071	259661	4510029	0:00:00
2072	259627	4510001	0:00:00
2073	259626	4510032	0:00:00
2074	259599	4510069	0:00:00
2075	259624	4510099	0:00:00
2076	259628	4510117	0:00:00
2077	259576	4510114	0:00:00
2078	259552	4510112	0:00:00
2079	259528	4510113	0:00:00
2080	259512	4510081	0:00:00
2081	259528	4510068	0:00:00
2082	259548	4510069	0:00:00
2083	259575	4510033	0:00:00
2084	259559	4510035	0:26:00
2085	259545	4510034	0:55:00
2086	259690	4510033	0:00:00
2087	259598	4510031	0:00:00
2088	259625	4510073	0:00:00
2089	259667	4510070	0:00:00
2090	259474	4510195	0:00:00
2091	259412	4510156	0:00:00
2092	259472	4510156	0:00:00
2093	259485	4510021	3:03:00
2094	259414	4510193	0:00:00
2095	259519	4509772	5:52:00
2096	259512	4509825	3:19:00
2097	259511	4509822	3:21:00
2098	259546	4509814	3:41:00
2099	259681	4509805	6:32:00
2100	259736	4509873	4:34:00
2101	259736	4509853	6:05:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
2102	259731	4509811	8:32:00
2103	259817	4509802	8:17:00
2104	259872	4509801	6:35:00
2105	259875	4509818	4:18:00
2106	259872	4509841	1:39:00
2107	259875	4509771	10:08:00
2108	259837	4509765	11:42:00
2109	259808	4509757	11:54:00
2110	259745	4509765	8:16:00
2111	259699	4509749	6:22:00
2112	259681	4509773	5:57:00
2113	259665	4509778	5:34:00
2114	259647	4509769	5:15:00
2115	259633	4509773	4:59:00
2116	259578	4509770	4:50:00
2117	259870	4509745	13:16:00
2118	259777	4510204	0:00:00
2119	265071	4508290	5:46:00
2120	264673	4508338	8:17:00
2121	264722	4508334	4:23:00
2122	264887	4508296	3:19:00
2123	264995	4508291	4:05:00
2124	264995	4508223	6:02:00
2125	264997	4508241	5:41:00
2126	265006	4508260	5:22:00
2127	264961	4508269	4:06:00
2128	264965	4508248	4:56:00
2129	264964	4508228	5:29:00
2130	264855	4508279	3:18:00
2131	264850	4508250	3:19:00
2132	264781	4508246	3:20:00
2133	264777	4508265	3:22:00
2134	264746	4508250	3:25:00
2135	264741	4508236	3:24:00
2136	264668	4508261	4:31:00
2137	264888	4508251	3:28:00
2138	264664	4508200	3:44:00
2139	264660	4508183	3:41:00
2140	264668	4508163	3:37:00
2141	264666	4508133	3:40:00
2142	264666	4508114	3:47:00
2143	264744	4508129	4:47:00
2144	264801	4508202	3:24:00
2145	264771	4508159	4:02:00

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Hardin Wind Farm
WindPro Shadow Flicker Analysis Results Summary

Receptor ID	UTM-E (m)	UTM-N (m)	WindPro Predicted Expected Shadow Flicker (hrs/yr)
2146	264769	4508130	5:20:00
2147	264847	4508085	7:16:00
2148	264851	4508119	6:36:00
2149	264832	4508130	6:18:00
2150	264854	4508199	4:15:00
2151	264912	4508204	5:18:00
2152	264879	4508154	6:11:00
2153	264882	4508106	7:07:00
2154	264948	4508085	7:43:00
2155	264957	4508119	8:45:00
2156	264950	4508152	6:53:00
2157	264990	4508196	6:29:00
2158	264991	4508151	8:36:00
2159	264993	4508123	8:42:00
2160	264988	4508102	7:38:00
2161	264987	4508091	6:48:00
2162	264988	4508078	5:40:00
2163	264773	4508231	3:21:00
2164	264995	4508272	4:46:00
4528	269418	4505058	1:18:00

ATTACHMENT B

Detailed Description of WindPro Predicted Shadow Flicker Impact Periods for Worst Case Receptor (#1737)

Project:
Hardin Wind Farm

Printed/Page
07/01/2009 2:23 PM / 794

Licensed user:
Tetra Tech EC, Inc
133 Federal Street - 6th Floor
US-BOSTON MA 02110
1 617 457 8405

Calculated:
06/23/2009 4:20 PM/2.5.6.79

SHADOW - Calendar

Calculation: Shadow Flicker Analysis - Hardin Wind Farm **Shadow receptor:** 1737 - 1737

Assumptions for shadow calculations

Maximum distance for influence	1,500 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.36	0.42	0.44	0.51	0.56	0.60	0.60	0.60	0.61	0.56	0.37	0.31

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
340	449	635	548	403	515	718	1,242	1,076	1,074	753	474	8,226

Day	January			February			March			April			May			June		
1	08:00			07:47		08:25 (2)	07:11			07:21			06:36		07:17 (1)	08:07		07:18 (1)
	17:19			17:53	49	09:14 (2)	18:26			20:00			20:30	57	08:14 (1)	21:00	53	08:11 (1)
2	08:00			07:46		08:25 (2)	07:09			07:19			06:34		07:16 (1)	06:07		07:18 (1)
	17:20			17:54	49	09:14 (2)	18:28			20:00			20:31	58	08:14 (1)	21:00	52	08:10 (1)
3	08:00			07:45		08:24 (2)	07:08			07:17			06:33		07:16 (1)	06:06		07:19 (1)
	17:21			17:55	51	09:15 (2)	18:29			20:01			20:32	59	08:15 (1)	21:01	51	08:10 (1)
4	08:00			07:44		08:24 (2)	07:06			07:16			06:32		07:14 (1)	06:06		07:20 (1)
	17:21			17:57	52	09:16 (2)	18:30			20:02			20:33	60	08:14 (1)	21:02	50	08:10 (1)
5	08:00			07:43		08:24 (2)	07:05			07:14			06:30		07:14 (1)	06:06		07:19 (1)
	17:22			17:58	52	09:16 (2)	18:31			20:03			20:34	61	08:15 (1)	21:02	51	08:10 (1)
6	08:00			07:42		08:23 (2)	07:03			07:13		07:31 (6)	06:29		07:14 (1)	06:05		07:20 (1)
	17:23			17:59	53	09:16 (2)	18:32			20:04	3	07:34 (6)	20:35	61	08:15 (1)	21:03	50	08:10 (1)
7	08:00			07:40		08:23 (2)	07:02			07:11		07:30 (6)	06:28		07:14 (1)	06:05		07:21 (1)
	17:24			18:00	53	09:16 (2)	18:33			20:05	5	07:35 (6)	20:36	61	08:15 (1)	21:04	49	08:10 (1)
8	08:00			07:39		08:23 (2)	08:00			07:09		07:28 (6)	06:27		07:13 (1)	06:05		07:22 (1)
	17:25			18:01	53	09:16 (2)	19:34			20:06	7	07:35 (6)	20:37	62	08:15 (1)	21:04	48	08:10 (1)
9	08:00			07:38		08:23 (2)	07:59			07:08		07:27 (6)	06:26		07:13 (1)	06:05		07:21 (1)
	17:26			18:03	54	09:17 (2)	19:35			20:07	8	07:35 (6)	20:38	62	08:15 (1)	21:05	48	08:09 (1)
10	08:00			07:37		08:24 (2)	07:57			07:06		07:25 (6)	06:25		07:13 (1)	06:04		07:22 (1)
	17:27			18:04	53	09:17 (2)	19:37			20:08	9	07:34 (6)	20:40	62	08:15 (1)	21:06	47	08:09 (1)
11	07:59			07:36		08:24 (2)	07:55			07:05		07:23 (6)	06:24		07:13 (1)	06:04		07:22 (1)
	17:28			18:05	53	09:17 (2)	19:38			20:09	10	07:33 (6)	20:41	62	08:15 (1)	21:06	47	08:09 (1)
12	07:59			07:35		08:23 (2)	07:54			07:03		07:22 (6)	06:23		07:13 (1)	06:04		07:23 (1)
	17:29			18:06	53	09:16 (2)	19:39			20:10	10	07:32 (6)	20:42	62	08:15 (1)	21:07	46	08:09 (1)
13	07:59			07:33		08:24 (2)	07:52			07:01		07:24 (6)	06:22		07:13 (1)	06:04		07:23 (1)
	17:30			18:08	52	09:16 (2)	19:40			20:11	5	07:29 (6)	20:43	62	08:15 (1)	21:07	46	08:09 (1)
14	07:59			07:32		08:24 (2)	07:50		08:09 (7)	07:00			06:21		07:13 (1)	06:04		07:24 (1)
	17:31			18:09	52	09:16 (2)	19:41	2	08:11 (7)	20:12			20:44	62	08:15 (1)	21:08	45	08:09 (1)
15	07:58			07:31		08:24 (2)	07:49		08:08 (7)	06:58			06:20		07:13 (1)	06:04		07:24 (1)
	17:33			18:10	51	09:15 (2)	19:42	4	08:12 (7)	20:14			20:45	62	08:15 (1)	21:08	45	08:09 (1)
16	07:58			07:30		08:25 (2)	07:47		08:08 (7)	06:57			06:19		07:13 (1)	06:04		07:25 (1)
	17:34			18:11	50	09:15 (2)	19:43	6	08:12 (7)	20:15			20:45	62	08:15 (1)	21:08	44	08:09 (1)
17	07:57		08:41 (2)	07:28		08:26 (2)	07:46		08:04 (7)	06:55			06:18		07:13 (1)	06:04		07:25 (1)
	17:35	8	08:49 (2)	18:12	48	09:14 (2)	19:44	7	08:11 (7)	20:16			20:46	61	08:14 (1)	21:09	44	08:09 (1)
18	07:57		08:38 (2)	07:27		08:26 (2)	07:44		08:03 (7)	06:54		07:42 (1)	06:17		07:13 (1)	06:04		07:25 (1)
	17:36	16	08:54 (2)	18:14	47	09:13 (2)	19:45	9	08:12 (7)	20:17	13	07:55 (1)	20:47	61	08:14 (1)	21:09	44	08:09 (1)
19	07:56		08:36 (2)	07:25		08:27 (2)	07:42		08:01 (7)	06:52		07:38 (1)	06:16		07:13 (1)	06:04		07:26 (1)
	17:37	20	08:56 (2)	18:15	45	09:12 (2)	19:46	9	08:10 (7)	20:18	23	07:59 (1)	20:48	61	08:14 (1)	21:10	44	08:10 (1)
20	07:56		08:35 (2)	07:24		08:28 (2)	07:41		07:59 (7)	06:51		07:33 (1)	06:15		07:14 (1)	06:05		07:26 (1)
	17:38	24	08:59 (2)	18:16	44	09:12 (2)	19:47	10	08:09 (7)	20:19	29	08:02 (1)	20:49	60	08:14 (1)	21:10	44	08:10 (1)
21	07:55		08:33 (2)	07:23		07:42 (8)	07:39		08:01 (7)	06:49		07:30 (1)	06:14		07:14 (1)	06:05		07:26 (1)
	17:39	28	09:01 (2)	18:17	44	09:10 (2)	19:48	6	08:07 (7)	20:20	34	08:04 (1)	20:50	60	08:14 (1)	21:10	44	08:10 (1)
22	07:55		08:31 (2)	07:21		07:41 (8)	07:37			06:48		07:28 (1)	06:13		07:14 (1)	06:05		07:26 (1)
	17:41	31	09:02 (2)	18:18	43	09:09 (2)	19:49			20:21	38	08:06 (1)	20:51	59	08:13 (1)	21:10	44	08:10 (1)
23	07:54		08:31 (2)	07:20		07:39 (8)	07:36			06:46		07:27 (1)	06:13		07:15 (1)	06:05		07:26 (1)
	17:42	33	09:04 (2)	18:20	43	09:07 (2)	19:50			20:22	41	08:08 (1)	20:52	59	08:14 (1)	21:11	44	08:10 (1)
24	07:53		08:30 (2)	07:18		07:38 (8)	07:34			06:45		07:24 (1)	06:12		07:15 (1)	06:05		07:27 (1)
	17:43	35	09:05 (2)	18:21	40	09:05 (2)	19:52			20:23	44	08:08 (1)	20:53	58	08:13 (1)	21:11	44	08:11 (1)
25	07:53		08:29 (2)	07:17		07:36 (8)	07:32			06:44		07:23 (1)	06:11		07:15 (1)	06:06		07:27 (1)
	17:44	38	09:07 (2)	18:22	38	09:03 (2)	19:53			20:24	47	08:10 (1)	20:54	57	08:12 (1)	21:11	44	08:11 (1)
26	07:52		08:28 (2)	07:15		07:35 (8)	07:31			06:42		07:21 (1)	06:11		07:16 (1)	06:06		07:27 (1)
	17:45	40	09:08 (2)	18:23	34	09:01 (2)	19:54			20:25	49	08:10 (1)	20:55	57	08:13 (1)	21:11	44	08:11 (1)
27	07:51		08:27 (2)	07:14		07:34 (8)	07:29			06:41		07:20 (1)	06:10		07:16 (1)	06:06		07:27 (1)
	17:47	42	09:09 (2)	18:24	26	08:57 (2)	19:55			20:26	51	08:11 (1)	20:56	56	08:12 (1)	21:11	45	08:12 (1)
28	07:50		08:27 (2)	07:13		08:46 (2)	07:27			06:39		07:19 (1)	06:09		07:17 (1)	06:07		07:27 (1)
	17:48	44	09:11 (2)	18:25	4	08:50 (2)	19:56			20:27	53	08:12 (1)	20:56	55	08:12 (1)	21:11	45	08:12 (1)
29	07:49		08:27 (2)				07:26			06:38		07:19 (1)	06:09		07:16 (1)	06:07		07:27 (1)
	17:49	44	09:11 (2)				19:57			20:28	54	08:13 (1)	20:57	56	08:12 (1)	21:11	45	08:12 (1)
30	07:48		08:26 (2)				07:24			06:37		07:17 (1)	06:08		07:17 (1)	06:08		07:27 (1)
	17:50	46	09:12 (2)				19:58			20:29	56	08:13 (1)	20:58	55	08:12 (1)	21:11	46	08:13 (1)
31	07:48		08:26 (2)				07:22						06:08		07:17 (1)			
	17:52	47	09:13 (2)				19:59						20:59	54	08:11 (1)			
Potential sun hours	299			298			370			398			447			451		
Total, worst case		496			1286			53			589			1844			1393	
Sun reduction		0.36			0.42			0.44			0.51			0.56			0.60	
Oper. time red.		0.94			0.94			0.94			0.94			0.94			0.94	
Wind dir. red.		0.59			0.59			0.62			0.66			0.66			0.66	
Total reduction		0.20			0.23			0.26			0.31			0.35			0.37	
Total, real		97			295			14			185			636			515	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(Turbine causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(Turbine causing flicker last time)

Project:
Hardin Wind Farm

Printed/Page
07/01/2009 2:23 PM / 795

Licensed user:
Tetra Tech EC, Inc
133 Federal Street - 6th Floor
US-BOSTON MA 02110
1 617 457 8405

Calculated:
06/23/2009 4:20 PM/2.5.6.79

SHADOW - Calendar

Calculation: Shadow Flicker Analysis - Hardin Wind Farm **Shadow receptor:** 1737 - 1737

