STATE OF MINNESOTA
BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

In the Matter of the Application of Pleasant Valley Wind LLC For a Site Permit For the 300 MW Pleasant Valley Project in Dodge and Mower Counties	Docket No. IP-6828/WS-09-1197 **PETITION FOR MODIFICATION OR AMENDMENT TO SITE PERMIT**

INTRODUCTION

On October 27, 2010, the Minnesota Public Utilities Commission ("Commission") issued a Site Permit to Pleasant Valley Wind, LLC ("Pleasant Valley Wind") for the 301 MW Pleasant Valley Wind Project located in Dodge and Mower Counties, Minnesota. On February 20, 2013, the Commission issued an amendment to the Site Permit to allow Pleasant Valley Wind additional time to secure an "enforceable mechanism for sale of the electricity to be generated by the Project," complete pre-construction surveys, and commence construction[1] of the Pleasant Valley Wind Project (as amended, the "Site Permit").

Since the Site Permit was issued, Pleasant Valley Wind has continued to advance the project toward construction, including arranging off-take for the project by way of a purchase and sale agreement with Northern States Power company d/b/a Xcel Energy ("Xcel Energy"). As a part of these advancements, adjustments to the Pleasant Valley Wind Project design became necessary; namely, a wind turbine generator other than the options specified in the Site Permit has been selected for the Pleasant Valley Wind Project. The Site Permit specifies in Section 1, the project description, two types of wind turbine generators and their associated tower heights to be utilized for the Pleasant Valley Wind Project: General Electric 1.5 MW wind turbine generators with WindBOOST Control System on 262.5 foot (80 meter) towers with a rotor diameter of 270 feet (82.5 meters) or Siemens 2.3 MW wind turbine generators on 262.5 foot (80 meter) towers with a rotor diameter of 331 feet (101 meters). Pleasant Valley Wind has now identified a different wind turbine generator for the Pleasant Valley Wind Project, which is the subject of this Petition for Modification or Amendment to the Site Permit ("Petition").

With this Petition, Pleasant Valley Wind hereby requests that the Commission amend the Site Permit to specify the alternative wind turbine model and associated changes to the Pleasant Valley Wind Project, as described further herein.

[1] Site Permit at §§ 10.2 and 10.3.

AMENDMENT REQUEST

For the Pleasant Valley Wind Project, Pleasant Valley Wind has selected the Vestas V100 2.0 MW wind turbine generator on 311.7 foot (95 meter) towers with a rotor diameter of 328.1 feet (100 meters). This change in the wind turbine generator identified in the Site Permit modifies the project description, the turbine layout, and the height of the wind turbine towers. Accordingly, Pleasant Valley Wind requests the Commission amend Sections 1, 2.2, and 4.9 of the Site Permit. The proposed amendment to Section 1 specifies the selected wind turbine generator in the project description, as follows:[2]

> The up to ~~301~~ 200 MW nameplate capacity LWECS authorized to be constructed in this permit will be developed and constructed by the Permittee. The Project will consist of up to ~~188 General Electric 1.5 MW wind turbine generators with WindBOOST Control System on 262.5 foot (80 meter) towers with a rotor diameter of 270 feet (82.5 meters) or 130 Siemens 2.3 MW wind turbine generators on 262.5 foot (80 meter) towers with a rotor diameter of 331 feet (101 meters)~~ one hundred Vestas V100 2.0 MW wind turbine generators on 311.7 foot (95 meter) towers with a rotor diameter of 328.1 feet (100 meters) having a combined nominal nameplate capacity of up to ~~301~~200 MW. Associated facilities will include. . . .

The proposed amendment to Section 2.2 references the revised preliminary turbine and associated facility layout (included as Attachment 1 to this Petition), as follows:

> ~~Two preliminary wind turbine and associated facility layouts are shown on maps at Attachments 1A and 1B~~. The preliminary layout of wind turbine generators and associated facilities is shown in Attachment 1. ~~Each~~This preliminary layout represents the approximate location of wind turbines and associated facilities within the Project boundary. . . .

The proposed amendment to Section 4.9 reflects the new tower height, as follows:[3]

> Structures for wind turbines shall be self-supporting tubular towers. The towers may be up to ~~80~~ 95 meters (~~262.5~~ 311.7 feet) above grade, measured from the foundation to ~~at~~ hub height.

[2] In accordance with Commission regulations, Pleasant Valley Wind will file notice in MPUC Docket No. IP-6828/CN-09-937 of the change in the nameplate capacity of the Pleasant Valley Wind Project indicated in the proposed amendment to Section 1 of the Site Permit. A conforming edit to the introductory paragraph of the Site Permit will also be required to reflect this change in nameplate capacity.

[3] As indicated in this revised language, wind turbine foundations may be slightly above grade, such that the hub height may be up to 2 feet higher than the tower specification.

Amending these provisions as described above will enable Pleasant Valley Wind to utilize the selected turbine, but will not otherwise change the terms and conditions of the Site Permit, including provisions establishing setback, survey, and/or reporting requirements.

The Commission has specific authority to amend the Site Permit, and has granted such amendments to other projects. In addition to the language in Section 11.2 of the Site Permit providing for modification of permit conditions, the Commission also has specific authority to modify or amend a site permit for a wind project pursuant to Minnesota Statutes § 216F.04(d) and Minnesota Rules Part 7854.1300, subp. 2.

Indeed, the Commission has found good cause exists and amended site permits for wind projects to permit use of an alternative model or models of wind turbine generator(s) for similar reasons as presented herein.[4]

GOOD CAUSE EXISTS TO AMEND THE SITE PERMIT

Good cause exists to amend the Site Permit to allow Pleasant Valley Wind to use the selected wind turbine generator. The Commission may amend the Site Permit at any time "if there is good cause to do so." Minn. R. 7854.11300, subp. 2. Similar to the other modifications to site permits previously granted that are referenced above, fluctuations in wind turbine availability and project off-take negotiations caused Pleasant Valley Wind to revise its turbine selection for the project.

As is true of many projects proposed to the Commission, the Pleasant Valley Wind Project proposal included multiple options for the wind turbine generator to afford Pleasant Valley Wind the flexibility to adjust to market conditions as project development progressed. In this case, the flexibility built into the project description was insufficient to account for the significant changes in turbine technology, turbine availability, and other market forces that took place during the course of a development process, including delay in the MISO generator interconnection process. Pleasant Valley Wind now has greater certainty with respect to interconnection timing, and recently entered into a purchase and sale agreement for the project.[5]

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[4] *See, e.g., In the Matter of Lake Country Wind Energy, LLC's Application for a 41-Megawatt Large Wind Energy Converstion System in Kandiyohi and Meeker Counties,* Order Amending Site Permit, MPUC Docket No. IP-6846/WS-10-798 (June 3, 2013) (approving amendments to site permit including changing the turbine type and layout for the project due to changes in turbine technology and availability); *In the Matter of the Site Permit Issued to Kenyon Wind, LLC for a Large Wind Energy Conversion System in Goodhue County*, Order Amending Site Permit, MPUC Docket No. IP-6605/WS-06-1445 (February 18, 2009) (approving amendments to site permit including changes to the turbine type and turbine spacing due to concerns with the reliability of the originally-designated turbine).

[5] On July 16, 2013, Xcel Energy filed a petition for approval of 600 MW of wind generation, including 200 MW from the Pleasant Valley Wind Project. *In the Matter of the Petition of Xcel Energy for Approval of the Acquisition of 600 MW of Wind Generation*, MPUC Docket No. E-002/M-13-603 (July 16, 2013). The matter of the petition was heard and approved by the Commission on October 17, 2013.