Assumptions for shadow calculations

Maximum distance for influence	1,500 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sun shine probabilities (part of time from sun rise to sun set with sun shine)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.36	0.42	0.44	0.51	0.56	0.60	0.60	0.60	0.61	0.56	0.37	0.31

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
340	449	635	548	403	515	718	1,242	1,076	1,074	753	474	8,226

	July			August			September			October			November			December
1	06:08		07:27 (1)	06:32		07:23 (1)	07:02		07:23 (6)	07:32			07:05		07:52 (2)	07:40
	21:11	46	08:13 (1)	20:53	63	08:26 (1)	20:11	10	07:33 (6)	19:19			17:33	54	08:46 (2)	17:09
2	06:09		07:27 (1)	06:33		07:23 (1)	07:03		07:23 (6)	07:33			07:07		07:53 (2)	07:41
	21:11	47	08:14 (1)	20:52	62	08:25 (1)	20:09	9	07:32 (6)	19:18			17:32	53	08:46 (2)	17:09
3	06:09		07:27 (1)	06:34		07:23 (1)	07:04		07:24 (6)	07:34			07:08		07:53 (2)	07:42
	21:11	47	08:14 (1)	20:51	62	08:25 (1)	20:08	8	07:32 (6)	19:16			17:31	53	08:46 (2)	17:09
4	06:10		07:27 (1)	06:35		07:23 (1)	07:05		07:25 (6)	07:35			07:09		07:53 (2)	07:43
	21:11	48	08:15 (1)	20:50	62	08:25 (1)	20:06	7	07:32 (6)	19:14			17:30	53	08:46 (2)	17:09
5	06:10		07:26 (1)	06:36		07:23 (1)	07:06		07:26 (6)	07:36			07:10		07:53 (2)	07:44
	21:11	49	08:15 (1)	20:49	62	08:25 (1)	20:04	5	07:31 (6)	19:13			17:28	52	08:45 (2)	17:09
6	06:11		07:27 (1)	06:37		07:23 (1)	07:07		07:27 (6)	07:37			07:11		07:54 (2)	07:45
	21:10	49	08:16 (1)	20:48	62	08:25 (1)	20:03	3	07:30 (6)	19:11			17:27	52	08:45 (2)	17:08
7	06:11		07:27 (1)	06:38		07:24 (1)	07:06			07:38			07:12		07:54 (2)	07:46
	21:10	50	08:17 (1)	20:46	60	08:24 (1)	20:01			19:09			17:26	51	08:45 (2)	17:08
8	06:12		07:26 (1)	06:39		07:24 (1)	07:09			07:39			07:14		07:54 (2)	07:47
	21:10	51	08:17 (1)	20:45	60	08:24 (1)	19:58			19:08			17:25	51	08:45 (2)	17:08
9	06:13		07:26 (1)	06:40		07:24 (1)	07:10			07:40			07:15		07:56 (2)	07:47
	21:09	51	08:17 (1)	20:44	60	08:24 (1)	19:56			19:06			17:24	49	08:45 (2)	17:08
10	06:13		07:26 (1)	06:41		07:25 (1)	07:11			07:41			07:16		07:56 (2)	07:48
	21:09	52	08:18 (1)	20:43	58	08:23 (1)	19:55			19:05			17:23	49	08:45 (2)	17:08
11	06:14		07:26 (1)	06:42		07:25 (1)	07:12			07:42			07:17		07:57 (2)	07:49
	21:09	52	08:18 (1)	20:41	58	08:23 (1)	19:53			19:03			17:22	47	08:44 (2)	17:09
12	06:15		07:26 (1)	06:42		07:25 (1)	07:13			07:43			07:18		07:57 (2)	07:50
	21:08	53	08:19 (1)	20:40	57	08:22 (1)	19:51			19:01			17:21	46	08:43 (2)	17:09
13	06:15		07:26 (1)	06:43		07:26 (1)	07:14			07:44			07:20		07:59 (2)	07:51
	21:08	54	08:20 (1)	20:39	56	08:22 (1)	19:49			19:00			17:20	44	08:43 (2)	17:09
14	06:16		07:25 (1)	06:44		07:27 (1)	07:15			07:45		08:08 (8)	07:21		07:59 (2)	07:52
	21:07	55	08:20 (1)	20:38	54	08:21 (1)	19:48			18:58	17	09:26 (2)	17:19	43	08:42 (2)	17:09
15	06:17		07:25 (1)	06:45		07:27 (1)	07:16			07:46		08:06 (8)	07:22		08:00 (2)	07:52
	21:07	55	08:20 (1)	20:36	53	08:20 (1)	19:46			18:57	29	09:30 (2)	17:19	42	08:42 (2)	17:09
16	06:18		07:25 (1)	06:46		07:28 (1)	07:17			07:47		08:07 (8)	07:23		08:01 (2)	07:53
	21:06	56	08:21 (1)	20:35	51	08:19 (1)	19:44			18:55	35	09:33 (2)	17:18	40	08:41 (2)	17:09
17	06:19		07:25 (1)	06:47		07:28 (1)	07:18			07:48		08:09 (8)	07:24		08:03 (2)	07:54
	21:06	57	08:22 (1)	20:33	49	08:17 (1)	19:43			18:54	39	09:36 (2)	17:17	38	08:41 (2)	17:10
18	06:19		07:24 (1)	06:48		07:29 (1)	07:19			07:50		08:10 (8)	07:25		08:04 (2)	07:54
	21:05	57	08:21 (1)	20:32	46	08:15 (1)	19:41			18:52	42	09:38 (2)	17:16	35	08:39 (2)	17:10
19	06:20		07:24 (1)	06:49		07:30 (1)	07:20			07:51		08:11 (8)	07:27		08:05 (2)	07:55
	21:04	58	08:22 (1)	20:31	44	08:14 (1)	19:39			18:51	44	09:39 (2)	17:15	33	08:38 (2)	17:11
20	06:21		07:24 (1)	06:50		07:32 (1)	07:21			07:52		08:12 (8)	07:28		08:06 (2)	07:56
	21:04	59	08:23 (1)	20:29	40	08:12 (1)	19:38			18:49	44	09:40 (2)	17:15	31	08:37 (2)	17:11
21	06:22		07:24 (1)	06:51		07:33 (1)	07:22			07:53		08:13 (8)	07:29		08:09 (2)	07:56
	21:03	59	08:23 (1)	20:28	37	08:10 (1)	19:36			18:48	45	09:41 (2)	17:14	28	08:37 (2)	17:11
22	06:23		07:24 (1)	06:52		07:35 (1)	07:23		07:46 (7)	07:54		08:57 (2)	07:30		08:11 (2)	07:57
	21:02	60	08:24 (1)	20:26	33	08:08 (1)	19:34	4	07:50 (7)	18:46	45	09:42 (2)	17:13	24	08:35 (2)	17:12
23	06:24		07:24 (1)	06:53		07:37 (1)	07:24		07:43 (7)	07:55		08:57 (2)	07:31		08:13 (2)	07:57
	21:01	60	08:24 (1)	20:25	28	08:05 (1)	19:33	10	07:53 (7)	18:45	46	09:43 (2)	17:13	20	08:33 (2)	17:12
24	06:24		07:23 (1)	06:54		07:40 (1)	07:25		07:44 (7)	07:56		08:56 (2)	07:32		08:15 (2)	07:58
	21:01	61	08:24 (1)	20:23	22	08:02 (1)	19:31	10	07:54 (7)	18:44	48	09:44 (2)	17:12	16	08:31 (2)	17:13
25	06:25		07:23 (1)	06:55		07:45 (1)	07:26		07:45 (7)	07:57		08:55 (2)	07:33		08:19 (2)	07:58
	21:00	61	08:24 (1)	20:22	12	07:57 (1)	19:29	9	07:54 (7)	18:42	49	09:44 (2)	17:12	8	08:27 (2)	17:14
26	06:26		07:23 (1)	06:56			07:27		07:46 (7)	07:58		08:54 (2)	07:34			07:58
	20:59	62	08:25 (1)	20:20			19:28	8	07:54 (7)	18:41	51	09:45 (2)	17:11			17:14
27	06:27		07:23 (1)	06:57			07:28		07:47 (7)	08:00		08:54 (2)	07:36			07:59
	20:58	62	08:25 (1)	20:19			19:26	6	07:53 (7)	18:40	51	09:45 (2)	17:11			17:15
28	06:28		07:23 (1)	06:58			07:29		07:48 (7)	08:01		08:54 (2)	07:37			07:59
	20:57	62	08:25 (1)	20:17			19:24	5	07:53 (7)	18:38	52	09:46 (2)	17:10			17:16
29	06:29		07:23 (1)	06:59			07:30		07:49 (7)	08:02		08:53 (2)	07:38			07:59
	20:56	63	08:26 (1)	20:16			19:23	2	07:51 (7)	18:37	53	09:46 (2)	17:10			17:16
30	06:30		07:23 (1)	07:00		07:25 (6)	07:31			08:03		08:53 (2)	07:39			08:00
	20:55	63	08:26 (1)	20:14	5	07:30 (6)	19:21			18:36	53	09:46 (2)	17:10			17:17
31	06:31		07:23 (1)	07:01		07:22 (6)				08:04		08:53 (2)				08:00
	20:54	63	08:26 (1)	20:12	10	07:32 (6)				18:34	53	09:46 (2)				17:18
Potential sun hours	458			428			375			345			298			289
Total, worst case		1722			1266			96			796			1012		
Sun reduction		0.60			0.60			0.61			0.56			0.37		
Oper. time red.		0.94			0.94			0.94			0.94			0.94		
Wind dir. red.		0.66			0.66			0.64			0.59			0.59		
Total reduction		0.37			0.37			0.36			0.31			0.20		
Total, real		637			468			35			243			204		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(Turbine causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(Turbine causing flicker last time)

Shadow Flicker Analysis

Graphical Calendar

The following page is a set of calendars, each representing an individual residence. The shaded areas in each calendar represent the amount of time that the specific residence will experience some level of shadow flicker. The color of the shaded area itself corresponds to a specific wind turbine, the number of which is shown at the bottom of the page.

Project:
Hardin Wind Farm

Printed/Page
07/01/2009 1:43 PM / 105

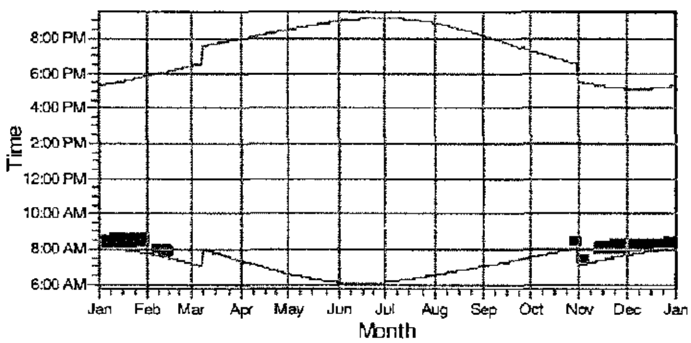
Licensed user:
Tetra Tech EC, Inc
133 Federal Street - 6th Floor
US-BOSTON MA 02110
1 617 457 8405

Calculated:
06/23/2009 4:20 PM/2.5.6.79

SHADOW - Calendar, graphical

Calculation: Shadow Flicker Analysis - Hardin Wind Farm

1736: 1736



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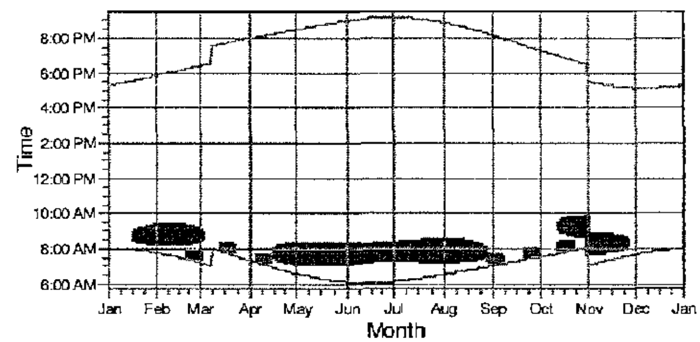

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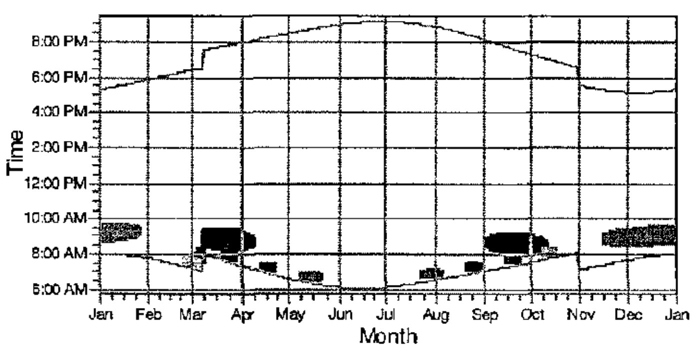

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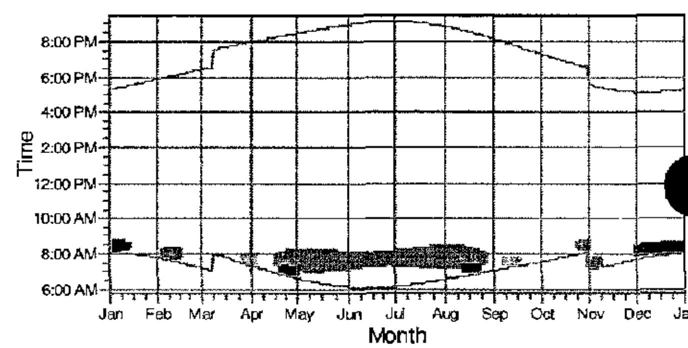

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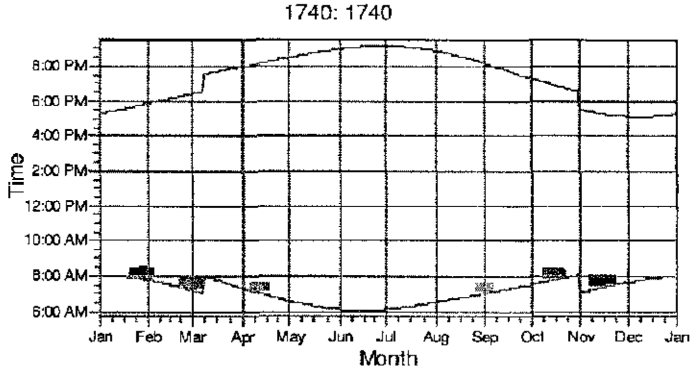

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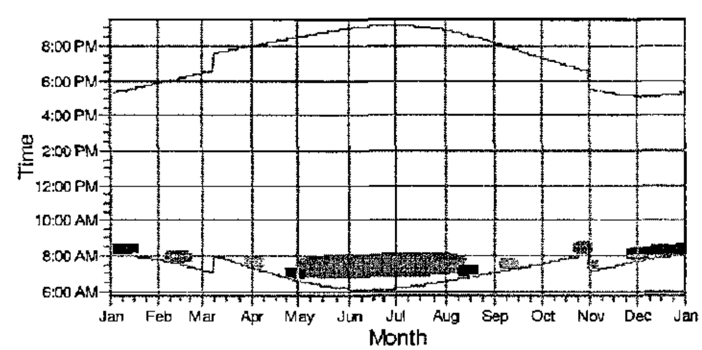

WTGs

1: 1
2: 2
4: 4
5: 5
6: 6
7: 7
8: 8
9: 9
10: 10
11: 11
12: 12
55: 55
56: 56

Ecological Critical Issues Analysis

JUNE 2009

for

HARDIN WIND FARM

Prepared For

Hardin Wind Energy, LLC
One South Wacker Drive Suite 2020
Chicago, Illinois 60606
(312) 224-1400

Prepared By

TETRA TECH EC, INC.