As such, Pleasant Valley Wind has also identified the Vestas V100 2.0 MW turbine as the optimal wind turbine generator for performance and cost.

While the proposed amendment results in a change in the wind turbine generator, tower height, and turbine layout, the proposed amendment will not substantively change the Commission's findings in its original approval of the Site Permit or whether the project is compatible with environmental preservation, sustainable development, and the efficient use of resources,[6] as the Pleasant Valley Wind Project will comply with all Site Permit terms and conditions.

First, the revised turbine layout is located entirely within the project boundary previously studied for potential human and environmental impacts as part of the LWECS permitting process. The revised turbine layout will comply with all setback requirements and site layout restrictions identified in the Site Permit–setbacks and layout restrictions that are comparable to those that the Commission has approved for projects using wind turbine generators similar to (or larger than) the Vestas V100.[7]

Second, Pleasant Valley Wind has included sound and shadow flicker modeling reports for the proposed Vestas turbine as Attachments 2 and 3 to this Petition, respectively. Pleasant Valley Wind's decision to use the Vestas V100 turbine, and only 100 of them in the layout, produced improved sound and shadow flicker modeling results compared to the turbines originally approved by the Commission for the LWECS Site Permit. Additionally, Pleasant Valley Wind is in the process of evaluating the revised turbine locations for potential impacts to cultural resources, wetlands, and other biological and natural resources, all of which Pleasant Valley Wind will file for pre-construction compliance. Because the revised turbine layout with comply with all Site Permit setbacks and layout restrictions, the proposed Site Permit amendment will not result in any impacts not already considered by the Commission.

Finally, all pre-construction survey, reporting, and administrative compliance obligations set forth in the Site Permit remain unchanged by the proposed Site Permit amendment and will be met by Pleasant Valley Wind. As the pre-construction filing timelines have yet to occur, the proposed Site Permit amendment will not result in any change to or otherwise prejudice the pre-construction evaluation process outlined by the Commission.

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[6] Minn. Stat. § 216F.03 and Minn. R. 7854.0500.

[7] *See, e.g, In the Matter of the Application for a Large Energy Conversion System Site Permit for the 40 MW Getty Wind Project in Stearns County, Minnesota*, Findings of Fact, Conclusions of Law and Order Issuing a Site Permit to Getty Wind Company, LLC for the Getty Wind Project, MPUC Docket No. IP-6866/WS-11-831 (Jan. 28, 2013)(requiring the same or less onerous setback, spacing, and buffer requirements for wind turbines with rotor diameters ranging from 87 to 112 meters and towers up to 100 meters in height); *In the Matter of the Site Permit Application for the 42 MW Large Wind Energy Conversion System in Stearns County, Minnesota*, Findings of Fact, Conclusions of Law and Order Issuing a Site Permit to Black Oak Wind, LLC for the Black Oak Wind Farm, MPUC Docket No. IP-6853/WS-11-608 (Jan. 28, 2013) (requiring the same or less onerous setback, spacing, and buffer requirements for wind turbines with rotor diameters ranging from 87 to 112 meters and towers up to 100 meters in height).

As noted above, the Commission has previously found that good cause exists for modifications to the proposed wind turbine generator and associated project details based on similar justifications relating to market conditions, and the Commission should similarly find that good cause exists for an amendment in this case. Accordingly, it is appropriate for the Commission to amend the Site Permit as requested herein.

CONCLUSION

Because good cause exists and for the reasons set forth herein, Pleasant Valley Wind respectfully requests that the Commission grant the proposed amendment to the Site Permit for the Pleasant Valley Wind Project to permit the use of the selected wind turbine generator.

Dated: November 22, 2013

Respectfully submitted,

/s/ *Brian M. Meloy*

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ATTACHMENT 1

PLEASANT VALLEY WIND

DODGE COUNTY

OLMSTED COUNTY

MOWER COUNTY

Hayfield

Waltham

Sargeant

Brownsdale

Dexter

Grand Meadow

Austin

Elkton

T105 R18W

T105 R17W

T105 R16W

T105 R15W

T104 R18W

T104 R17W

T104 R16W

T104 R15W

T104 R14W

T103 R18W

T103 R17W

T103 R16W

T103 R15W

T103 R14W

T102 R18W

T102 R17W

T102 R16W

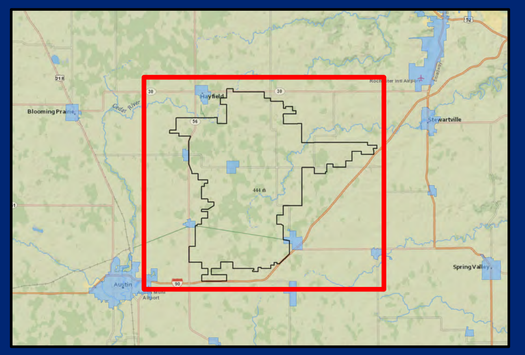
T102 R15W

T102 R14W

LEGEND

- Vestas V100-2.0 Primary Turbine (100 Total)
- Vestas V100-2.0 Alternate Turbine (6 Total)
- Point Of Interconnection
- Proposed Road
- Project Boundary
- County Boundary
- Township & Range Boundary
- Municipal Boundary

PRELIMINARY
SUBJECT TO CHANGE



0 0.5 1 2 3 4 Miles

COORDINATE SYSTEM: UTM27-15 METERS
LAYOUT NUMBER: PUSAGMD205
DRAWING NUMBER: 01772D2214-01
DRAWN BY: EW Date: 11/11/2013
APPROVED BY: ADB Date: 11/11/2013

Renewable Energy Systems
11101 W. 120th Ave., Suite 400, Broomfield, CO, 80021
Phone: (303) 429-4200 Fax: (303) 429-4299

ATTACHMENT 2

GL Garrad Hassan

SOUND MODELING ASSESSMENT

PLEASANT VALLEY WIND FARM, MOWER AND DODGE COUNTIES, MINNESOTA

Client	Pleasant Valley Wind, LLC
Contact	Sean Flannery
Document No.	702501-USPO-R-01
Issue	B
Status	Final
Classification	Client's Discretion
Date	15 November 2013

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Checked by

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REVISION HISTORY

Issue	Issue Date	Summary
A	14 November 2013	Initial issue for review
B	15 November 2013	Reissuance based on Client comments

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Pleasant Valley Wind, LLC has requested Garrad Hassan America, Inc. ("GL GH") perform environmental and permitting services including a sound modeling assessment for the Pleasant Valley Wind Farm located in Mower and Dodge counties, Minnesota, approximately 160 km south of Minneapolis. The Project consists of 100 Vestas V100-2.0 MW wind turbine generators at a hub height of 95 m and a rotor diameter of 100 m.

These turbines can have an effect on the sound levels experienced at receptors in the vicinity of the site. Sound impacts from a Project substation and neighboring wind farms are also included. The objective of this assessment is to predict the sound levels generated by the Project's wind turbine generators at all receptors, using the ISO 9613-2 method [1] and in accordance with *Minnesota Administration Rule 7030.0040 Noise Standards* ("Minnesota Noise Standards") [2].

This report includes an explanation of environmental sound, applicable state regulations, a brief description of the Project site, an assessment of the sound assessment methodology, results of the analysis including maps showing sound pressure levels at each receptor, and concluding comments.