133 Federal Street, 6th Floor
Boston, MA 02110

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TABLES

FIGURES

EXECUTIVE SUMMARY

This Draft Ecological Critical Issues Analysis (CIA) provides a preliminary assessment of potential biological issues associated with the Hardin Wind Resource Area (WRA) located in Hardin County, Ohio. The CIA includes a relevant literature and Geographic Information System (GIS) data review.

Based on the data obtained for this analysis, there do not seem to be any issues that would preclude siting of the proposed wind project or transmission facilities in this location. However, background research has resulted in the identification of vegetation and wildlife issues that may require further investigation prior to construction. In addition, regulatory federal and/or state permits may be required based on the final layout and construction plans for the proposed facility.

Tetra Tech EC, Inc. (Tetra Tech) has identified several areas where further evaluation would ensure the facility is sited in a manner that minimizes potential ecological issues. The following table (Table E-1) provides a summary of the critical issues addressed in this report and recommendations for further evaluation of each issue, if warranted. The importance of each issue may be adjusted as more information becomes available.

Table E-1. Critical Issues Summary

Issue	Importance Rating High	Med	Low	Comment	Recommendation
Vegetation					
Presence of Threatened and Endangered Species			X	One state-endangered (heart-leaved plantain), one state-threatened (lesser bladderwort), and four state potentially threatened species (raven-food sedge, reflexed sedge, grove sandwort, and tuberclad rein orchid) have been documented within Hardin County. However, much of the area has already been developed into agriculture thereby limiting the amount of native habitat. Potential riparian corridors along the Scioto River and its tributaries may have some remaining native species.	Tetra Tech recommends conducting plant surveys only in those areas, if any, where project facilities would be developed in native or otherwise suitable habitat for the special status species identified. These surveys can most-likely be combined with any additional wetland surveys. The ideal survey times would be in the spring during the months of May and June.
Easements, Conservation Areas, and Other Limitations			X	None are known at this time. Additionally the presence of any CRP (Conservation Reserve Program) lands may restrict use without specific authorization. Other protected lands should be avoided to the maximum extent possible.	Invenergy should verify with federal and state agencies whether proposed project locations are in CRP lands or similar easements to confirm construction activities will comply with program restrictions. In developing project layouts, Invenergy should consult with the Ohio DNR and avoid the locations of any protected areas and/or sensitive habitats. Particular attention should be paid to Scioto River and associated tributaries.
Impacts to Wetlands		X		Access road construction and improvements have the greatest potential for impacts to wetlands and natural vegetation resulting in permanent loss of these habitats where they occur along access routes. Installation of associated buried and overhead electrical collector system will result in some temporary effects. Where disturbance is significant, effects can be mitigated by reseeding trenched areas with native vegetation following completion of construction activities. Much of the wetlands in the area have already been altered. Additional information on access roads and construction of power lines and other facilities on site may require additional surveys and permitting as the project develops.	A preconstruction wetland survey conducted prior to construction and/or while designing roads and collector cables could avoid or minimize impacts to jurisdictional wetlands and waters of the United States and subsequently avoid the need to obtain a 404 Permit from the U.S. Army Corps of Engineers (USACE). If water resources are to be impacted, the Buffalo District of the Corps of Engineers should be contacted for possible need of a section 404 Permit.
Wildlife					
Potential for Protected Species to Occur		X		According to the USFWS and the Ohio DNR, two federally endangered species (Indiana myotis and clubshell), one federally threatened species (copperbelly water snake), two candidate species (eastern massasauga and rayed bean) and three additional state threatened or endangered species (northern harrier, sandhill crane, and bald eagle) of wildlife are known to occur within Hardin County. The USFWS has provided documentation stating that no action will be required by Invenery on behalf of the copperbelly water snake and eastern massasauga. Potential habitat may exist for state endangered northern harriers and bald eagles. Bald eagles are also federally protected by the bald and golden eagle protection act.	Tetra Tech recommends avian point counts and raptor nest surveys during the spring (April – June) and avian point counts during the fall (August – October). As the project develops, additional surveys may be required for any potential disturbance to listed species. Since wetlands are not to be disturbed, no additional surveys may be needed for the listed species of mussels. Tetra Tech recommends a detailed desktop and field-based habitat assessment for Indiana myotis. Should such habitat exist it may be warranted to perform mist-netting surveys as recommended by the USFW during the summer (June and July).
Potential For Use by Bats		X		Bat habitat is relatively low in abundance within the WRA, consisting mainly of any old barns and shelterbelts (for roosting) and waterways and wetlands (for feeding) particularly the Scioto River in the north. It is important to note that the relative paucity of bat roosting and feeding habitat in the WRA does not mean that bats will not be moving through the WRA during the spring and fall migration periods.	Relatively little is known about the migratory pathways and use of the area by bats. Tetra Tech recommends conducting fall and spring acoustic surveys of bat activity to determine passage rates of various bat species that may be present, in various habitats and land form types. If the results clearly indicate that use is higher in some types of habitat and/or landforms, this information can be used to site turbines in areas with lower bat use.

Table E-1. Critical Issues Summary

Issue	Importance Rating High	Med	Low	Comment	Recommendation
Potential for Raptor Nest Sites		X		Tree-nesting habitat is not abundant in the WRA. Large woody vegetation is mostly restricted to shelterbelts planted around dwellings. Native grassland is also not present in significant quantities.	Wind farms are known to impact some raptor species. Despite the potentially low nesting habitat availability, Tetra Tech recommends a spring survey for active raptor nests throughout the WRA (April – June) to document the intensity of resident raptor use and to aid in micro-siting of project facilities to reduce collision risk. This survey would be best conducted prior to project development in order for the results to be used in decisions regarding development or to document changes in use resulting from the facility's construction.
Potential Raptor Flight Collisions		X		Heaviest use of the WRA area by raptors is likely to occur during migration periods in the spring and fall. Some raptors would be expected to reside in the WRA during spring and summer. Bald eagles are know to nest in Hardin County and the riparian areas along the Scioto River represent the best possible habitat for most nesting raptors in the area.	Raptor nest surveys and avian point counts will assist in identifying areas of high raptor use where micro-siting could be used to reduce collision risk.
Potential Migration Pathways		X		The WRA lies within the Mississippi Flyway, which is heavily utilized by numerous species of birds during the spring and fall migrations.	Tetra Tech recommends conducting avian point counts during the spring and fall migration periods (See protected species occurrence). This information could then be used to delineate areas or habitats within the WRA with lower bird use (and, therefore, risk), and identify more favorable sites for wind turbine placement.
Potential for Raptor Prey Species		X		The WRA may be attractive to raptors because of the presence of rodent prey species utilizing waste grain as a food resource. Prey species potentially occurring within the WRA include mice, voles, squirrels, woodchuck, rabbits and other small mammals.	If surveys indicate the presence of raptors, a prey survey may help identify areas of high use and/or concentration. Under such conditions, Tetra Tech recommends conducting a prey assessment (June – August) during the summer to assess raptor prey species within the WRA. See also the recommendation for avian point counts above.
Potential for Commercial and Recreational Species.		X		The WRA may be attractive to species that are regulated for hunting purposes. Crops and wetlands often attract migratory waterfowl, deer, turkey, pheasant, and several furbearer species.	Many of these species can be confirmed through the avian and wetland surveys. Tetra Tech recommends consulting with ODNR on any potential game preserves or state hunting areas within the WRA. ODNR may also require additional surveys certain commercial or recreational species before development.
Uniqueness of Habitat in Project Area			X	Habitat in the WRA is not unique to the surrounding landscape or region.	No recommendations.

1.0 INTRODUCTION

Invenergy LLC (Invenergy) is planning to develop a wind power project at the Hardin Wind Resource Area (WRA) within Hardin County in Ohio (Figure 1). The proposed WRA consists of approximately 37,000 acres of mostly private, unincorporated, agricultural land. The project is in the initial development state and many details of the project design have not yet been determined.

Tetra Tech EC, Inc. (Tetra Tech) was contracted to prepare an Environmental Critical Issues Analysis (CIA) which includes a desktop study to identify potential biological issues associated with building and operating the proposed facility. The geographic areas of concern for the CIA were determined through communication with key Invenergy personnel. If the location of the proposed WRA development changes, additional studies may become necessary. Results of background research are summarized in this report. Additional investigations that may help to address the potential effects of the project are also identified and presented for consideration in this CIA.

2.0 METHODS

Tetra Tech's evaluation of biological resources within the Hardin WRA is based on searches of relevant and readily available databases and reports, Geographic Information System (GIS) data, and an existing consultation between the USFW and WEST Inc. Existing literature and other information related to sensitive species distributions, cultural resources, zoning, and public planning requirements were reviewed for relevance to developing the proposed project.

Existing information was collected from a number of public domain sources. Cartographic information and related literature compiled through agency and internet sources included the following datasets:

- U.S. Geologic Survey (USGS) 7.5-minute quadrangle maps;
- USFWS National Wetlands Inventory (NWI) data;
- USFWS Threatened and Endangered Species System (TESS);
- Ohio State Natural Heritage Program;
- Ohio Department of Natural Resources (ODNR);
- U.S. Geological Survey National Land Cover Database (NLCD)

Figure 1. Hardin WRA Site Vicinity

3.0 ENVIRONMENTAL SETTING

This section summarizes existing environmental conditions within the Hardin WRA. Information presented describes potentially affected habitats (i.e., wetlands, riparian corridors, and general plant communities), fish, wildlife, and plant species (including potentially-occurring threatened, endangered, and rare species). Environmental resource information presented in this section will be used to help determine if additional preconstruction surveys are needed.

3.1 Regional Setting

The Hardin WRA is situated in the Central Till Plains Section of the Eastern Broadleaf Province (McNab and Avers 1994, USDA 1996, ODNR 2009). The WRA is primarily situated on the Central Till – Beech and Maple Plain Landform Region (USDA 1996). The Central Till Plain is characterized by its flatness and by shallow entrenchment of its drainages. Much of the natural drainage follows glacial ground moraines with broad bottom lands along the few major river valleys. The plain is overlain by a series of low ridges (glacial end moraines) generally trending west to east in an undulating pattern. The dominant geomorphic process is fluvial erosion, transport and deposition. Elevation ranges from 650 to 1,000 ft (200 to 300 m).

Most of the area is under heavy developmental pressures from urban development and agriculture. Most forested tracts are now second growth wood lots less than 250 acres in size (ODNR 2009). Native plant communities are found in mostly wetlands and riparian areas. Local waterways include the Scioto River and several smaller permanent tributaries which drain into the Ohio River located to the southeast of the WRA (OSU 2009). Several smaller, mostly intermittent, streams are also present and are characterized by a low volume of water flowing at low velocity. The bottoms of most of the streams are composed of sand, gravel, bedrock, and boulders. Many of the small streams and ditches in the WRA have been modified and straightened for agricultural purposes. Wetlands were once abundant but now occur as remnants in the form of bog ponds, pothole lakes, and springs. Precipitation average 35 to 40 in (900 to 1,030 mm; ODNR 2009). Half or more of this precipitation occurs during freeze-free periods. The low precipitation in winter is mostly snow. Annual temperature averages 50 to 55°F (10 to 13°C). The agriculture growing season lasts 155 to 180 days.

3.2 Hardin WRA Setting

The Hardin WRA is located on approximately 37,000 acres of mostly private, unincorporated, agricultural land in northwestern Ohio (Figure 1). The WRA is located within Hardin County, Ohio. Incorporated areas within the WRA include the Towns of Alger and McGuffy in the northwest. The WRA is not densely populated; the few residences located outside of incorporated areas are scattered, permanent farm houses and associated barns and farm buildings. Land use within the WRA is primarily crop agriculture (soybean, corn, and wheat) and pasture (hay). Patches of trees and shrubs are limited primarily to isolated shelterbelts around existing or former homesteads, riparian swales and intermittent stream corridors. Several woodlots greater than 10 hectares exist within the project boundaries.

The project is in the initial development stage; as a result, many details of the project design, including the turbine model to be used, turbine height and rotor dimensions, and overall project generating capacity, have not yet been determined. In addition, details pertaining to associated facilities and structures, such as substations, underground and above ground transmission lines, and meteorological towers, are not yet available. As of June 2009, Invenergy has identified 200 potential turbine positions using GE 1.5xle turbines and two potential areas of interconnection (Figure 1).

4.0 VEGETATION and WETLANDS

This section describes plant and wetland communities known to occur within the vicinity of the Hardin WRA. Literature reviews were conducted to determine the types of vegetative communities present and to identify potentially sensitive plant species and vegetation communities present within the WRA.

4.1 Plant Communities

A plant community is a combination of different plants growing together. Each plant community has a unique structure and appearance, which is determined by the proportions of the species growing in it. The composition of a plant community type changes from place to place due to the physical environment and factors such as rainfall, temperature, elevation, soil type, and slope. Each species has certain limits to where it will grow and survive, and those species that have similar limits often are found growing together; hence, they become a loosely assembled "plant community."

Plant communities can influence the type of wildlife that use the area, including listed species or species of concern, and plant communities themselves can often be rare or in need of conservation. The identification of native plant communities is essential to identifying wildlife-habitat relationships. Cultivated crops (soybean, corn, and wheat) comprise approximately 88.3% of the total land cover of the Hardin WRA (Table 1). Approximately 4.3 percent of the WRA is identified as open space that is mostly made up of large family housing and plantation farming. Historically this area was characterized by prairie habitat that supported a variety of grassland and woody plant species. Deciduous forest comprise approximately 3 percent of the WRA along with the woodland wetlands (<0.1 percent) interspersed throughout the project area as fragmented tracts consisting primarily of oaks, hickories, maples, and cottonwoods. Pastures managed as hayfields for cattle grazing make up and additional 2.7 percent of the WRA. The percentages of other less prevalent cover types are presented below in Table 1.

Table 1. Land Use/Land Cover within the WRA

Land Use/Land Cover Description[1] (alphabetical order)	Acres	Percent of Total
Barren Land (gravel pits, strip mines)	1.3	<0.1%
Cultivated Crops (soybean, corn, and wheat)	32,742.4	88.3%
Deciduous Forest (hardwood forests >5 meters tall)	1,112.0	3.0%
Developed High Intensity (cities and towns – 80 to 100% cover)	6.5	<0.1%
Developed Low Intensity (single family housing – 20 to 49% cover)	234.2	0.6%
Developed Medium Intensity (farm buildings – 50 to 79% cover))	20.5	0.1%
Developed Open Space (large lot single family housing, golf courses, parks)	1,583.7	4.3%
Emergent Wetlands (herbaceous plants often covered in water)	14.0	<0.1%
Evergreen Forest (softwoods such as pines, cedars, and hemlocks)	3.4	<0.1%
Grassland (open areas dominated by grammanoids)	322.4	0.9%
Open Water (creeks, ponds, drainage areas, rivers)	9.3	<0.1%
Pasture (Hay fields managed for cattle grazing)	1,014.6	2.7%
Woodland Wetlands (forested to shrubland transition vegetation)	12.0	<0.1%
Total Acreage	**37,076.5**	
[1]Source: *NLCD 2001*		

4.2 Special-Status Plant Species

The USFW and Ohio DNR maintain a list of federally and state-protected plant species. Species listed as threatened or endangered by either of these agencies require protective measures for their perpetuation due to low populations, sensitivity to habitat alteration, and/or cultural significance.