2 ENVIRONMENTAL SOUND BACKGROUND

Sound levels are expressed in the decibel unit and are quantified on a logarithmic scale to account for the large range of acoustic pressures to which the human ear is exposed. A decibel (dB) is used to quantify sound levels relative to a 0 dB reference. The reference level of 0 dB is defined as a sound pressure level of 20 micropascals (µpa), which is the typical lower threshold of hearing for humans.

Sound levels can be presented both in broadband (sound energy summed across the entire audible frequency spectrum) and in octave band spectra (audible frequency spectrum divided into bands). Frequency is expressed in the Hertz unit (Hz), measuring the cycles per second of the sound pressure waves. The audible range of humans spans from 20 to 20,000 Hz. Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighting filter is applied to closely approximate the human ear's response to sound. This scale is commonly used in environmental and industrial sound. Sound expressed in the A-weighted scale is denoted dBA.

A sound source has a certain sound power level (PWL) rating which describes the amount of sound energy per unit of time. This is a basic measure of how much acoustical energy it can produce and is independent of its surroundings. Sound pressure is created as sound energy flows away from the source. The measured sound pressure level (SPL) at a given point depends not only on the power rating of the source and the distance between the source and the measurement point (geometric divergence), but also on the amount of sound energy absorbed by environmental elements between the source and the measurement point (attenuation). Sound attenuation factors include meteorological conditions such as wind direction, temperature, and humidity; sound interaction with the ground; atmospheric absorption; terrain effects; diffraction of sound around objects and topographical features; and foliage.

3 APPLICABLE REGULATIONS

The regulations applicable to the Pleasant Valley Wind Farm are the Minnesota Noise Standards.

Minnesota Administrative Rule 7030.0040 Noise Standards state the following [2]:

> ***7030.0040 Noise Standards.***
>
> ***Subpart 1. Scope.*** *These standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare. These standards are consistent with speech, sleep, annoyance, and hearing conservation requirements for receivers within areas grouped according to land activities by the noise area classification (NAC) system established in part 7030.0050. However, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare. Noise standards in subpart 2 apply to all sources.*
>
> ***Subp. 2. Noise Standards.***

Table 3-1: Minnesota Noise Standards

	Daytime		*Nighttime*	
Noise Area Classification	L_{50}	L_{10}	L_{50}	L_{10}
1	*60*	*65*	*50*	*55*
2	*65*	*70*	*65*	*70*
3	*75*	*80*	*75*	*80*

Wind farms are considered under noise area classification 1, which includes homes, other residential uses, religious activities, and educational services [3]. The applicable nighttime limit is therefore 50 dBA for each of this project's receptors.

The state of Minnesota also has prepared the Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota, which was used in the development of this report and states the following [4]:

> *8.3. Noise*
>
> *Provide existing and projected ambient noise levels. The project must meet MN noise standards (Minnesota Rules Chapter 7030) at all residential receivers (homes). Typically 750-1500 ft is required to meet noise standards depending on turbine model, number of turbines, layout, and site specific conditions. Provide an analysis and discussion of potential impacts of the project, proposed mitigative measures, and any adverse environmental effects that cannot be avoided.*
>
> *8.3.1. Provide wind turbine noise estimates and isopleths for all preliminary turbine layouts at 40 and 50 dB.*
>
> *8.3.2. Describe the noise impacts from a single turbine and from multiple turbines in relation to the noise standard. LWECS Application Guidance Introduction*
>
> *8.3.3. Provide the method or type of model used to determine noise levels.*
>
> *17. Sound/Noise*
>
> *Map noise modeling data for each turbine type under consideration. Include all homes within the project area.*

The counties in which this Project is located have no county noise standards for wind energy conversion facilities larger than 5 MW [5][6].

DESCRIPTION OF THE WIND FARM SITE

3.1 Site Description

The site is located in southern Minnesota approximately 160 km south of Minneapolis, near the border with Iowa. The proposed wind far is situated in simple terrain, generally consisting of open farmland. Land cover on and near the site consists primarily of arable farmland, interspersed with farmhouses and outbuildings surrounded by small wind breaks of deciduous trees. The site elevation ranges from 390 m to 430 m.

3.2 Wind Farm Layout

The proposed turbine layout, which consists of 100 Vestas V100-2.0 MW wind turbine generators, six alternate turbine locations, one substation, and the layouts from the neighboring Grand Meadow and Wapsipinicon wind farms have been provided by the Client [7][8]. The coordinates of each Project turbine and the two substation transformers are presented in Appendix A. The coordinates of each turbine in the neighboring wind farms are presented in Appendix B .

3.3 Receptor Locations

A list of 551 sound receptors has been provided by the Client [9]. All of the 551 receptors provided by the Client are included in this study. The ID numbers and coordinates of these receptors are listed in Appendix C.

4 SOUND ASSESSMENT

4.1 Description of the Sound Source

The sources of sound considered in this analysis are the Project wind turbine generators and transformers, and two neighboring wind farms. Sound associated with construction activities and other sources of sound in the vicinity of the Project have not been considered.

Broadband sound power levels, octave band distributions, and uncertainty levels for the Vestas V100-2.0 MW wind turbine generators, at a hub height of 95 m, were provided by the Client [10]. This acoustic emissions data was determined in accordance with the IEC 61400-11 standard [11]. At the specific request of the Client, an uncertainty level of 2 dBA was conservatively added to the maximum wind turbine acoustic emission levels in this analysis.

The maximum wind turbine acoustic emission at standard setting (no sound restriction control mode) plus the 2 dBA uncertainty level is considered in this assessment and is presented in Table 5-2 for the Vestas V100-2.0 MW.

Table 5-2: Wind turbine acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	77.5	86.7	93.1	97.2	99.7	101.6	101.1	97.2	86.4	107.0

For the two transformers, a generic sound power level of 104.3 dBA based on standard NEMA TR.1 Table 0-1 [12] for two 125 MVA, 161 kV transformers, and typical octave band distributions were taken, as shown in Table 5-3 below.

Table 5-3: Transformer acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	61.5	80.7	92.8	95.3	100.7	97.9	94.1	88.9	79.8	104.3

The neighboring Grand Meadow and Wapsipinicon wind farms are each comprised of 67 GE 1.5 sle wind turbines at a hub height of 80 m. Octave band sound power levels for the neighboring wind farm turbines were taken from GL GH's internal database. The wind turbine acoustic emissions data for the GE 1.5 sle wind turbine are presented in Table 5-4. At the Client's request, these also conservatively include an added 2 dB uncertainty level.

Table 5-4: Neighboring wind farms acoustic emission summary

Frequency [Hz]	31.5	63	125	250	500	1000	2000	4000	8000	Broadband
Sound Power Level [dBA]	N/A	87.1	96.0	99.2	100.6	99.9	96.5	89.3	80.1	106.0

4.2 Assessment Methodology

The sound pressure level (SPL) at each receptor for the aggregate of all wind turbine generators and transformers associated with the Pleasant Valley Wind Farm and neighboring wind projects were calculated based on the ISO 9613-2 method [1]. The simulation was run for the wind speed corresponding with the maximum sound power level (PWL) of the turbines and the maximum sound power level of the transformers (considering octave band sound levels), the hub height

of the turbines, a height of 3 m above ground level (AGL) for the transformers, and a receptor height of 4.5 m for receptors. In order to provide a more conservative assessment, all receptors were modeled as two-story dwellings.