According to the Ohio DNR and the U.S. Fish and Wildlife websites, no federally endangered or threatened species may occur in Hardin County (ODNR 2009; Table 2). Two state-endangered, one state-threatened and four state potentially threatened species are known to occur in Hardin County. However, species occurrence and distribution information is often based on opportunistic sightings rather than systematic survey data, so a lack of records does not necessarily indicate that other species are absent from the WRA.

Table 2. Federally and State-Protected Plant Species Documented within Hardin County

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Likelihood of Occurrence Within WRA[2]	Habitat Association
heart-leaved plantain	*Plantago cordata*	NA	E	Low	Basic rock or pebble substrates of clear, slow moving streams. It also grows in mud-bottomed streams and in wooded floodplains. Infrequently grows in full sun.
lesser bladderwort	*Utricularia minor*	NA	T	Low	In full sun, in both bogs and fens; floating or rooted in mud in calm, shallow waters.

[1]E=Endangered, T=Threatened, NA=Not applicable (no status)
Source: ODNR 2009 *http://ohiodnr.com/RarePlantSpeciesbyCount/tabid/20404/Default.aspx*
USFW 2009a http://www.fws.gov/midwest/Endangered/lists/ohio-spp.html
[2]Likelihood is based on recent and historical documentation from ODNR and USFW about the species occurrence and the amount of remaining undisturbed habitat known.

4.2.1 State-protected Plant Species

Heart-leaved plantain (Endangered) – The heart-leaved plantain inhabits rock or pebble substrates of shallow slow-moving streams. Heart-leaved plantain is also found, on occasion, in mud-bottomed streams and wooded floodplains. Heart-leaved plantain flowers from April to May. ODNR (2009) states that heart-leaved plantain is known to occur in Hardin County from post-1980 records and may still occur in any of the small intermittent streams associated with the Scioto River watershed. Threats to heart-leaved plantain include loss of habitat to development as the plant is only found in undisturbed streams and floodplains. Based on known information, the likelihood of occurrence within the WRA is low given that most of the known habitat has already been disturbed by development.

Lesser bladderwort (Threatened) – Lesser bladderwort inhabits undisturbed bogs and fens often rooted in calm shallow mud-bottomed wetlands. Lesser bladderwort flowers from May to August. ODNR (2009) states that lesser bladderwort is known to occur in Hardin County from post 1980 records. Threats include drainage of habitat and overgrowth by woody species through succession. Based on known information, the likelihood of occurrence within the WRA is low.

4.2.2 State Potentially Threatened Plant Species

Under the State of Ohio's Threatened and Endangered Species Program (ODNR 2009), any native Ohio plant species may be designated "potentially threatened" if one or more of the following criteria apply: 1. The species is extant in Ohio and does not qualify as a state endangered or threatened species, but it is a proposed federal endangered or threatened species or a species listed in the *Federal Register* as under review for such proposal. 2. The natural populations of the species are imperiled to the extent that the species could conceivably become a threatened species in Ohio within the foreseeable future. 3. The natural populations of the species, even though they are not threatened in Ohio at the time of designation, are believed to be declining in abundance or vitality at a significant rate throughout all or large portions of the state. These species are not protected by the Ohio Threatened and Endangered Species law (ODNR 2009). ODNR lists four state potentially threatened species known to occur within Hardin County (ODNR 2009; Table 3). Species occurrence and distribution information is often based on opportunistic data, so a lack of records does not necessarily indicate that a species is absent from a particular area.

Table 3. State Potentially Threatened Species Documented within Hardin County

Common Name	Scientific Name	Likelihood of Occurrence Within WRA	Habitat Association
raven-foot sedge	*Carex crus-corvi*	Low	Wetlands such as swamps, floodplains, and roadside ditches
reflexed sedge	*Carex retroflexa*	Low	Well-drained woods and slopes, dry fields; often in sandy or rocky soil, partial shade to full sun.
grove sandwort	*Moehringia lateriflora*	Low	Damp open woods. Flowers late April to mid August.
tuberclad rein orchid	*Platanthera flava*	Low	A variety of moist situations in semi-shade, usually in acidic or subacidic substrates; swamp woods; floodplains; shrub borders; often around standing water; only rarely found in mature woodlands. Flowers from June to July.
Source: ODNR 2009			

4.3 Easements, Conservation Areas, and Other Limitations

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA) administer a number of conservation-based programs for private landowners. The Conservation Reserve Program (CRP) conserves soil and water resources, and provides wildlife habitat by removing enrolled tracts from agricultural production, generally for a period of 10 years. An offspring of the CRP program is the Conservation Reserve Enhancement Program (CREP) with similar management constraints and goals. These tracts cannot be hayed, tilled, seeded, or otherwise disturbed (including disturbance associated with powerline or other project construction) without authorization from the USDA. NRCS and FSA policies do not allow the release of information regarding the locations of tracts enrolled in the CRP or other programs. As project layouts continue to mature, the precise locations of lands enrolled in the CRP program should be obtained from USDA to avoid siting project components in these areas.

Figure 2. NLCD Land Cover Map

4.4 Wetland Assessment and Recommendations

Wetlands identified within the WRA were either isolated or located along streams (Figure 2). The greatest potential for encountering jurisdictional wetlands and waters of the United States would be during the construction of new access roads (or road improvements or collector systems) across drainages or streams. Tetra Tech recommends that wetlands be avoided to the maximum extent practicable during the project design phase. Wetland delineations should be conducted following development of a project array and during the micro-siting of project facilities (i.e., turbine pads, roads, collector cables, substations, transmission line facilities). These wetland determinations will decrease the likelihood of impacting wetlands or their recommended buffer zone. Water wells and other drinking and agricultural drainage areas infrastructure should be avoided to the extent possible when siting project components. If water resources are to be impacted, the Buffalo District of the Corps of Engineers should be contacted for possible need of a section 404 Permit.

4.5 Summary of Impact Assessment to Plant Communities and Recommendations

Approximately 96 percent of the WRA has already been impacted by agriculture and development (Table 1) making additional impacts to native plant communities minimal. The remaining 4% includes mostly hardwood forests, grasslands, and wetlands that should be avoided as these areas represent the highest potential habitat for native plant communities and endangered and threatened species (Figure 2). These areas also have the highest potential for use by migratory birds (such as raptors and waterfowl) and potential breeding sights for many animals native to the area.

Access road construction and improvements have the greatest potential for impacts to wetlands and natural vegetation resulting in permanent loss of these habitats where they occur along access routes. Installation of associated buried and overhead electrical collector system will result in some temporary effects. Where disturbance is significant, effects can be mitigated by reseeding trenched areas with native vegetation following completion of construction activities.

One state-endangered, one state-threatened, and three state potentially threatened species have been documented within Hardin County. However, much of the area has already been developed into agriculture thereby limiting the amount of native habitat. Potential riparian corridors along the Scioto River and its tributaries may have some remaining native species (Figure 2). Tetra Tech recommends conducting plant surveys only in those areas, if any, where project facilities would be developed in native (non-agricultural) or otherwise suitable habitat for the special status species identified. These types of surveys could be, if warranted, conducted in conjunction with the wetlands determination for cost efficiency. Established survey protocols for some species often require that surveys be conducted during the normal flowering period which facilitates the identification of the species of interest.

5.0 WILDLIFE

This section identifies sensitive wildlife species known to occur or potentially occur within the proposed Hardin WRA. Based on issues identified at other wind generation facilities throughout the United States, those species of greatest concern are federally or state-protected avian species and bats that may occur in the vicinity of the wind energy facility. Other species of conservation concern are those directly associated with sensitive or unique habitats.

5.1 Special-Status Species

The Endangered Species Act requires protection of species federally listed as threatened or endangered. Significant changes to the habitats of these species and projects that have potential to result in a "take" will require close scrutiny by USFWS and may require special permitting or mitigation measures to avoid or reduce impacts to these species.

Two federally endangered species (Indiana myotis and clubshell), one federally threatened (copperbelly water snake), and two candidate species (eastern massasauga and rayed bean), have been documented within Hardin County (Table 4). In a letter dated February 3, 2009, the USFWS has stated that no action will be required on behalf of the copperbelly water snake or eastern massassauga. In addition, the ODNR lists 3 wildlife species that are considered state-endangered or threatened that are known to occur within Hardin County (Table 4). Species occurrence and distribution information is often based on opportunistic observations; therefore, a lack of records does not necessarily indicate that a species is absent from a given area. Site-specific habitat surveys will need to be conducted to determine if suitable habitat exists for protected species that have the potential to occur within the WRA.

Table 4. Federally and State-Protected Wildlife Species Documented within Hardin County

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Likelihood of Occurrence Within WRA	Habitat Association
Mammals					
Indiana myotis	*Myotis sodalis*	E	E	Low	Foraging by females and juveniles are limited to riparian and floodplain areas. Creeks are apparently not used if riparian trees have been removed. Males forage over floodplain ridges and hillside forests. Summer maternity colonies are found in hollow trees or trees with lose bark. Winter hibernacula are caves or abandoned mines.
Birds[2]					
northern harrier	*Circus cyaneus*	NA[2]	E	High	Open shortgrass fields, wetlands and recently harvested agriculture fields.
sandhill crane	*Grus canadensis*	NA[2]	E	Moderate	Wetlands, grasslands, and agriculture fields.
bald eagle	*Haliaeetus leucocephalus*	NA[3]	T	Moderate	Areas around large bodies of water – lakes and rivers.
Freshwater Mussels					
clubshell	*Pleurobema clava*	E	E	Low	Clean, loose sand and gravel in medium to small rivers and streams. This mussel will bury itself in the bottom substrate to depths of up to four inches.
rayed bean	*Villosa fabalis*	C	E	Low	Mostly small headwater creeks but records exist in larger rivers. They are usually found in or near shoal or riffle areas in gravel and sand.

[1] E=Endangered, T=Threatened, C=Candidate (federal only), NA= Not listed (no status)
[2] Birds are federally protected under the Migratory Bird Treaty Act
[3] Bald eagles are federally protected under the Bald and Golden Eagle Protection Act.
Source: *ODNR 2009, USFW 2009a*

5.1.1 Federally Protected Species

Indiana myotis (Endangered) – In winter, Indiana myotis live in caves and abandoned mines (USFW 2007, ODNR 2009). Male and female Indiana bats then segregate in the summer. It is assumed that male bats roost alone or live in small bachelor colonies. Females nest under loose bark of exfoliating trees or in tree hollows. See section 5.2 for information on the status of Indiana myotis in Ohio. Based on known information, the likelihood of occurrence is low due to unsuitable habitat winter hibernacula. Consultation with the USFW shows that the USFW currently has no records for Indiana myotis within Hardin County; however this is due to an absence of survey data for this area. Suitable summer habitat does potentially exist within the project area for maternity colonies. Some individuals may pass through the area during migration. The USFW recommends the primary focus of any survey be mature woodlots greater than 100 acres in size with permanent water sources.

Clubshell (Endangered) - Historically known to have occurred in the Scioto River (USFW 1994, ODNR 2009), the clubshell is found in clean, coarse sand and gravel in runs, often just downstream of a riffle. It cannot tolerate mud or slackwater conditions, and is very susceptible to siltation. Clubshell are known to bury itself in up to four inches of substrate making detection difficult (ODNR 2009). The clubshell are threatened by runoff and channelization, domestic and commercial pollution, in-stream sand and gravel mining, impoundment, and zebra/quagga mussel infestation. The likelihood of occurrence is low within the WRA due to agricultural development. Should the proposed project directly or indirectly impact the Scioto or Blanchard Rivers, further coordination with the USFW and ODNR is warranted, and surveys to determine the presence or probable absence of mussels may be necessary.

Rayed bean (Candidate) - Historically known to have occurred in the Scioto River system the rayed bean is now limited to a small isolated population found in the Brush Creek tributary of the Scioto River in nearby Scioto County (South of Hardin County; USFW 1992a). Adult and juvenile specimens appear to produce byssal threads apparently to attach themselves to substrate particles (ODNR 2009). Substrates typically include gravel and sand, and they are often associated with, and buried under the roots of, vegetation, including water willow *(Justicia americana)* and water milfoil *(Myriophyllum* sp.). Threatened by runoff and channelization, domestic and commercial pollution, in-stream sand and gravel mining, impoundment, and zebra/quagga mussel infestation. The likelihood of occurrence is low in within the WRA given the amount of agricultural development within the WRA. Should the proposed project directly or indirectly impact the Scioto or Blanchard Rivers, further coordination with the USFW and ODNR is warranted, and surveys to determine the presence or probable absence of mussels may be necessary.

5.1.2 State-protected Species

Northern harrier (Endangered) – The northern harrier breeds in abandoned fields, wet hayfields, prairies, and cattail marshes (ODNR 2009). Nesting sites are chosen based on availability and the abundance of prey (small mammals) in adjacent areas. They nest on the ground, commonly near low shrubs, in tall weeds or reeds, on top of low bushes above water, on knolls of dry ground or on dry marsh vegetation. Threats include habitat loss and degradation (e.g., draining of wetlands, monotypic farming), human disturbance of nesting birds, and nest predation. The likelihood of occurrence is high within the WRA as northern harriers will utilize open agricultural fields for hunting. Small amounts of grasslands may still be present to provide some habitat for breeding.

Sandhill crane (Endangered) - Sandhill cranes are primarily a wetland-dependent species (ODNR 2009). On their wintering grounds, they will utilize agricultural fields; however, they roost in shallow, standing water or moist bottomlands. On breeding grounds they require a rather large tract of wet meadow, shallow marsh, or bog for nesting. The likelihood of occurrence within the WRA is moderate as sandhill cranes often utilize agricultural fields to forage in when during migration during the spring and fall.

Bald eagle (Threatened) - The bald eagle can be found near sizeable bodies of water, natural and man-made. In Ohio, the bald eagle's stronghold is the marsh region of western Lake Erie (ODNR 2009). Bald eagles prefer an area where water with ample food (fish) is located within two miles of the nest site. Nesting begins as early as February and March. Bald eagles have nested in Hardin County (ODNR 2009) however no specific information was given as when they nested or where in Hardin County. Given the presence of the Scioto River as potential suitable habitat and documentation that bald eagles have nested in Hardin County, the likelihood of occurrence is moderate. Bald eagles are protected by the Bald and Golden Eagle Protection Act.

5.1.3 State Species of Special Concern

Under the State of Ohio's Threatened and Endangered Species Program, a species of "concern" is a species or subspecies which might become threatened in Ohio under continued or increased stress (ODNR 2009). Also, a species or subspecies for which there is some concern, but for which information is insufficient to permit an adequate status evaluation. This category may contain species designated as a furbearer or game species, but whose statewide population is dependent on the quality and/or quantity of habitat and is not adversely impacted by regulated harvest. These species are not protected by the Ohio Threatened and Endangered Species law and the use of the term "concern" does not mean the species will be proposed for listing as threatened or endangered; however, some animal species listed as special concern are protected under other state and federal laws addressing hunting, fishing, collecting and harvesting (ODNR 2009). The ODNR has identified two state species of special concern known to occur within Hardin County (Table 5). Species occurrence and distribution information is often based on opportunistic observations, so a lack of records does not necessarily indicate that a species is absent from a particular area.

Table 5. State Wildlife Species of Special Concern Documented within Hardin County.

Common Name	Scientific Name	Likelihood of Occurrence Within WRA*	Habitat Association
sharp-shinned hawk	*Accipiter striatus*	Low	Forests. They can also be seen in agricultural and suburban areas, mostly during migration.
henslow's sparrow	*Ammodramus henslowii*	Low	Grasslands greater than 100 acres.

Source: ODNR 2009.

5.2 Bats

Bat collision mortality at wind farms is a widespread phenomenon, often exceeding avian collision mortality. Of forty-six species of bats in North America, eleven species have been identified among fatalities at wind farms, although no federally endangered or threatened bats have been reported as fatalities at a U.S. wind farm. Typically, bat mortality involves solitary, tree-roosting bat species. The overall average bat fatality rate for U.S. wind projects is 3.4 fatalities per turbine per year, or 4.6 per MW per year (RESOLVE, Inc. 2004). The highest rates of bat mortality at wind farms have been found in the eastern U.S. (Arnett et al., 2008), with one particularly large fatality event occurring at Mountaineer, West Virginia (Kerns and Kerlinger 2004). In all other regions of the U.S., bat fatality rates are relatively low. Bat mortality occurs primarily in the late summer and early fall. The seasonal timing of high bat fatality rates at wind farms does suggest that migrating bats are involved.

Other evidence regarding bat mortality at wind energy facilities suggests that fatalities do not involve resident or foraging populations (Johnson 2005, Arnett et al. 2008). With respect to resident populations, research has shown that at select locations in Colorado, Minnesota, Wisconsin, Wyoming, and Wisconsin, relatively large populations of bats were documented breeding in close proximity to wind farms where no or few fatalities were documented. The turbines in the west and midwest with the highest bat mortality are situated in crop fields, pastures, or shortgrass prairies, all of which are habitats not typically used by foraging, resident bats.

Nine species of bats occur regularly in Ohio, one of which, the Indiana myotis, is listed as endangered by both the Ohio DNR and the USFWS. The Indiana myotis has been detected in 18 counties in Ohio (USFW 2007). Preble County in southern Ohio (~100 miles south of Hardin County) has one Priority 2 (>1,000 bats per site) winter hibernacula (Lewisburg Limestone Mine – USFW 2007). Maternity roosts have been detected in 11 colonies, most in southern Ohio (Ashtabula, Butler, Clermont, Cuyahoga, Greene, Hocking, Lawrence, Paulding, Pickaway, Summit, and Wayne Counties – USFW 2007). The closest known maternity colony to Hardin County is in Paulding County (~50 miles to the northwest). Furthermore, Hardin County does not appear to reside along a possible migratory route between a known winter hibernacula and a summer maternity colony. Hardin County has no records for Indiana myotis (USFWS 2007, ODNR 2009). Given the location of the proposed Hardin WRA relative to these records, the likelihood of Indiana myotis occurrence on the WRA is low (Table 6).

Non-listed bats encountered in Ohio include the big brown bat, little brown myotis, northern myotis, eastern pipistrelle, evening bat, eastern red bat, hoary bat, and silver-haired bat. Three of these species – eastern red bat, hoary bat, and silver-haired bat – appear to be especially prone to turbine-related mortality, particularly during migration (Johnson 2005, Arnett et al. 2008). Little is known about the migration corridors used by these species. The proposed WRA will likely host both breeding and migratory populations of these species (Table 6).

Farm buildings, dead or dying trees, riparian corridors, and wetlands are common areas that may have the greatest potential for bat-turbine interactions. Bats typically utilize farm buildings and dead or dying trees with cavities and loose bark as roosting and maternity habitat; meanwhile, riparian corridors and wetlands commonly serve as feeding habitats due to their higher nocturnal insect densities. Within the Hardin WRA, the most likely places to be utilized by bats in the WRA are barns and established shelterbelts (for roosting) and waterways (for feeding). These areas, or travel corridors between them, may have the greatest potential for bat-turbine interaction. It is important to note, however, that the relative paucity of bat roosting and feeding habitat in the WRA does not mean that bats will not be moving through the WRA during the spring and fall migration periods.

Table 6. Life History Characteristics and Likelihood of Occurrence in Hardin WRA for Bat Species Known to Regularly Occur in Ohio

Common Name (*Scientific Name*)	State Status[1]	Federal Status[1]	Likelihood of Occurrence Within WRA*	Foraging Habits/Habitat	Summer Roosts	Winter Roosts or Hibernacula	Ohio Range Notes
big brown bat (*Eptesicus fuscus*)	NA	NA	High	Generalists in their foraging behavior and habitat selections, seemingly showing little preference for feeding over water vs. land, or in forests vs. clearings.	Roosts beneath loose bark and in small cavities of pine, oak, beech, bald cypress and other trees. Maternity roosts can be found in buildings, barns, bridges, and even bat houses. Colonial.	Winter roosts tend to be natural subterranean locations such as caves and underground mines where temperatures remain stable. Colonial.	Range overlaps with WRA.
tri-colored bat (*Perimyotix subflavus*)	NA	NA	High	Forage over watercourses or over pastures and woodlands. Likelihood based on range overlap with WRA, and riparian areas and pasture on site.	Roosts in caves, crevices in cliffs, buildings, and other man-made structures.	Hibernates in suitable caves within its summer range. Colonial.	Range overlaps with WRA.
little brown myotis (*Myotis lucifugus*)	NA	NA	High	Forage over water, forest trails, cliff faces, meadows, and farmland.	Roosts in tree cavities and crevices. Colonial.	Very little known. Colonial.	Range overlaps with WRA.
eastern red bat (*Lasiurus borealis*)	NA	NA	Medium	Typically feed around forest edges, in clearings, or around street-lights.	Roost in the foliage of deciduous or sometimes evergreen trees. Solitary.	Migratory. Very little is known about winter habitat or behavior. Solitary.	Range overlaps with WRA.
evening bat (*Nycticeius humeralis*)	NA	NA	Medium	Feed on flying insects, commonly in open habitat, such as crop fields.	Forms nursery colonies in hollow trees, behind loose bark, and sometimes in buildings and attics. Colonial.	Winter range is unknown.	Range overlaps with WRA
hoary bat (*Lasiurus cinereus*)	NA	NA	Medium	Found in deciduous and coniferous forests. Often forages in early evening along watercourses. Feeds primarily on moths.	Typically roost 10-15 feet up in trees along forest borders. Solitary.	Winters on tree trunks and tree cavities. Solitary.	Range overlaps with WRA.

Table 6. Life History Characteristics and Likelihood of Occurrence in Hardin WRA for Bat Species Known to Regularly Occur in Ohio

Common Name (*Scientific Name*)	State Status[1]	Federal Status[1]	Likelihood of Occurrence Within WRA*	Foraging Habits/Habitat	Summer Roosts	Winter Roosts or Hibernacula	*Ohio* Range Notes
northern myotis (*Myotis septentrionalis*)	NA	NA	Medium	Has been observed foraging along forest edges, over forest clearings, at tree-top level, and occasionally over ponds.	Found in dense forest stands and chooses maternity roosts beneath exfoliating bark and in tree cavities. Solitary.	Relies upon caves and underground mines. Solitary.	Range overlaps with WRA.
silver-haired bat (*Lasionycteris noctivagans*)	NA	NA	Medium	Feed predominantly in disturbed areas, sometimes at tree-top level, but often in small clearings and along roadways or water courses.	Form maternity colonies almost exclusively in tree cavities or small hollows. Like many forest-roosting bats, silver-haired bats will switch roosts throughout the maternity season.	Typical hibernation roosts for this species include small tree hollows, beneath exfoliating bark, in wood piles, and in cliff faces. Occasionally silver-haired bats will hibernate in cave entrances, especially in northern regions of their range. Colonial.	Range overlaps with WRA.
Indiana myotis (*Myotis sodalis*)	E	E	Low	Summer foraging by females and juveniles is limited to riparian and floodplain areas. Creeks are apparently not used if riparian trees have been removed. Males forage over floodplain ridges and hillside forests.	Roost and rear their young under loose bark or in tree hollows. Colonial.	Caves or mines. Colonial.	Range overlaps with WRA.

*Likelihood based on presence of appropriate foraging habitat and distance to known locations

[1]E=Endangered, T=Threatened, C=Candidate (federal only), NA= Not listed (no status). *ODNR 2009, USFW 2009a*

5.3 Raptors

Raptor species include hawks, eagles, falcons, kestrels, owls, and vultures. Concerns regarding potential impacts to raptors from wind turbines or associated electric transmission lines have been expressed by the USFWS at other wind energy projects. According to a report prepared by the National Wind Coordinating Committee (NWCC 2004), raptor species appear to be at higher risk of collisions with wind turbines than other avian species relative to their occurrence, and the reason for this higher frequency relative to other species is not fully understood.

Composition of avian fatalities is most likely biased towards larger birds, since small birds are more difficult to detect, and scavenging of small birds can be expected to be higher (Johnson et al., 2000). Of 841 avian fatalities reported from California studies, 41.5 percent were diurnal raptors. Outside of California, diurnal raptor fatalities comprised only 2.7 percent of wind farm fatalities. The high levels of raptor mortality associated with some California wind farms have not been documented at wind farms constructed in other states (WEST, Inc. 2001).

Raptor densities are expected to be highest in unfragmented areas of forested and shrubland habitats. These habitats are not abundant within the proposed WRA. Potential perches are present on the poles of existing power lines, fence posts, and trees in shelterbelts. Raptor collisions with wind turbines may be most likely to occur while the raptor is foraging or stooping towards a prey item. A dense or abundant prey base within the WRA may attract a greater number of raptors within the vicinity of wind turbines, and subsequently increase the potential for collision fatalities among raptor species. The Hardin WRA may be attractive to raptors because of the presence of rodent prey species utilizing waste grain as a food resource. Prey sources within the WRA might include small birds, mice, voles, squirrels, woodchuck, cottontails, and other small animals.

5.4 Avian Migration and Potential Occurrence in the Hardin WRA

The Hardin WRA lies within the Mississippi Flyway, which is heavily utilized by numerous species of birds during the spring and fall migrations (USFW 2009b, BirdNature 2009). These include many species of waterfowl (i.e., ducks, geese, and swans), shorebirds, songbirds, and raptors. Bird-turbine interactions are determined by a number of factors including visibility and weather, with increased bird and turbine interactions occurring at night and in inclement weather. Inclement weather and low cloud ceilings force migrating birds to fly at reduced altitudes, thereby putting them at greater risk for adverse interactions with turbines, turbine towers and support infrastructure (NWCC 2004). Based on the low number and types of wetlands present in the WRA, these habitats are not likely to provide critical habitat for large numbers of breeding waterfowl or shorebirds.

No large fatality events of nocturnal migrant passerines (defined as over 50 individuals in one night) have been recorded at existing wind projects (Erickson et al., 2002; NWCC 2004). Erickson et al., (2002) summarized information on fatalities recorded at wind power projects where standardized fatality monitoring was conducted and estimated that nocturnal migrants comprised approximately 50 percent (estimated range of 34 to 59 percent) of the fatalities at new wind projects. Only two small fatality events have been documented, one with 14 nocturnal migrants at Buffalo Ridge in Minnesota, and one with 33 migrants at the Mountaineer Wind Energy Center in West Virginia near a well-lit substation (Erickson et al., 2002; Kerns and Kerlinger 2004). In West Virginia, the substation lights were subsequently turned off, and no further events were recorded. In both cases, weather conditions may have also been a factor.

Although passage rates of migrating birds have been estimated by numerous radar studies (Mabee and Cooper 2001, Mabee and Cooper 2004, ABR Inc. 2004), only a few studies have attempted to relate estimated passage rates to estimated collision rates (McCrary et al. 1986, Mabee and Cooper 2001, Erickson et al. 2003, Erickson et al. 2004). These studies indicated that the number of fatalities compared to the number of birds passing over the turbines was extremely low. McCrary et al. (1986) estimated that 75 million migrants passed over the San Gorgonio, California wind project and that only 0.009 percent of those became fatalities. Erickson et al. (2004) estimated that of the approximately 3.5 million migrants that passed over the Buffalo Ridge, Minnesota, wind power project, less than 0.01 percent were killed by turbines. Similarly, only a small number of the several hundred thousand to one million migrants passing over the Stateline Wind Project's 454 turbines resulted in fatalities (Erickson et al., 2004). Radar studies of nocturnal migration at the Stateline and Vansycle Ridge project areas in Oregon during the spring and fall of 2001 recorded 85 percent (spring) to 94 percent (fall) of targets (birds) observed flew at altitudes above proposed turbine heights (Mabee and Cooper 2004).

5.5 Regulated Commercial and Recreational Species

The ODNR maintains a list of species regularly hunted in the state. Several common commercial (muskrat, fox, coyote, beaver, skunk, raccoon, mink, and opossum) and recreational species (deer, squirrel, rabbit, woodchuck, pheasant, turkey, doves, boar, and waterfowl) may be present on the WRA. Much of the WRA is on privately owned lands and written permission from the land owner and a valid Ohio hunting permit are required to hunt on private lands (ODNR 2009). While it is anticipated that most of the species do occur on the WRA (either permanently or seasonally) the likelihood of occurrence for most recreational and commercial species will be low to moderate. Several species (such as pheasant, turkeys, waterfowl, deer, and rabbits) that are attracted to agriculture will have a moderate to high likelihood of occurrence. Most of these species can be confirmed to be on the WRA through other surveys such as avian and wetland surveys. No additional surveys should be required unless directed by the ODNR. Additionally, as the project progresses, consultation with the ODNR may help identify any state protected hunting areas or game preserves that should be avoided.

5.6 Wildlife Impact Assessment and Recommendations

Based on the available literature, it is anticipated that impacts to wildlife species (particularly birds and bats) from the proposed Hardin WRA would be low to moderate. According to the ODNR and USFWS, two federally endangered species, one federally threatened species, two candidate species and three additional state threatened or endangered species of wildlife are known to occur within Hardin County. As the project develops, surveys may be required for any potential disturbance to listed species. Since wetlands are not to be disturbed, no additional surveys may be needed for the listed species of mussels.

Due to the lack of information available concerning bird populations, especially migratory species, within the WRA, Tetra Tech recommends conducting point counts during the spring (April – June) and fall (August to October) migration periods. This information could then be used to delineate areas or habitats within the WRA with lower bird use (and, therefore, potential risk), and identify more favorable sites for wind turbine placement.

Raptor nest surveys prior to project construction are generally recommended by USFWS. Tetra Tech recommends a spring survey for active raptor nests throughout the WRA to document the intensity of resident raptor use and to identify sites where effects could be further minimized as practicable. This survey would be best conducted prior to project development in order for the results to be used in decisions regarding development or to document changes in use resulting from the facility's construction.

The Hardin WRA falls within the breeding range of the Indiana bat and potential habitat for maternity colonies exist within WRA boundaries. As a result, Tetra Tech recommends conducting a detailed desktop habitat analysis. The objective of this analysis will be to evaluate the amount and location of suitable Indiana bat roosting and foraging habitat in the Hardin WRA. This will include an assessment of the relative value of these habitats in the context of the surrounding landscape. If potential roosting habitat occurs within the WRA, Tetra Tech will assist Invenergy in designing an appropriate mist-netting strategy.