The ISO 9613 standard provides a prediction of the equivalent continuous sound pressure level at a distance from one or more point sources. The method consists of octave-band algorithms (i.e., with nominal mid-band frequencies from 31.5 Hz to 8 kHz) for calculating the attenuation of the emitted sound. The algorithm takes into account the following physical effects:

- Geometrical divergence – attenuation due to spherical spreading from the sound source
- Atmospheric absorption – attenuation due to absorption by the atmosphere
- Ground effect – attenuation due to the acoustical properties of the ground

The ISO 9613 standard calculates attenuation under meteorological conditions favorable to propagation from sources of sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as it commonly occurs at night. In other words, though a physical impracticality, the ISO 9613-2 standard treats every receptor as being downwind from every source of sound emission (in this case, turbines and transformers).

The ISO 9613-2 standard accounts for ground effect by assigning a numerical coefficient (G) with a value ranging from 0 to 1. A G = 0 equates to hard ground (paving, water, ice, concrete, tamped ground, and other ground surfaces with a low porosity), while a G = 1 equates to porous ground (ground covered by grass, trees, or other vegetation, and other ground surfaces suitable for the growth of vegetation such as farming land). Though the land cover at the Project site is primarily farm land, a mixed (semi-reflective) overall ground factor of G = 0.7 was used in this assessment.

Additionally, temperature, barometric pressure, and humidity parameters were selected to represent conditions favorable to sound propagation, and topographical information (official United States Geological Survey (USGS) digital elevation dataset) to accurately represent terrain in three-dimensions was included in this assessment.

Specifically, the ISO 9613-2 parameters were set as follows:

- Ambient air temperature: 10ºC
- Ambient barometric pressure: 101.32 kPa
- Humidity: 70%
- Global ground factor: 0.7
- Topography included

Additional attenuation from foliage was not considered in this assessment, implying that the lower sound levels are expected in areas where there is foliage present in the line of sight between any turbine and a sound receptor. Similarly, because the model assumes every receptor is downwind of every sound source at all times, lower sound levels are expected at times when a receptor is upwind of any sound source.

The wind turbine sound emission ratings used for each octave band were those specified in Table 5-2. The sound impact was calculated for each receptor, and the calculated sound level was then compared with the applicable sound limit.

5 RESULTS

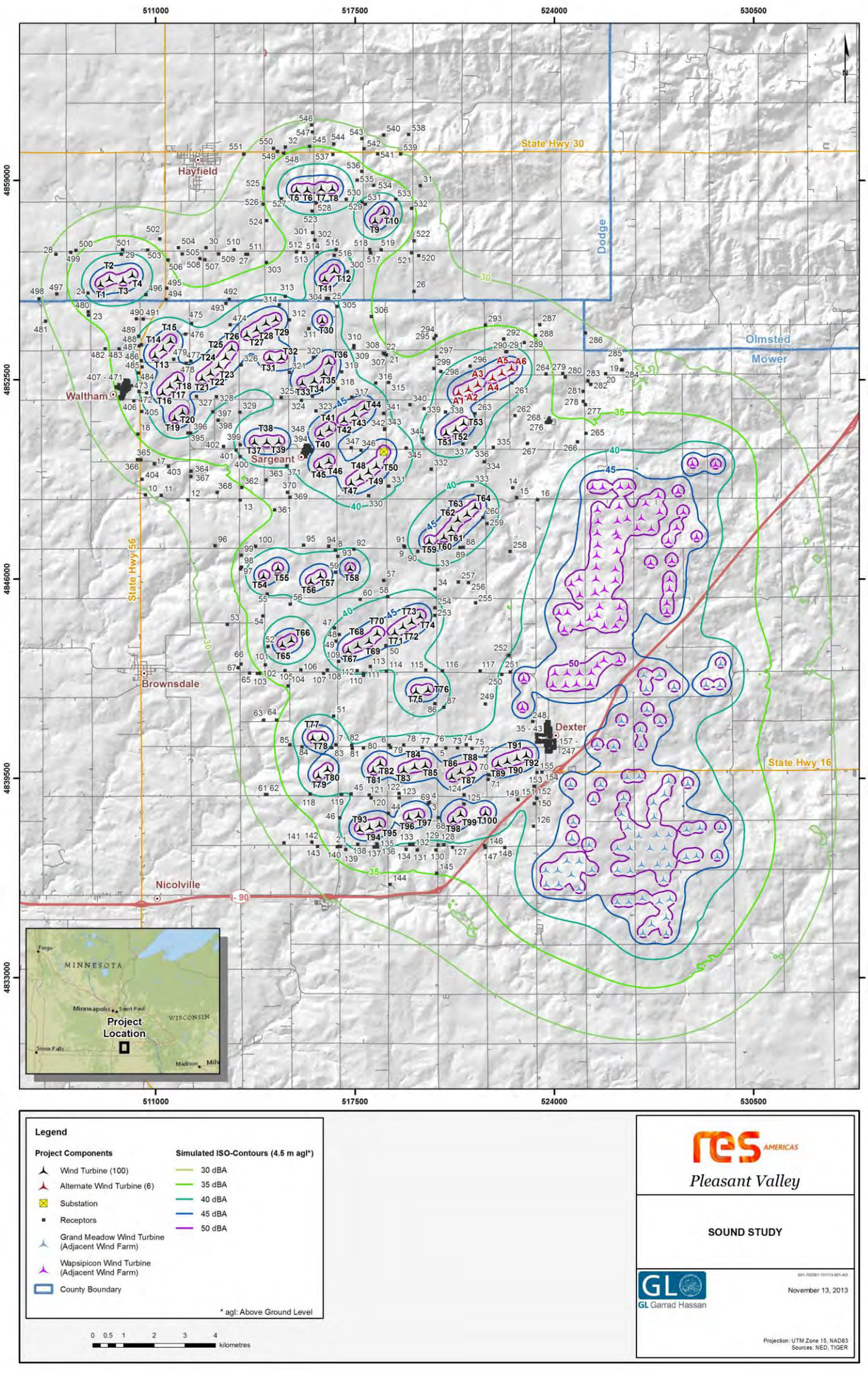
A map illustrating predicted A-weighted sound levels at receptors located in the vicinity of the Pleasant Valley Wind Farm is presented in Figure 5-1.

The results of the sound study are presented for all sound receptors in tabular format in Appendix C. For each receptor, the following information is provided:

- ID;
- Coordinates;
- Town (if any);
- The sound level in dBA at the receptor location at 4.5 m;
- The distance to the closest wind turbine or transformer;
- The ID of the closest wind turbine or transformer.

The sound pressure levels at each of the 551 receptors are below 50 dBA, and are therefore within the allowable limits under the Minnesota Noise Standards.

Figure 5-1: Modeled sound levels at 4.5 m at Pleasant Valley Wind Far



6 CONCLUSION

An analysis has been conducted to determine the maximum sound levels likely to be experienced at sound receptors in the vicinity of the Pleasant Valley Wind Farm in Mower and Dodge counties, Minnesota. This analysis was undertaken specifically for the Vestas V100-2.0 MW wind turbine generator at a hub height of 95 m.

The sound pressure levels at each of the 551 receptors are within the allowable limits under the Minnesota Noise Standards.

7 REFERENCES

[1] International Organization for Standardization. ISO 9613-2: Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation. 15 December 1996.

[2] Minnesota Administrative Rules 7030.0040 Noise Standards. Posted 12 December 2003, https://www.revisor.leg.state.mn.us/rules/?id=7030.0040.

[3] Minnesota Administrative Rules 7030.0050 Noise Area Classification. Posted 12 December 2003, https://www.revisor.leg.state.mn.us/rules/?id=7030.0050.

[4] Minnesota Department of Commerce, Office of Energy Security-Energy Facilities Permitting, "Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota," http://mn.gov/commerce/energyfacilities/documents/LWECS_APP_Guide_AUG2010.pdf, August 2010.

[5] Mower County Public Works. Mower County Zoning Ordinance, 2003. Updated 30 August 2011, http://www.co.mower.mn.us/files/PZES/ZoningOrdinance/Mower%20County%20Zoning%20Ordinance%2008%2030%2011.pdf.

[6] Dodge County Courthouse. Dodge County Zoning Ordinance, Chapter 16 – Performance Standards, http://www.co.dodge.mn.us/documents/Chapter16PerformanceStandards.pdf.

[7] Turbine locations sent by email, S. Flannery, Pleasant Valley Wind, LLC, to E. Crivella, GL GH, 16 October 2013, "Pleasant Valley Wind – GLGH Noise and Shadow Flicker Data Package.zip"

[8] Substation location send by email, S. Flannery, Pleasant Valley Wind, LLC, to K. Kallevig-Childers, GL GH, 8 November 2013, "FigX_PleasantValley_ProposedTline_ArchD_20131007_subAltMarkup.pdf"

[9] Receptor Locations sent by email, S. Flannery, Pleasant Valley Wind, LLC, to E. Crivella, GL GH, 29 October 2013, "13-10-29 HOUSE SHAPE FILES.shp"

[10] Turbine noise emissions document sent by email, S. Flannery, Pleasant Valley, LLC, to E. Crivella, GL GH, 30 October 2013, "V100-2.0 MW Octave Banks.xlsx"

[11] International Electrotechnical Commission. IEC 61400-11 Wind Turbine Generator Systems – Part 11: Acoustic Measurement Techniques. 07 November 2012.

[12] National Electrical Manufacturers Association. NEMA Standards Publication No TR 1-1993 (R2000): Transformers, Regulators, and Reactors. 2000.

APPENDIX A WIND TURBINE GENERATOR AND TRANSFORMER LAYOUT

Client ID	Easting [m][1]	Northing [m][1]
T1	509209	4855639
T2	509502	4855812
T3	509947	4855760
T4	510247	4855940
T5	515604	4858708
T6	515954	4858708
T7	516408	4858761
T8	516775	4858761
T9	518158	4857702
T10	518447	4857989
T11	516523	4855804
T12	516833	4856081
T13	510985	4853310
T14	511257	4853546
T15	511495	4853801
T16	511235	4852105
T17	511481	4852329
T18	511726	4852551
T19	511630	4851264
T20	511887	4851472
T21	512519	4852567
T22	512798	4852749
T23	513063	4852991
T24	513289	4853268
T25	513496	4853547
T26	513978	4853994
T27	514303	4854172
T28	514608	4854379
T29	514929	4854501

Client ID	Easting [m][1]	Northing [m] [1]
T30	516440	4854446
T31	514718	4853229
T32	515115	4853249
T33	515794	4852419
T34	516180	4852501
T35	516500	4852736
T36	516659	4853107
T37	514236	4850493
T38	514630	4850503
T39	515025	4850508
T40	516384	4850756
T41	516663	4850932
T42	517152	4851215
T43	517493	4851403
T44	517813	4851619
T45	516349	4849719
T46	516656	4849872
T47	517389	4849165
T48	517670	4849336
T49	517944	4849520
T50	518205	4849721
T51	520484	4850787
T52	520788	4850915
T53	521048	4851119
T54	514529	4846117
T55	514994	4846371
T56	516068	4845950
T57	516384	4846138
T58	517350	4846371
T59	519931	4847249
T60	520408	4847403

Client ID	Easting [m][1]	Northing [m][1]
T61	520652	4847657
T62	520861	4847971
T63	521168	4848147
T64	521422	4848389
T65	515143	4843890
T66	515439	4844036
T67	517291	4843699
T68	517603	4843862
T69	517967	4844005
T70	518232	4844265
T71	518803	4844292
T72	519071	4844484
T73	519361	4844642
T74	519635	4844826
T75	519503	4842372
T76	519894	4842413
T77	516135	4840840
T78	516443	4840840
T79	516322	4839606
T80	516611	4839827
T81	518099	4839797
T82	518333	4840019
T83	519101	4839796
T84	519455	4839915
T85	519799	4839958
T86	520667	4839583
T87	520950	4839754
T88	521264	4839854
T89	522170	4839988
T90	522478	4840091
T91	522786	4840191

Client ID	Easting [m][1]	Northing [m] [1]
T92	523094	4840286
T93	517664	4837869
T94	517987	4837935
T95	518306	4838023
T96	519262	4838251
T97	519583	4838328
T98	520709	4838166
T99	520954	4838369
T100	521763	4838399
Alt_1	520890	4852095
Alt_2	521207	4852221
Alt_3	521512	4852373
Alt_4	521997	4852581
Alt_5	522301	4852744
Alt_6	522615	4852897
Transfo_1	518439	4850151
Transfo_2	518460	4850151

1. Coordinates given in UTM Zone 15N, NAD 83 Datum.

APPENDIX B NEIGHBORING WIND FARMS LAYOUT

Client ID	Easting [m][1]	Northing [m] [1]	Wind Farm Name
T1	529430.3	4843282.7	Grand Meadow
T2	526927.6	4842905.7	Grand Meadow
T3	527442.9	4842919.7	Grand Meadow
T4	527010.1	4842439.7	Grand Meadow
T5	527919.7	4842510.7	Grand Meadow
T6	528958.3	4842581.7	Grand Meadow
T7	529417.4	4842572.7	Grand Meadow
T8	527036.9	4841773.7	Grand Meadow
T9	526192.7	4841414.7	Grand Meadow
T10	527465.4	4841386.7	Grand Meadow
T11	526814.1	4841117.7	Grand Meadow
T12	525398.3	4840623.7	Grand Meadow
T13	525946.2	4840569.7	Grand Meadow
T14	526832.2	4840617.7	Grand Meadow
T15	526385.2	4839582.7	Grand Meadow
T16	526771.8	4839595.7	Grand Meadow
T17	524541.0	4839331.7	Grand Meadow
T18	525515.9	4839335.7	Grand Meadow
T19	527739.2	4839443.7	Grand Meadow
T20	528360.0	4839357.7	Grand Meadow
T21	527604.1	4839021.7	Grand Meadow
T22	525276.1	4838834.7	Grand Meadow
T23	526267.0	4838893.7	Grand Meadow
T24	527250.6	4838753.7	Grand Meadow
T25	526196.5	4838382.7	Grand Meadow
T26	527260.6	4838275.7	Grand Meadow
T27	524626.1	4838121.7	Grand Meadow
T28	526407.7	4837939.7	Grand Meadow
T29	528326.1	4837869.7	Grand Meadow
T30	528752.9	4837926.7	Grand Meadow
T31	529421.7	4837929.7	Grand Meadow
T32	524579.8	4837565.7	Grand Meadow
T33	526763.4	4837662.7	Grand Meadow
T34	527335.4	4837698.7	Grand Meadow
T35	527738.4	4837700.7	Grand Meadow
T36	525144.6	4837367.7	Grand Meadow
T37	526071.9	4837260.7	Grand Meadow