Because bat use is unknown, and potentially suitable habitat for bats is present in the form of barns, shelterbelts, waterways, and wetlands, we recommend that fall and spring acoustic surveys be conducted to gather information on bat passage rates in the various habitats of the WRA. If the results clearly indicate that use is higher in some types of habitat and/or landforms, this information can be used to site turbines in areas with lower bat use.

Where overhead lines are constructed, the USFWS recommends that potential for bird electrocutions and bird strikes be reduced through implementation of measures outlined in "Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006" (APLIC 2006).

The construction of turbine pads, access roads, associated buried electrical collection system, overhead transmission line, substation, and operations and management building would result in temporary, construction-related, and long-term loss of habitat in the small patches of native grassland habitat and agricultural fields within the WRA. In addition, activities such as road construction and tree clearing can destroy or disrupt habitats and allow for the introduction of unwanted plant species. Wildlife would also be temporarily displaced from the WRA during construction. Displaced wildlife would likely temporarily relocate to nearby unaffected areas. In order to minimize impacts to wildlife resources, Tetra Tech recommends utilizing the impacts reduction and mitigation strategies resources presented in NWCC's Mitigation Toolbox (2007) and the USFWS voluntary "Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines" (USFW 2003).

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CULTURAL RESOURCES LITERATURE REVIEW AND SITE VISIT OF THE PROPOSED HARDIN WIND FARM TOWNSHIPS OF CESSNA, LYNN, MARION, McDONALD, AND TAYLOR CREEK, HARDIN COUNTY, OHIO

PRIVILEGED INFORMATION--DO NOT RELEASE

Prepared for
Hardin Wind Energy, LLC

JUNE 2009

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EXECUTIVE SUMMARY

Hardin Wind Energy, LLC (Hardin Wind) is proposing construction of a wind-powered electrical generating facility (the Project) in Hardin County, Ohio. The Project will be located within the Townships of Cessna, Lynn, Marion, McDonald, and Taylor Creek. The project area encompasses 35,864 acres. Facility construction will include up to 200 wind turbines, an operation and maintenance building, an electrical substation, and a construction laydown area. Linear construction will include access roads and a medium voltage collection system. At the time of this review, project layout was in a preliminary design stage, and placement of linear elements had not been formalized.

Tetra Tech EC, Inc. (TtEC) is assisting Hardin Wind by gathering background information to assess archaeological sensitivity of the project area and potential effects on cultural resources, including archaeological sites, from the Hardin Wind Farm. TtEC conducted this Phase I review under the Ohio Power Siting Board's (OPSB) Wind Energy guidelines (Ohio Administrative Code, Chapter 4906-17), and following consultation between Hardin Wind, OPSB, and the Ohio Historic Preservation Office (OHPO), at Columbus, Ohio on May 21, 2009. The Project might require a Nationwide Section 10/404 Permit from the United States Army Corps of Engineers (USACE). If a USACE permit is required, the Project will be reviewed by the USACE and the OHPO under provisions of Section 106 of the *National Historic Preservation Act*, 1966, as amended.

The literature review included three major tasks: background research; field overview; and report preparation. The OHPO site files identify 40 previously documented prehistoric Native American archaeological sites located within one mile of the project area. Previously recorded prehistoric sites range from Paleo-Indian to Late Prehistoric periods. No recorded historic archaeological sites are known within one mile of the project area. Six historic bridges within one mile of the project area are listed on the Ohio Historic Inventory. No determination of eligibility for the National Register has been made for these bridges. No archaeological or architectural properties listed on the National Register are present within one mile of the project area. Two National Register Historic Districts and two National Register-listed individual properties are located within five miles of the project area. Geographical Information System (GIS) review indicates the presence of 44 churches, 33 cemeteries, 72 former and current schools, and 4 parks and recreation areas within five miles of the project area.

Seven environmental zones were identified during the field inspection and following analysis of geo-physical map data and archaeological site patterning. These zones include: end moraine; ground moraine; lake-planed moraine; Scioto Marsh; sand terrace; Scioto River floodplain (non-marsh); and kames. Three local habitats are expected to be especially sensitive for prehistoric archeological sites. The Ft. Wayne end moraine, located at the northern edge of the project area, forms the drainage divide between the Ohio-Mississippi-Gulf of Mexico system to the south and the Great Lakes to the north. Recorded archaeological sites are clustered on the Ft. Wayne end moraine in proximity to the northern margins of Scioto Marsh. Well-drained locations on the Ft. Wayne Moraine are anticipated to be sensitive for the presence of undocumented prehistoric archaeological resources. Well-drained soils on the Wabash end moraine in the southern portion of the project area are also expected to be sensitive for the presence of unrecorded prehistoric archaeological sites, particularly in proximity to the southern margin of Scioto Marsh, and near the North Fork Great Miami River and its tributaries. Several known archaeological sites cluster on the sand terrace at the northern margin of Scioto Marsh near the town of McGuffey. This zone is considered to be sensitive for the presence of as yet undocumented archaeological resources. It is anticipated that not all archaeological sites that may be located within the Project area will qualify as significant landmarks or as eligible for listing in the National Register of Historic Places.

Review of historic maps indicated that most historic buildings and structures occurred on or near roads. The project design has minimized construction impacts on potential historic archeological sites. Turbines are located at least 584 feet (178 meters) from active roads and dwellings. Most proposed access roads and interconnect lines also avoid historic roads and modern structures. It is anticipated that not all architecture, structures, cemeteries, landmarks, and recreation areas that may be located within the Project area and its viewshed will qualify as significant landmarks or as eligible for listing in the National Register of Historic Places .

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1.0 INTRODUCTION

Hardin Wind Energy, LLC (Hardin Wind) has proposed developing the Hardin Wind Farm (the Project) in Hardin County, Ohio (Figure 1). This wind-powered generating facility is designed for approximately 200 wind turbines with a combined capacity of 300 megawatts (MW). The proposed project area measures approximately 35,864 acres and is situated in portions of the Townships of Cessna, Lynn, Marion, McDonald, and Taylor Creek. Project elements will include wind turbine generators, an operation and maintenance building, an electrical substation, access roads, and medium voltage collection system. A temporary construction laydown area will be located within the project area. Electricity generated by the Project will be transmitted to users via the AEP Marysville Substation-East Lima 345kV transmission line. Hardin Wind has requested a backup point of interconnection within the project area on the AEP South Kenton – East Lima 138kV transmission line, however this smaller transmission line would not be capable of providing 300MW of capacity.

Tetra Tech EC, Inc. (TtEC) is assisting Hardin Wind by gathering background information to assess cultural resources sensitivity of the project area and potential effects of the Project on archaeological and architectural properties. TtEC conducted this cultural resource background literature review and site visit under the guidelines of the Ohio Power Siting Board (OPSB) rules regarding wind power that went into effect May 7, 2009 (Ohio Administrative Code, Chapter 4906-17). TtEC and Hardin Wind met with the Ohio Historic Preservation Office (OHPO) and OPSB in Columbus, Ohio on May 21, 2009 to address cultural resources issues associated with the Project. At present, OHPO does not have specific guidelines for cultural resources investigations pertaining to wind power undertakings. The Project might require a Nationwide Section 10/404 Permit from the United States Army Corps of Engineers (USACE). If a USACE permit is required, the Project will be reviewed by the USACE and the SHPO under provisions of Section 106 of the *National Historic Preservation Act*, 1966, as amended.

This background literature review and field overview involved three major tasks, including background research, a field inspection of the proposed project area, and report preparation. Background research was conducted to identify important aspects of the natural environment, known prehistoric and historic Native American archeological sites, and historic Euro-American sites located within a one-mile (1.6-kilometer) radius of the proposed project area. The project area was visited by Sydne Marshall, Ph.D. and Robert Jacoby, M.A., on May 20, 2009.

Following this Introduction, Section 2.0 describes the results of background research, including the project environmental setting and the prehistoric and historic cultural contexts. Section 3.0 discusses the development of sensitivity models for prehistoric and historic archaeological sites within the project area. Section 4.0 summarizes the findings and possible further investigations. Section 5.0 presents references cited in the report. Figures, Tables and Photographs follow the text. Sydne Marshall served as TtEC principal investigator for cultural resources investigations. Robert Jacoby wrote this report.

2.0 BACKGROUND RESEARCH

TtEC staff conducted a file search at OHPO to collect information on previously recorded archaeological sites, archaeological surveys, and historic properties within a one-mile (1.6 kilometers) radius of the project area. Resources consulted at OHPO included the Ohio Historic Inventory, the Ohio Archaeological Inventory, the National Register of Historic Places (NRHP), and the Ohio Historic Bridge Inventory. Additional information on Hardin County history and historical maps came from the collection of the Mary Lou Johnson-Hardin County District Library in Kenton, Ohio.

Table 1 presents information on 40 previously recorded prehistoric-period archaeological sites located within one mile of the project area. No historic-period sites have been identified within one mile of the project area. The recorded sites represent base camps, short-term camps, procurement and processing stations, lithic scatters, isolated finds, and kame burials. The sites are located in four environmental settings: Ft. Wayne end moraine (n=25); sand terrace (n=7); ground moraine (n=4); Scioto River floodplain (non-marsh) (n=1); Scioto Marsh (n=1); lake-planed moraine (n=1); and kame (n=1). No NRHP-listed properties are present within one mile of the project area.

One archaeological survey has been conducted within one mile of the project area. DeRegnaucourt (1984) performed a longitudinal study of the headwaters of the Scioto River, one of several such investigations undertaken in Ohio during the 1980s under Ohio Historical Society survey and planning grants. Within a 10 mile by 4 mile corridor extending roughly southeast to northwest between Kenton and Alger, DeRegnaucourt surveyed 615 acres divided between five environmental zones: Scioto River floodplain, Scioto River terrace, secondary stream valleys, uplands, and the Ft. Wayne end moraine, a Wisconsinan glacial feature. The study identified 70 previously unrecorded archaeological sites, with datable components from Paleo-Indian; Early-, Middle-, and Late-Archaic; Early-, Middle, and Late-Woodland; and historic periods (1984:3). The majority of prehistoric sites clustered around the Scioto River terrace and Scioto Marsh terrace. Approximately 50 percent of DeRegnaucourt's study area is within the project area.

During the nineteenth century, extensive quarrying of glacially derived gravel deposits in Hardin County uncovered numerous prehistoric-period Native American burials located within kames. Typically associated with the burials were distinctive sandal-shaped shell gorgets, copper artifacts, tubular stone pipes, and polished birdstones that collectively came to be referred to as the Glacial Kame Culture (Cunningham 1948). Identified from southern Ontario to western Illinois, these burial sites are coterminous with Late Archaic and Early Woodland groups (Dragoo 1963:239-245). Dragoo speculated that the Adena cultural phase was a direct descendant of the Glacial Kame Culture, particularly its emphasis on burial symbolism and practices. Hardin County is an important center of this cultural expression, and three kame sites are located within one mile of the project area. While such sites continued to be found into the twentieth century, none were excavated and recorded using professional archaeological methods. The Zimmerman Site (33HR2) yielded 148 burials exposed during quarrying activities in 1931. Located approximately two miles west of the project area, the Zimmerman Site is listed on the National Register. An additional nine kame sites are located in the Taylor Creek and Silver Creek drainages approximately two to three miles east of the project area.

Three archaeological surveys investigated areas within approximately five miles of the project area. Weller von Molsdorff et al (1996) surveyed 50 acres outside the town of Ada, Ohio about 4.5 miles north of the project area, and identified six prehistoric-period archaeological sites. Temporally diagnostic finds included Paleo-Indian, Early- and Late-Archaic, and Middle/Late-

Woodland material. Fobes and Skinner (1988) surveyed 60 acres along the southern terrace of the Scioto River near Kenton, Ohio, 4.7 miles east of the project area. They identified six non-diagnostic lithic scatter sites. Wilson and Bergman (2000) surveyed 55 acres southwest of the town of Alger, Ohio, about 1.5 miles west of the project area. Their investigations identified three non-diagnostic lithic scatters, two isolated LeCroy point (Middle Archaic) finds, and three nineteenth century farmsteads.

2.1 Environmental Setting

Hardin County belongs to the Central Ohio Clayey Till Plain region of the Central Lowland physiographic province (Brockman 1998). The Till Plains section is a portion of the glaciated area east of the Mississippi River in which the movement of the ice was minimally controlled and diverted by deep valleys (Fenneman 1938:500). Bedrock underlying this region consists of Ordovician limestone overlain by Silurian dolomite (Ohio Division of Geological Survey 2009). The project area lies entirely within the glaciated portion of Ohio, with at least three Pleistocene glacial advances represented by surficial geology. The pre-Illinoian, dating more than 300,000 years before the present (BP), is the least well known of the three advances and shows limited evidence as ground moraine in the lower Ohio River valley. The Illinoian glacial advance dates from 300,00 to 130,000 BP and is broadly expressed as ground moraine in a sinuous band from southwestern to northeastern Ohio. There is no evidence of the Illinoian episode in Hardin County. The final glacial advance during the Pleistocene, the Wisconsinan, covered two-thirds of the surface of Ohio in the period from 24,000 to 14,000 BP, and is responsible for sediment deposits above bedrock that range from near-surface to 100 feet in depth in Hardin County (Ohio Division of Geological Survey 2009).

The Wisconsinan ice advance left evidence of multiple retreat episodes in the form of parallel end moraines, where the melting front of the glacier remained stationary for considerable lengths of time. In Hardin County, three such end moraines are present. The Ft. Wayne Moraine forms the upland terrain at the northernmost edge of the project area, and represents the drainage divide between the Ohio-Mississippi-Gulf of Mexico system to the south and the Great Lakes to the north (Figure 2). The Wabash and St. Johns Moraines are situated to the south of Scioto Marsh.

The principal drainage within the project area and environs is the Scioto River, which arises in the southwestern corner of Hardin County and is deflected southeastward by the Ft. Wayne Moraine to its confluence with the Ohio River. The North Fork Great Miami River drains the southern portion of the project area from uplands formed in the Wabash Moraine. Drainages tributary to the Scioto River in the vicinity of the project area include Taylor Creek, Silver Creek, Payden Run, McCoy Run, and Flat Branch. A prominent feature of the project area is Scioto Marsh, a late-glacial lakebed occupying approximately 16,000 acres in the western part of Hardin County (Spongberg and Moebius 2006:181). Drained in the latter part of the nineteenth century and early twentieth century, the muck soils of the marsh support extensive cultivation. Topography of the project area is generally level with slight rises within end moraines. Elevations range from 955 feet above seal level in Scioto Marsh to 1100 feet in the uplands of the Wabash Moraine at the southern portion of the project area.

The dominant geologic and parent soil material in the county is glacial drift derived from dolomitic limestone. This glacially deposited material is composed of unsorted till and deposits of stratified outwash. Soils in the project area formed from till, and in the Scioto Marsh area from organic and lacustrine deposits. Till-derived soils include the Blount-Pewamo unit which formed on broad flats and slight rises on ground moraines, and the Blount-Glynwood-Pewamo unit, formed on somewhat more sloping end moraines. The principal soil unit of Scioto Marsh is

Roundhead-McGuffey, derived from organic material and lacustrine sediment on lake plains. The Milford-Patton unit comprises the northern margin and first terrace of the marsh, and was formed on broad flats on lake plains (Miller and Robbins 1994).

Following retreat of glacial ice, herbaceous plants colonized the glacial landscape, with alders and water birch expanding along drainages. By 12,000 BP, warmer-adapted trees began expanding into the lower Erie-Ontario Lowlands, including white pines, northern hardwoods (birch, alder, beech and hemlock) and oaks. Climate became warmer during the subsequent Boreal period (10,200 to 8,000 BP) corresponding with increases of pine, oak, birch, hemlock, and ash across uplands and lowlands. Climatic warming culminated in a period of maximum heat and dryness during the Atlantic climatic period (8,000 to 5,000 BP), corresponding with increases of oaks and other hardwoods, with hemlocks dominating in moister areas. Late Holocene climates became wetter and cooler during the Sub-Boreal climatic period (5,000 to 2,500 BP), then warmer during the Sub-Atlantic climatic period (2,500 to 500 BP) to a cold period during the Little Ice Age (500 to100 BP). The Little Ice Age marked a significant cold period discernible by the expansion of spruce, northern hardwoods, spruce and hemlock on uplands of the Appalachian Plateau (Davis 1983).

The present distribution of plants in the project area bears little resemblance to the natural environment first encountered by Euro-American traders and settlers. At the time of earliest Euro-American settlement, nearly all of Hardin County was forested with beech and maple communities on better-drained uplands, and elm and ash communities on poorly drained soils (Miller and Robbins 1994:62). An early atlas of Hardin County mentions various maples, hickory, cherry, ash, walnut, butternut, beech, oaks, and elm among the natural vegetation (Warner, Beers & Co. 1883:739). By the late twentieth century, only seven percent of the county supported woodland, generally small and isolated stands in poorly drained soils considered unsuitable for cultivation. Prior to its drainage, Scioto Marsh was classified as a wet prairie that supported a wide variety of hydric-adapted grasses, sedges, and shrubs (Sears 1926).

Faunal remains recovered at Sheriden Cave (33WY252), a Paleo-Indian-period site located about 25 miles northeast of the project area, indicate the presence of a wide range of taxa, including caribou, black bear, white-tailed deer, beaver, woodchuck, small mammals, amphibians, and lizards (Redmond and Tankersley 2005:512-513). Many of the same species were present in the Late Woodland archaeological deposits at Chesser Cave, located about 160 miles southeast of the project area (Prufer 1967:45). Economically significant mammals mentioned in early written descriptions of Hardin County include bear, deer, wild boar, fox, raccoon, and woodchuck, among others (Warner, Beers & Co. 1883:341). Most large mammals have been extirpated from the project area as a result of land clearance and the elimination of habitat.

2.2 Prehistoric Native American Cultural Contexts

Ohio prehistory is characterized by four major chronological periods that correspond to human adaptive shifts to changing natural and cultural conditions. These are the Paleo-Indian Period (12,000-10,000 BP), the Archaic Period (10,000-2,700 BP), the Woodland period (2,700-1,000 BP), and the Late Prehistoric Period (1,000-350 BP). The Archaic and Woodland periods are further subdivided into Early, Middle, and Late periods based on differences among chronologically diagnostic artifacts such as projectile points, ground- and chipped-stone technologies, and ceramic styles during the Woodland stage.

2.2.1 Paleo-Indian Period (12,000-10,000 BP)

Paleo-Indian groups, the first known prehistoric populations to occupy the Ohio region, were highly mobile, small-band hunters of large game. The evidence from Sheriden Cave, located about 25 miles northeast of the project area, indicates that Paleo-Indian groups exploited a wide range of available food resources. Their lithic tool kits are characterized by fluted, lanceolate-shaped projectile points, discoidal cores, serrated blades, and unifacial endscrapers with graver spurs. Paleo-Indian tools in Ohio were most often manufactured from high quality lithic raw material, such as Upper Mercer and Flint Ridge cherts. Sites associated with Paleo-Indian occupations are rare, and isolated finds of shaped-stone fluted points are the most common expression of this archaeological period. Excavations at Sheriden Cave yielded two examples of bone points with beveled edges (Redmond and Tankersley 2005:514-515). Investigations have recovered one Paleo-Indian point within one mile of the project area, from Site 33HR68 along the Scioto Marsh sand terrace (DeRegnaucourt 1984).

2.2.2 Archaic Period (10,000-2,700 BP)

The Archaic Stage (10,000 to 2,700 BP) reflected hunting, fishing and plant gathering subsistence patterns developed in response to increasing environmental diversity. Climatic warming led to forest closure after 10,000 BP and increasing dominance of Boreal conifers and northern hardwoods over Boreal conifers (Davis 1983, Shane et al 2001). The Pleistocene megafauna that were possibly a major focus of Paleo-Indian adaptation had become extinct by the Early Archaic Period (10,000-8,000 BP). The expanding deciduous forests produced a more favorable habitat for such species as white-tailed deer and elk, and though still nomadic, human groups gradually became more geographically restricted as seasonally-oriented hunting and gathering activities were focused on smaller, well-exploited territories (Chapman 1977). Artifacts and assemblages from the Early Archaic period were more diverse in style than earlier toolkits, probably reflecting an increased diversity in resource exploitation, including a broader spectrum of plant foods and aquatic species. Beveled hafted bifaces (e.g. Palmer, Thebes, Lost Lake, and St. Charles varieties) are interpreted as specialized deer-processing tools (Stothers et al 2001). Another stylistic element of the Early Archaic tool form is the manufacture of points with bifurcated bases, such as the MacCorkle and St. Albans varieties. Within one mile of the project area, Early Archaic sites are far more numerous than are Paleo-Indian finds, with 12 sites yielding Early Archaic points including Thebes, Kirk, MacCorkle, and Big Sandy varieties. The majority of these sites are located on the Scioto Marsh sand terrace, located with or immediately adjacent to the project area.

The Middle Archaic period (8,000-5,000 BP) is rather poorly represented in the archaeological record in Ohio, and Purtill (2005) has suggested that this paucity of evidence reflects population reduction or out-migration during this period. It is likely that cultural adaptations were little differentiated from the Early Archaic period, exemplified by the continued use of bifurcated points, such as LeCroy, Lake Erie, and Kanawha varieties. It is during the Middle Archaic period, however, that grooved axes, pestles, and atlatl weights are first noted in the record (Broyles 1971). One Middle Archaic site, represented by a Kanawha point, is present within one mile of the project area.

The Late Archaic period (5,000-2,700 BP) is characterized by increased population evidenced by larger and more numerous sites, the onset of long-distance trade networks, and an increased focus on riverine settings for site locations. These factors appear related to increased environmental stress caused by a shift toward a warmer, drier climate. The manufacture and use of small notched point and narrow stemmed point types became common over broad regions of the eastern woodlands, tool styles that are found in the archaeological record for extended periods. Increased territorial permanence was coupled with the appearance of regional cultural adaptations such as Glacial Kame, Red Ochre, and the Old Copper Cultures (Cleland 1966:93). Ceremonialism grew in importance, indicated by more elaborate, formalized burial practices and the presence of exotic raw materials as symbols of enhanced status and rank. Hardin County was a major focus of the Glacial Kame Culture. Nine archaeological sites within one mile of the project area yielded diagnostic artifacts from the Late Archaic period, three of which are kame burial sites (33HR04, 33HR08, and 33HR25).

2.2.3 Woodland Period (2,700-1,000 BP)

The Early Woodland period (2,700-2,100 BP) represents a cultural expansion of ongoing Late Archaic adaptations, and includes the use of ceramic vessels as a major technological innovation. In southern and central Ohio, the local Early Woodland expression was the Adena culture, noted for its construction of conical burial mounds and circular ceremonial earthworks (Dragoo 1963). Characteristic artifacts of this culture include Fayette Thick (plain and cordmarked), Montgomery Incised, and Adena Plain pottery, gorgets made of ground stone and occasionally of copper, shell bead necklaces, and tobacco pipes of tubular design manufactured from both clay and stone. projectile types associated with the Adena culture are ovate-based stemmed Adena, and broad bladed stemmed Robbins points (Dragoo 1963:178-180). Indicative of increased ceremonialism and trade, animal effigies were incorporated into smoking pipes and pendants, which were sometimes manufactured from exotic stone. The effigies are believed to be expressions of totemic clans. Adena culture is marked by more territorially restrictive seasonal movement than occurred in the Archaic period, with evidence of semi-permanent camp sites in the larger drainage basins, especially along the lower Scioto River (Prufer 1967). Mills (1914) documented 20 mounds in Hardin County, although it is not clear whether these all related to Adena or later Woodland periods. One mapped mound appears to be within the project area, although the 1915 USGS topographic map does not depict an elevated feature in the general area suggested by Mills.

Long distance trade networks reached a zenith with the Hopewell culture during the Middle Woodland period (2,100-1,500 BP). Reaching outward from its core area in the Illinois River valley, Hopewell was present throughout southern and central Ohio. Ceremonially, Hopewell appears to represent a continuation of the Adena culture, although on a more expanded scale. Hopewell groups built burial mounds containing elaborate grave goods, and large ceremonial earthworks. Trade goods from the Upper Great Lakes (copper), Rocky Mountain front (obsidian), and Gulf Coast (marine shell) have been found at Hopewell burial and habitation sites. The earthwork architecture, burial practices, and artifact styles reveal social ranking and leadership roles in Hopewell society. Recent excavations in Ohio suggest that Hopewell society represented dispersed sedentary households practicing horticulture (Pacheco 1996, Smith 2001). Pollen records at Fort Ancient indicate that Hopewell peoples domesticated a variety of plant species with starchy or oily seeds, including goosefoot, maygrass, sumpweed, and sunflower (McLauchlan 2003).Investigations at Brown's Bottom #1 Site (33RO21) indicate the presence of large house structures and deep storage pits during the Hopewell phase (Pacheco et al 2006). Characteristic point types of this period include the broad bladed, corner notched Snyders, followed by the narrower Steuben Expanded Stemmed and Chesser Notched forms (Justice 1987). Diagnostic point types indicate the presence of five Middle Woodland sites within one mile of the project area.

After the decline of Scioto Hopewell circa 1,500 BP, long-distance trade networks contracted and Late Woodland (1,500-1,000 BP) groups shifted residential focus from riverine to a variety of environmental settings. This period is rather poorly represented for most of Ohio, and its definition is based largely on ceramic differentiation. In central Ohio, the predominant ceramic type is the

Cole series, a grit tempered, cordmarked ware. There is a notable modification of projectile point design during the Late Woodland period, with smaller, triangular forms gaining popularity. The triangle point is associated with use of bow and arrow, and continued as the predominant point type through the following Late Prehistoric period. Toward the end of the period, the cultivation of maize and other cultigens began to make up a significant portion of dietary requirements leading to greater nucleation of residential settlement patterns.

2.2.4 Late Prehistoric Period (1,000-400 BP)

An influx of Mississipian groups and influences circa 1,000 BP led to the appearance of the Fort Ancient culture in the Ohio valley and central Ohio (Drooker 1997). With an emphasis on maize agriculture, Fort Ancient sites reflect increased sedentism and population size, along with a focus on riverine settings. More stable food surpluses, increased social complexity, and greater territoriality are associated with the emergence of chiefdoms during this period. The presence of some palisaded villages among Fort Ancient communities suggests that population pressure and competition for resources led to conflict between groups. Diagnostic artifacts recovered from Fort Ancient sites continue the Late Woodland patterns of grit-tempered ceramics and triangular projectile points. The Late Prehistoric period is poorly represented in Hardin County, and only two sites within one mile of the project area contain Madison points.

2.3 Historic Cultural Contexts

2.3.1 Contact Period (AD 1600-1820)

Earliest historic references to Ohio indicate extensive raiding by the Iroquois into the region south of Lake Erie, which wrested control from the Erie around 1650 (Hunter 1978:588). The Iroquois utilized the area between Lake Erie and the Ohio River for hunting, especially in their pursuit of deer hides for their lucrative trade with the French and English. Contacts between Native Americans and Europeans can be confirmed by the mid-seventeenth century in the Ohio valley, but within interior regions these encounters occurred decades later (Hunter 1978:588). Initially of a limited nature, interaction between the two groups intensified through the eighteenth century. In the mid-eighteenth century groups of Miami entered western Ohio from the region south of Lake Michigan, and Wyandot moved into the Maumee River and Sandusky River basins from the north. During this period, Miami, Wyandot, and Shawnee all utilized the area that encompassed Hardin County. With the introduction of increasing numbers of Euro-American settlers to the region in the second half of the eighteenth century, sporadic conflicts occurred, and Native American groups began migrating westward to avoid destruction. After the American Revolution, the United States forced a series of treaties upon Native Americans, pushing them out of the Ohio valley, and in 1842, when the Wyandot surrendered their final claim to land around Upper Sandusky, Ohio was emptied of its Native American inhabitants (Hunter 1978:593).

2.3.2 Hardin County History

During the War of 1812, the Ohio Militia established Fort McArthur on the Scioto River, about three miles upstream from the present location of Kenton, Ohio. The fort remained garrisoned until 1816. The first permanent Euro-American settlement in the region was on the Scioto River at Roundhead in 1818. The Treaty of the Maumee Rapids in 1817 dispossessed the Wyandot, Seneca, Shawnee, and other Native American groups of their claim to northwestern Ohio (Warner, Beers & Co. 1883:272). By 1820, the state of Ohio had organized this territory into 14 counties, with Hardin County established in 1833.

Platting in the county followed two patterns. The Scioto River formed the northern boundary of the Virginia Military District, a vast tract claimed by Virginia after the Revolutionary War as land bounty for war veterans. Land grants within the district were defined by metes and bounds, as was common in Virginia. Outside the district, plats were organized under the township and section system as established by the congressional Land Ordinance of 1785. The township system imposed a rectilinear organization of political subdivisions, roads, and property ownership upon the land.

Economic growth in Hardin County was closely tied to the clearing of the forest for cultivation and the construction of railroads. By 1887 approximately half of the county area, or slightly more than 132,000 acres, had been cleared and turned over for agricultural purposes. Corn, wheat, and oats were the principal crops, with potatoes, dairy, and wool production important secondary activities. The Mad River and Lake Erie Railroad opened a branch to Kenton in 1846 from its Sandusky to Dayton line, creating access for agricultural produce to markets and establishing Kenton as the principal town of the county (Howe 1891: 160). Water power from the Scioto River operated several mills in the vicinity of Kenton, adding to the town's importance as a regional hub. The Ohio and Indiana Railroad laid a line through the northern part of the county in the mid-1850s (Warner, Beers & Co. 1883). A third railroad, the Chicago & Atlantic, connected Kenton directly with Chicago in 1883 (Rumer 1999:46).

Economic take-off stalled in Hardin County until efforts to drain Scioto Marsh and the smaller Hog Creek Marsh succeeded around 1890. The fertile muck soils of the marshes proved exceptionally suited to the cultivation of onions, and by the early twentieth century Hardin County had become one of the principal onion producing centers in North America. The towns of McGuffey and Alger grew to service this industry, and land owners recruited hundreds of seasonal workers to plant, weed, and harvest the onion crop. Kentuckians made up the largest contingent of workers, with most returning home after each harvest (Rumer 1999: 72-76). During the early 1930s, declining wages and decreasing agricultural yields forced many seasonal workers to remain in Hardin County, severely straining local social services. In 1934, striking farm workers clashed with armed police deputies, an event that made national news, and which for many years to come characterized the Scioto Marsh region (Rumer 1999:169-224).