Client ID	Easting [m][1]	Northing [m][1]	Wind Farm Name
T38	526482.9	4837262.7	Grand Meadow
T39	527127.6	4837264.7	Grand Meadow
T40	527611.2	4837266.7	Grand Meadow
T41	524421.2	4836854.7	Grand Meadow
T42	524824.2	4836844.7	Grand Meadow
T43	528313.7	4836969.7	Grand Meadow
T44	528644.0	4837015.7	Grand Meadow
T45	529321.1	4836985.7	Grand Meadow
T46	526855.8	4836730.7	Grand Meadow
T47	527371.6	4836732.7	Grand Meadow
T48	527742.4	4836722.7	Grand Meadow
T49	523737.2	4836540.8	Grand Meadow
T50	524116.0	4836542.8	Grand Meadow
T51	525228.3	4836546.7	Grand Meadow
T52	526066.6	4836549.7	Grand Meadow
T53	526485.8	4836528.7	Grand Meadow
T54	524568.0	4836399.7	Grand Meadow
T55	527567.1	4836233.7	Grand Meadow
T56	523747.0	4836074.8	Grand Meadow
T57	524150.0	4836086.8	Grand Meadow
T58	524811.5	4835945.8	Grand Meadow
T59	526062.6	4835505.7	Grand Meadow
T60	526433.4	4835518.7	Grand Meadow
T61	526884.4	4835630.7	Grand Meadow
T62	527433.0	4835522.7	Grand Meadow
T63	527779.3	4835601.7	Grand Meadow
T64	527652.8	4835001.7	Grand Meadow
T65	527178.0	4834788.7	Grand Meadow
T66	526897.0	4834498.7	Grand Meadow
T67	527655.0	4834479.7	Grand Meadow
T1	524166.8	4844938.7	Wapsipinicon
T2	525640.8	4844500.7	Wapsipinicon
T3	525156.8	4844753.7	Wapsipinicon
T4	526011.8	4844523.7	Wapsipinicon
T5	526163.8	4844735.7	Wapsipinicon
T6	526145.8	4845112.7	Wapsipinicon
T7	525997.8	4845989.7	Wapsipinicon
T8	525995.8	4846367.7	Wapsipinicon
T9	526049.8	4846945.7	Wapsipinicon

Client ID	Easting [m][1]	Northing [m][1]	Wind Farm Name
T10	526023.8	4847544.8	Wapsipinicon
T11	526070.8	4847933.8	Wapsipinicon
T12	526124.7	4848400.8	Wapsipinicon
T13	525417.7	4848297.8	Wapsipinicon
T14	525434.7	4847920.8	Wapsipinicon
T15	525429.8	4847153.7	Wapsipinicon
T16	525375.8	4846420.7	Wapsipinicon
T17	525390.8	4846809.7	Wapsipinicon
T18	525644.8	4845699.7	Wapsipinicon
T19	525477.8	4845143.7	Wapsipinicon
T20	524840.8	4845518.7	Wapsipinicon
T21	525338.8	4845587.7	Wapsipinicon
T22	525369.8	4846042.7	Wapsipinicon
T23	524430.8	4842974.7	Wapsipinicon
T24	524028.8	4842972.7	Wapsipinicon
T25	522969.7	4841824.7	Wapsipinicon
T26	527683.8	4844963.7	Wapsipinicon
T27	527761.8	4845708.7	Wapsipinicon
T28	526706.8	4847691.8	Wapsipinicon
T29	527845.8	4846630.7	Wapsipinicon
T30	527682.8	4845252.7	Wapsipinicon
T31	526391.8	4848001.8	Wapsipinicon
T32	526162.7	4849044.8	Wapsipinicon
T33	525411.7	4847542.8	Wapsipinicon
T34	526120.8	4843391.7	Wapsipinicon
T35	525412.8	4843222.7	Wapsipinicon
T36	527775.8	4846030.7	Wapsipinicon
T37	524833.8	4842975.7	Wapsipinicon
T38	525628.8	4843400.7	Wapsipinicon
T39	526842.8	4848036.8	Wapsipinicon
T40	526985.8	4848503.8	Wapsipinicon
T41	525397.8	4844854.7	Wapsipinicon
T42	525211.8	4842999.7	Wapsipinicon
T43	525181.8	4842621.7	Wapsipinicon
T44	524565.8	4845884.7	Wapsipinicon
T45	524821.8	4846051.7	Wapsipinicon
T46	523014.8	4842769.7	Wapsipinicon
T47	527445.8	4848216.8	Wapsipinicon
T48	528217.8	4848220.8	Wapsipinicon

Client ID	Easting [m][1]	Northing [m][1]	Wind Farm Name
T49	528516.8	4849787.8	Wapsipinicon
T50	523965.8	4842572.7	Wapsipinicon
T51	524375.8	4842573.7	Wapsipinicon
T52	524730.8	4842608.7	Wapsipinicon
T53	528053.8	4848885.8	Wapsipinicon
T54	524439.8	4844950.7	Wapsipinicon
T55	524329.8	4844373.7	Wapsipinicon
T56	524859.8	4844563.7	Wapsipinicon
T57	527173.8	4847671.8	Wapsipinicon
T58	526080.8	4847422.7	Wapsipinicon
T59	528655.8	4847400.7	Wapsipinicon
T60	527730.8	4847262.7	Wapsipinicon
T61	527146.8	4846560.7	Wapsipinicon
T62	525591.7	4849031.8	Wapsipinicon
T63	526435.7	4849045.8	Wapsipinicon
T64	527394.8	4848749.8	Wapsipinicon
T65	528002.8	4847708.7	Wapsipinicon
T66	529272.8	4849757.8	Wapsipinicon
T67	525261.7	4849030.8	Wapsipinicon

1. Coordinates given in UTM Zone 15N, NAD 83 Datum.

APPENDIX C RECEPTOR LOCATIONS AND ASSOCIATED SOUND LEVELS

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
125	521068	4838660		46.9	313	T99
479	511598	4853165		45.7	512	T14
50	518515	4843833		45.5	517	T70
72	521761	4840229		45.1	475	T89
71	521875	4839620		45.0	472	T89
261	522631	4852388		44.8	485	Alt_5
317	517408	4851926		44.8	509	T44
478	512009	4853038		44.8	563	T18
44	518599	4838363		44.7	448	T95
320	516161	4853231		44.7	513	T36
321	515372	4852740		44.7	530	T33
260	521684	4848003		44.6	466	T64
385	516103	4850205	Sargeant	44.6	545	T45
68	520233	4838216		44.5	479	T98
322	516125	4851962		44.5	542	T34
326	513796	4852981		44.5	583	T24
380	516070	4850173	Sargeant	44.5	532	T45
477	512156	4853106		44.5	649	T21
346	517709	4850195		44.4	687	T50
384	516074	4850224	Sargeant	44.4	575	T45
528	516248	4858272		44.4	515	T7
69	519901	4838677		44.3	472	T97
263	521427	4851395		44.3	468	T53
352	516040	4850153	Sargeant	44.3	533	T45
59	516877	4846226		44.2	494	T58
83	516752	4840499		44.2	460	T78
124	521068	4838965		44.2	607	T99
350	516033	4850327	Sargeant	44.2	554	T40
381	516039	4850179	Sargeant	44.2	555	T45
312	515372	4854454		44.1	446	T29
379	516036	4850272	Sargeant	44.1	596	T40
327	512342	4851958		44.0	634	T21
70	521851	4839468		43.9	610	T89
338	520462	4851450		43.9	627	T52
349	515984	4850372	Sargeant	43.9	554	T40
354	515991	4850165	Sargeant	43.9	572	T45

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
378	516002	4850275	Sargeant	43.9	614	T40
383	516006	4850223	Sargeant	43.9	609	T45
3	519940	4838726		43.8	535	T97
4	519932	4838726		43.8	529	T97
319	517077	4852758		43.8	545	T36
353	515970	4850167	Sargeant	43.8	586	T45
375	515974	4850322	Sargeant	43.8	597	T40
387	515958	4850085	Sargeant	43.8	535	T45
314	515039	4854942		43.7	454	T29
360	515906	4849985	Sargeant	43.7	516	T45
377	515974	4850272	Sargeant	43.7	634	T40
386	515957	4850134	Sargeant	43.7	571	T45
198	523433	4840674	Dexter	43.6	515	T92
347	517385	4850282		43.6	837	T46
348	515933	4850369	Sargeant	43.6	593	T40
382	515951	4850224	Sargeant	43.6	642	T45
77	519704	4840505		43.5	556	T85
374	515933	4850326	Sargeant	43.5	623	T40
389	515916	4850112	Sargeant	43.5	584	T45
390	515909	4850083	Sargeant	43.5	571	T45
359	515891	4850026	Sargeant	43.4	551	T45
373	515902	4850370	Sargeant	43.4	617	T40
391	515920	4850194	Sargeant	43.4	640	T45
358	515888	4850130	Sargeant	43.3	617	T45
376	515902	4850267	Sargeant	43.3	687	T40
392	515908	4850173	Sargeant	43.3	632	T45
7	516885	4840600		43.2	504	T78
49	516893	4843979		43.2	486	T67
318	516948	4852212		43.2	689	T35
323	516235	4851482		43.2	696	T41
351	515879	4850289	Sargeant	43.2	688	T40
372	515880	4850326	Sargeant	43.2	662	T40
393	515877	4850170	Sargeant	43.2	652	T45
199	523493	4840688	Dexter	43.1	566	T92
253	520116	4844811		43.1	481	T74
337	521035	4850401		43.1	570	T52
357	515863	4850129	Sargeant	43.1	635	T45
388	515851	4850085	Sargeant	43.1	618	T45

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
474	513437	4854287		43.1	615	T26
486	510541	4853125		43.1	481	T13
84	515779	4840526		43.0	474	T77
197	523525	4840678	Dexter	43.0	583	T92
202	523457	4840749	Dexter	43.0	588	T92
394	515839	4850230	Sargeant	43.0	722	T45
123	518958	4838870		42.9	690	T96
251	522578	4842973		42.9	2736	T92
296	521266	4852945		42.9	622	Alt_3
324	515764	4851828		42.9	592	T33
355	515828	4850170	Sargeant	42.9	689	T45
472	510723	4852072		42.9	513	T16
75	521326	4840484		42.8	633	T88
196	523551	4840692	Dexter	42.8	611	T92
201	523493	4840747	Dexter	42.8	610	T92
248	523305	4841353		42.8	1088	T92
300	517275	4856024		42.8	446	T12
476	511987	4853986		42.8	526	T15
48	516996	4844193		42.7	575	T67
79	518671	4840506		42.7	592	T82
89	520940	4847028		42.7	650	T60
122	518945	4839007		42.7	804	T83
155	523448	4839696		42.7	687	T92
200	523526	4840741	Dexter	42.7	627	T92
356	515789	4850114	Sargeant	42.7	685	T45
43	523440	4840840	Dexter	42.6	652	T92
109	516980	4843317		42.6	492	T67
290	522429	4853406		42.6	542	Alt_6
311	516003	4854162		42.6	520	T30
330	517961	4848721		42.6	680	T48
135	518226	4837361		42.5	621	T94
138	517602	4837355		42.5	518	T93
195	523595	4840689	Dexter	42.5	643	T92
399	513770	4850380		42.5	479	T37
488	510546	4853639		42.5	549	T13
86	520111	4841938		42.4	522	T76
159	523750	4840365	Dexter	42.4	660	T92
291	522456	4853421		42.4	548	Alt_6

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
37	523429	4840941	Dexter	42.3	736	T92
42	523460	4840929	Dexter	42.3	739	T92
73	520854	4840497		42.3	749	T87
158	523753	4840421	Dexter	42.3	672	T92
160	523774	4840370	Dexter	42.3	685	T92
485	510570	4852920		42.3	569	T13
516	516832	4856557		42.3	476	T12
90	519562	4846899		42.2	509	T59
154	523606	4839703		42.2	776	T92
156	523759	4840470	Dexter	42.2	690	T92
161	523799	4840371	Dexter	42.2	710	T92
193	523728	4840573	Dexter	42.2	696	T92
254	520115	4845064		42.2	536	T74
6	518623	4840583		42.1	634	T82
41	523510	4840922	Dexter	42.1	760	T92
52	514674	4843795		42.1	478	T65
78	519099	4840590		42.1	764	T84
88	521039	4847033		42.1	731	T60
157	523806	4840418	Dexter	42.1	724	T92
192	523733	4840597	Dexter	42.1	710	T92
194	523733	4840628	Dexter	42.1	725	T92
203	523680	4840691	Dexter	42.1	712	T92
204	523698	4840695	Dexter	42.1	729	T92
206	523653	4840738	Dexter	42.1	719	T92
39	523567	4840922	Dexter	42.0	793	T92
40	523543	4840919	Dexter	42.0	776	T92
162	523835	4840359	Dexter	42.0	744	T92
190	523784	4840545	Dexter	42.0	737	T92
191	523787	4840567	Dexter	42.0	747	T92
205	523704	4840730	Dexter	42.0	754	T92
207	523733	4840651	Dexter	42.0	735	T92
208	523737	4840666	Dexter	42.0	747	T92
342	518476	4850873		42.0	722	Transfo_2
5	520468	4840495		41.9	857	T85
38	523599	4840915	Dexter	41.9	806	T92
93	516954	4846743		41.9	543	T58
163	523870	4840357	Dexter	41.9	779	T92
189	523786	4840588	Dexter	41.9	755	T92

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
209	523738	4840685	Dexter	41.9	757	T92
246	523768	4841357	Dexter	41.9	1265	T92
259	521819	4847806		41.9	705	T64
328	512991	4851950		41.9	777	T21
36	523666	4840903	Dexter	41.8	841	T92
74	521139	4840600		41.8	756	T88
76	520148	4840586		41.8	719	T85
164	523904	4840368	Dexter	41.8	814	T92
186	523839	4840571	Dexter	41.8	797	T92
210	523785	4840693	Dexter	41.8	802	T92
211	523788	4840675	Dexter	41.8	795	T92
247	523843	4841351	Dexter	41.8	1302	T92
343	518477	4850910		41.8	760	Transfo_2
487	510466	4853602		41.8	595	T13
115	519823	4843035		41.7	626	T76
165	523910	4840419	Dexter	41.7	826	T92
166	523910	4840451	Dexter	41.7	832	T92
181	523839	4840635	Dexter	41.7	822	T92
184	523836	4840604	Dexter	41.7	807	T92
212	523796	4840729	Dexter	41.7	830	T92
243	523789	4841290	Dexter	41.7	1221	T92
244	523727	4841219	Dexter	41.7	1128	T92
245	523728	4841263	Dexter	41.7	1164	T92
531	517848	4858222		41.7	606	T9
24	508803	4855324		41.6	514	T1
25	516574	4855153		41.6	653	T11
35	523729	4841134	Dexter	41.6	1060	T92
121	518036	4838870		41.6	889	T95
137	518139	4837263		41.6	689	T94
167	523914	4840492	Dexter	41.6	845	T92
179	523842	4840693	Dexter	41.6	851	T92
182	523840	4840664	Dexter	41.6	836	T92
183	523888	4840620	Dexter	41.6	861	T92
185	523888	4840599	Dexter	41.6	854	T92
188	523893	4840549	Dexter	41.6	841	T92
219	523735	4840932	Dexter	41.6	910	T92
220	523730	4840993	Dexter	41.6	951	T92
221	523732	4840963	Dexter	41.6	930	T92