Hardin County had an estimated population of around 32,000 in 2008, with Kenton containing 8,050 residents (U.S. Census Bureau 2009). Median household income in the county for 2007 was $41,500, about 12 percent below the state average. Farmland makes up about 90 percent of the county area, with soybeans and corn planted on 102,700 acres and 81,500 acres, respectively (Miller and Robbins 1994:2). Other significant crops include wheat, oats, and hay.

2.4 Architecture, Standing Structures, and Landmarks of Cultural Significance

The National Register of Historic Places lists three individual buildings and two historic districts within five miles of the project area. Ada Depot (NR #98001014) is a nineteenth century train station in Ada, Ohio. The Hardin County Courthouse (NR #79001863) in Kenton, Ohio is a classical revival building that dates to 1900. Andrew Carnegie funded the construction of the Kenton Public Library (NR #83004311) in 1905. Kenton, Ohio hosts two historic districts: Kenton Courthouse Square Historic District (NR #84003722) which contains 51 buildings and the town green, and North Main-North Detroit Street Historic District (NR #85000867) which includes 158 buildings (NPS 2009) (Figure 4).

The Ohio Historic Inventory (OHI) contains 19 residential properties and farm complexes located within one mile of the project area. These residences include Italianate, Queen Anne, craftsman, bungalow, and vernacular styles, built circa 1850 to 1920. None of these properties are listed on the

National Register; three have been determined not eligible for the National Register and the remainder have no determination. The OHI lists six bridges located within one mile of the project area, four of which cross the Scioto River (Figure 5). The other two cross the North Fork Great Miami River and Cottonwood Ditch, respectively. These bridges date from the 1920s and 1930s and include Pratt half-hip and Warren pony truss designs. None are listed on the National Register, nor have any been determined eligible for listing.

Review of GIS data reveals the presence of 44 churches, 33 cemeteries, and 58 former school buildings and 14 current schools, within five miles of the project area (Figure 4). None of these properties are individually listed on the National Register. Three churches (St. John's United Church of Christ, First United Methodist Church, and First Christian Church) are contributing elements of the North Main-North Detroit Street National Register Historic District in Kenton, Ohio. Table 4 presents locational information on these properties.

2.5 Recreational Areas and Parks

Five recreation areas or parks are located in whole or part within five miles of the project area. Indian Lake State Park, located in northern Logan County, Ohio, is tangential to the five-mile radius around the Hardin Wind Farm project area; more than 99 percent of the park lies outside the five-mile ring. The impounded 5,800-acre Indian Lake contains numerous islands and wetlands, and is fed by the North Fork Great Miami River which traverses the project area. Three municipal parks are located in the Townships of Liberty, Buck, and Marion. The Colonial Golfers Club is located in Jackson Township near the town of Harrod, Ohio (Figure 4).

3.0 ARCHAEOLOGICAL SENSITIVITY MODELS

Archaeological sensitivity is a measure of the potential of a study area to contain significant cultural resources. Sensitivity assessments take into account the known density and distribution of sites in the project area, local environmental factors that might have influenced aboriginal or historical use of the area, and available information from documents, oral traditions, and other sources concerning human use of the area. Though this sensitivity model is based on literature review and map analysis, and has not been field tested to evaluate its utility, the model is one possible tool to assist in estimating if potentially significant prehistoric or historic period archaeological sites may be affected by a proposed project.. It is anticipated that not all archaeological sites that may be located within the Project area will qualify as significant landmarks or as eligible for listing in the National Register of Historic Places.

3.1 Prehistoric Archaeological Sensitivity Model

The pattern of recorded archaeological sites in the vicinity of the project area reflects both, the social organization and resource needs of prehistoric human groups, as well as the frequency and location of archaeological surveys undertaken in the region. Prior to DeRegnaucourt's 1984 longitudinal study of the upper Scioto River valley, few sites had been recorded in the region, with site documentation limited largely to kame burials and find spots by avocational archaeologists (Mills 1914, Cunningham 1948).

DeRegnaucourt surveyed approximately 615 acres, comprising roughly equal parts of five environmental zones in the valley. Approximately 50 percent of the survey was undertaken within the Hardin Wind Farm project area. DeRegnaucourt identified 70 sites clustered in the Ft. Wayne moraine just to the north of Scioto Marsh, on ground moraine forming the terraces of the Scioto River, and on the lower terraces overlooking the northern edge of Scioto Marsh. Isolated sites also occurred within Scioto Marsh and near secondary drainages within slightly undulating terrain that are associated with ground moraine features. Table 2 presents a cross-tabulation of environmental zones and site types of all recorded archaeological sites from OAI files that occur within a one-mile radius of the project area.

Seven environmental zones are present within the project area (Figure 2). They are defined by soils, topography, and drainage. In order of prevalence within the project area, the environmental zones are described below.

- Ground moraine. A flat to gently undulating Late Wisconsinan surface feature composed of clayey till (Photograph 1). Soils belong to the Blount-Pewamo association. Flat areas are interspersed with drainageways and shallow depressions. Better drained areas occur on low knolls and on drainageway side slopes. Elevations range from about 980 to 1050 feet above mean sea level (amsl). Ground moraine composes 26.4 percent of the project area.

- End Moraine. A Late Wisconsinan surface feature that occurs as hummocky ridges higher than adjacent terrain (Photograph 2). Soils belong to the Blount-Glynwood-Pewamo association. The landscape is characterized by knolls and ridges that are bisected by perennial streams and seasonal drainageways. Areas of end moraine comprise the Ft. Wayne Moraine at the northern portion of the project area and Wabash Moraine to the south. The Ft. Wayne Moraine forms the drainage divide between the Ohio-Mississippi-Gulf of Mexico system to the south, and the Great Lakes to the north. Surface elevations are between 980 to 1040 feet amsl in the Ft. Wayne Moraine, and between 1050 and 1135 feet amsl in the Wabash Moraine. End moraine makes up 24.8 percent of the project area.

- Scioto Marsh. Very flat terrain of organic muck and marl soils formed from glacial lake plain (Photograph 3). The soil association is Roundhead-McGuffey. Ground elevation is 968 to 970 feet amsl. The drained marsh is 33.6 percent of the project area.

- Lake-planed moraine. Flat terrain formed on glacial lake plain adjacent to Scioto Marsh and non-marsh sections of Scioto River (Photograph 4). Soils in the zone are members of the Milford-Patton association, and Blount-Pewamo association. Elevation ranges from 970 to 975 feet amsl. Lake-planed moraine includes 11.4 percent of the project area.

- Scioto River floodplain (non-marsh). A narrow region encompasses the non-marsh section of the Scioto River floodplain (Photograph 5). Clayey soils are in the Blount-Pewamo association. Ground elevation is between 970 to 975 feet amsl. The river floodplain makes up 1.5 percent of the project area.

- Sand terrace. A rising terrace of sand delta, bar, and dunes, along the northern edge of Scioto Marsh. Soils are within the Milford-Patton association. The town of McGuffey is situated in this zone. Surface elevations are between 970 and 980 feet amsl. The zone measures 2.4 percent of the project area.

- Kames. Ridges and terraces composed of sand and gravel were deposited by glacial meltwater during the Late Wisconsinan episode (Photograph 6). These well drained landforms are prominent features on the landscape, with elevations frequently 20 feet or more above the surrounding terrain. Kames occupy only a very small fraction of the project area (< 0.1 percent).

Review of map data took account of factors relating to topography, soils, drainage, and geology. Based on the results reported by DeRegnaucourt (1984) and map review, areas of highest archaeological sensitivity within the project area are expected to occur within three environmental zones; end moraine, sand terrace, and kames.

The Ft. Wayne Moraine contains the vast majority of recorded prehistoric sites within one mile of the project area. This zone is considered to be particularly sensitive for the occurrence of prehistoric resources on better drained soils along the northern margins of Scioto Marsh. No sites are recorded within the southern end moraine (Wabash Moraine), however no previous cultural resource surveys have been undertaken in that region. It is considered likely that prehistoric cultural resources may be present within the Wabash Moraine in proximity to the North Fork Great Miami River and its tributaries, and on the better drained soils along the southern margins of Scioto Marsh.

The sand terrace environmental zone contains 18 percent of the known prehistoric archaeological sites within one mile of the project area. It is well-suited for the presence of archaeological sites on better-drained locations because of its proximity to the animal and plant resources that assembled around Scioto Marsh during prehistoric periods.

Three recorded kame sites are present within one mile of the project area. While most of these prominent landforms have been documented or quarried for gravel and sand, an undetermined number of undocumented kames may be present. These glacial-outwash features have the potential to contain burials and camp sites dating to the Late Archaic and Early Woodland periods. The

Zimmerman Kame Site (33HR02), a National Register-listed property, is located about 2.5 miles west of the Project in McDonald Township.

The remaining four environmental zones within the project study area are expected to have low archaeological sensitivity. The ground moraine environmental zone contains several prehistoric sites in proximity to the Scioto River. It does not, however, contain archaeological sites outside of this narrow band near the river. The lake-planed moraine and marsh environmental zones contain very few documented sites, and are considered to have been poorly suited for prehistoric occupation because of wet and poorly drained soils. The Scioto River floodplain (non-marsh) environmental zone has yielded few documented sites. In addition, the construction of a river levee in the twentieth century has resulted in possible removal or disturbance to archaeological sites that may have been present in this zone. Within the project area, therefore, these four zones (ground moraine, lake-planed moraine, marsh, and river floodplain) are not considered sensitive for the presence of archaeological sites.

3.2 Historic Archaeological Sensitivity Model

In contrast to the diversity of environmental settings expected to influence historic archaeological sensitivity, historic maps indicate that the overwhelming majority of historic buildings and structures are located along roads (Howland 1879, USGS 1915a, and USGS 1915b). Due to the level terrain and the resultant low head of water, water-powered mills generally were not feasible within the project area. None are denoted on the historic maps, although the name of Saw Mill Run in Cessna Township suggests the presence of an early mill on that drainage (Howland 1879). Located entirely within the project area, the lower half of Saw Mill Run was re-engineered into a drainage ditch in the early twentieth century. A saw mill in Lynn Township was located on a road, more than one-half mile from the Scioto River, and is thought to have been powered by an internal combustion engine. This mill seat is situated outside of the project area.

On properties located north of the Scioto River, which were platted according to the township-section system, municipalities in the nineteenth century typically placed public schools at the corner of a section near intersecting roads. Most churches also occupied section corners. Cemeteries were more likely to be located on roads between section corners. South of the Scioto River, where platting followed the older metes and bounds scheme, schools were less regularly sited, although all were on roads, and some at crossroads. Commercial enterprises, such as blacksmith shops, were also located on roads (Figure 3).

Temporary housing for seasonal farm workers was located close to the agricultural fields in which they labored, often on farm roads or along drainage ditches (Rumer 1999:84). Crudely built, these one-room sill-on-grade shacks would have left little to no subsurface expression in the archaeological record. Domestic refuse was likely deposited in thin sheet scatters a short distance from the residence or tossed into a drainage ditch. The intensive nature of cultivation on Scioto Marsh land suggests that sheet scatters on the edge of fields retain little depositional integrity and cannot be associated with identified house sites.

Project designs have minimized construction impacts on potential historic archaeological sites, since turbines are located at least 584 feet (178 meters) from active roads and dwellings. Access roads and collection lines also are designed to avoid active roads and modern structures.

4.0 SUMMARY OF FINDINGS

Hardin Wind Energy, LLC is proposing to construct approximately 200 wind turbines on leased private land in the Townships of Cessna, Lynn, Marion, McDonald, and Taylor Creek, Hardin County, Ohio. The project encompasses 35,864 acres located approximately 4 mile west of Kenton, Ohio and 3.5 miles south of Ada, Ohio (Figure 4). No archaeological or architectural properties are listed on the National Register within one mile of the project area.

OHPO site files identify 40 prehistoric period archaeological sites within one mile of the project. These sites range from Paleo-Indian through Late Prehistoric occupations. Site types include base camps, short-term camps, procurement stations, small lithic scatters, and isolated finds. No historic period archaeological sites are documented within one mile of the project area.

Seven environmental zones were delineated following a field visit and analysis of soils and bedrock maps. These environmental zones include: level to slightly undulating ground moraine; sloping end moraine (Ft. Wayne and Wabash Moraines); flat Scioto Marsh; level lake-planed moraine; non-marsh sections of the Scioto River floodplain; sand terraces; and kames. The distribution of recorded archaeological sites in the project vicinity clusters principally in the Ft. Wayne end moraine environmental zone, with a secondary cluster in the sand terrace environmental zone. Documented sites also occur on glacial kame features. These three zones are anticipated to be sensitive for the presence of undocumented archaeological sites.

Another site cluster occurs in the ground moraine environmental zone proximal to the non-marsh sections of the Scioto River. Numerous small lithic scatter and camp sites are situated on low terraces within one-half mile of the Scioto River. Elsewhere, few sites occur within the ground moraine environmental zone. Because the juxtaposition of ground moraine and Scioto River floodplain (non-marsh) occurs only outside of the project area, the ground moraine environmental zone is not expected to be sensitive for the presence of prehistoric archaeological resources.

Three kame burial sites have been documented within one mile of the project area. This landform is considered to be sensitive for the presence of undocumented prehistoric archaeological sites. The kame environmental zone occupies an extremely small percentage of the project area. Because of their prominent appearance on the landscape, the historic quarrying of gravel from kames, and their exploration by avocational archaeologists and local artifact collectors, there are unlikely to be many kame sites within the project area.

Scioto Marsh and the lake-planed moraine environmental zones are not considered sensitive for the presence of prehistoric sites because of the overwhelming preponderance of poorly drained soils. Prior to the start of drainage activities in the second half of the nineteenth century, the marsh itself would have been difficult to traverse and not conducive to supporting even temporary camp or maintenance sites. It is considered very unlikely that cultural resources aside from occasional isolates are present in either environmental zone. An intensive archaeological survey by DeRegnaucourt (1984) identified very few sites within the marsh and lake-planed moraine environmental zones.

Once Hardin Wind Energy selects the turbine type that it will use for the project, it will be possible to coordinate with the appropriate reviewing agencies to define the area of potential effects (APE) for archaeology and for architecture, structures, cemeteries, landmarks and recreation areas. All portions of the end moraine and sand terrace environmental zones are considered to have high potential to contain archaeological sites related to prehistoric time periods. Portions of the ground moraine environmental zone that are located within .5-mile of documented sites or on uplands and topographic rises within 1,000 feet of water courses or drained marsh may also have high potential to contain prehistoric period archaeological sites. Also sensitive are portions of the project area that occur within the Scioto River floodplain (non-marsh) environmental zone, and any kame features that will be affected by project impacts. Similarly, a review of historic maps (Howland 1879; USGS 1915a, 1915b) will indicate the locations of potential historic period archeological sites, an additional criterion for archaeological sensitivity. An unknown number of prehistoric and historic archaeological sites that may be located within the APE for archaeology may qualify as potentially eligible to the NRHP or as locally significant. Hardin Wind Energy will coordinate with reviewing agencies and work with them to determine if any future studies may be required to evaluate project effects to significant archaeological sites.

Hardin Wind Energy expects to avoid impacts to significant archaeological sites, architecture, structures, cemeteries, landmarks and recreation areas through thoughtful and deliberate project design. Hardin Wind Energy's project design will also seek to avoid effects to wetlands and other environmental issues of concern.

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