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
223	523728	4841022	Dexter	41.6	972	T92
234	523729	4841116	Dexter	41.6	1045	T92
235	523737	4841155	Dexter	41.6	1081	T92
238	523736	4841177	Dexter	41.6	1098	T92
239	523796	4841214	Dexter	41.6	1163	T92
241	523845	4841211	Dexter	41.6	1191	T92
242	523845	4841239	Dexter	41.6	1213	T92
331	518610	4849029		41.6	802	T50
168	523969	4840491	Dexter	41.5	898	T92
169	524023	4840485	Dexter	41.5	949	T92
172	523974	4840548	Dexter	41.5	918	T92
177	523893	4840729	Dexter	41.5	913	T92
178	523887	4840687	Dexter	41.5	888	T92
180	523890	4840662	Dexter	41.5	880	T92
187	523952	4840550	Dexter	41.5	897	T92
222	523795	4841010	Dexter	41.5	1007	T92
224	523728	4841047	Dexter	41.5	991	T92
225	523792	4841047	Dexter	41.5	1032	T92
229	523842	4841125	Dexter	41.5	1124	T92
231	523731	4841078	Dexter	41.5	1016	T92
232	523794	4841070	Dexter	41.5	1051	T92
233	523796	4841095	Dexter	41.5	1070	T92
236	523795	4841142	Dexter	41.5	1106	T92
237	523794	4841172	Dexter	41.5	1129	T92
240	523845	4841166	Dexter	41.5	1157	T92
80	517791	4840492		41.4	720	T82
113	518013	4843149		41.4	822	T68
120	517975	4838960		41.4	847	T81
170	524033	4840550	Dexter	41.4	975	T92
171	524008	4840549	Dexter	41.4	951	T92
213	523890	4840847	Dexter	41.4	973	T92
214	523843	4840878	Dexter	41.4	955	T92
215	523891	4840876	Dexter	41.4	991	T92
216	523837	4840933	Dexter	41.4	985	T92
217	523890	4840909	Dexter	41.4	1011	T92
218	523894	4840941	Dexter	41.4	1034	T92
226	523892	4841011	Dexter	41.4	1078	T92
227	523895	4841046	Dexter	41.4	1104	T92

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
228	523893	4841077	Dexter	41.4	1124	T92
230	523899	4841141	Dexter	41.4	1174	T92
304	516646	4855144		41.4	672	T11
341	518448	4851399		41.4	672	T44
136	518246	4837260		41.3	723	T94
173	524027	4840637	Dexter	41.3	997	T92
174	524025	4840743	Dexter	41.3	1037	T92
175	523997	4840739	Dexter	41.3	1010	T92
176	524022	4840683	Dexter	41.3	1009	T92
529	517223	4858381		41.3	587	T8
152	523370	4839243		41.2	1078	T92
153	523350	4839243		41.2	1074	T92
345	519175	4850270		41.2	725	Transfo_2
523	516114	4858000		41.1	726	T6
333	521336	4849055		41.0	672	T64
395	512064	4850758		41.0	667	T19
112	517580	4843014		40.9	744	T67
325	515108	4851916		40.8	850	T33
126	523335	4837941		40.7	1637	T100
151	523445	4838847		40.7	1481	T92
250	522303	4842890		40.7	2455	T76
527	515117	4858399		40.7	576	T5
396	512152	4850758		40.6	727	T19
484	510456	4852719		40.6	793	T13
530	517748	4858283		40.6	712	T9
29	509890	4856591		40.5	743	T4
55	514649	4845510		40.5	619	T54
81	517423	4840477		40.5	959	T81
150	523362	4838678		40.5	1618	T91
47	516847	4844408		40.4	836	T67
149	522829	4838804		40.4	1140	T100
305	516922	4854890		40.4	656	T30
344	519739	4850580		40.4	773	T51
371	515287	4849693		40.4	856	T39
533	518840	4858381		40.4	554	T10
82	517403	4840575		40.2	997	T78
92	517474	4846973		40.2	615	T58
252	522534	4843509		40.2	2858	T76

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
45	517391	4838990		40.1	1074	T81
58	518586	4845433		40.1	1066	T72
313	515241	4855218		40.1	782	T29
473	510469	4852118		40.1	766	T16
489	510452	4853918		40.1	808	T13
111	517789	4842924		40.0	921	T67
336	521425	4850289		40.0	893	T52
397	512875	4851453		40.0	989	T20
400	513772	4849997		40.0	679	T37
401	513637	4850200		40.0	666	T37
8	516868	4846940		39.9	746	T58
46	517025	4838217		39.9	728	T93
114	518536	4842996		39.9	1151	T75
116	520361	4843008		39.9	756	T76
119	517071	4838978		39.9	966	T80
515	516900	4856739		39.9	661	T12
87	520409	4841819		39.8	785	T76
118	516047	4838993		39.7	672	T79
475	512180	4854335		39.7	869	T15
110	517789	4842860		39.6	976	T67
133	519293	4837344		39.6	908	T96
496	510693	4855268		39.6	807	T4
60	517679	4845338		39.5	1085	T58
132	519405	4837344		39.5	918	T96
51	516821	4841534		39.3	790	T78
316	518186	4852393		39.3	859	T44
339	519763	4851550		39.3	1050	T51
33	520200	4846300		39.2	986	T59
56	515403	4845184		39.2	1014	T56
298	520308	4852768		39.2	890	Alt_1
329	513756	4851434		39.2	1056	T37
514	516277	4856647		39.2	793	T12
9	519136	4847046		39.1	821	T59
127	520699	4837259		39.1	907	T98
129	520218	4837325		39.1	974	T98
91	519106	4847080		39.0	842	T59
128	520408	4837331		39.0	888	T98
501	509937	4856732		39.0	850	T4

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
34	520126	4845680		38.9	985	T74
94	516658	4847069		38.9	971	T57
148	522397	4837245		38.9	1316	T100
249	521765	4841925		38.9	1933	T76
405	510560	4851467		38.9	929	T16
85	515392	4840596		38.8	781	T77
147	521737	4837309		38.8	1090	T100
309	517473	4853539		38.8	922	T36
398	513044	4851177		38.8	1195	T20
134	519182	4837187		38.7	1067	T96
310	517476	4853611		38.6	960	T36
491	510603	4854475		38.6	1118	T15
146	521756	4837243		38.5	1156	T100
332	519999	4849580		38.5	1301	T51
108	516608	4843032		38.4	954	T67
139	517211	4837187		38.4	819	T93
57	518444	4845951		38.3	1172	T58
95	515834	4847105		38.3	1112	T57
131	519549	4837161		38.3	1127	T96
471	510218	4852299	Waltham	38.3	1035	T16
493	513303	4854987		38.3	1201	T26
130	520151	4837162		38.2	1149	T98
535	517588	4859008		38.2	850	T8
406	510296	4851815		38.1	983	T16
490	510378	4854487		38.1	1288	T14
258	522568	4846902		38.0	1873	T63
340	519307	4851683		38.0	1480	T51
492	513414	4855121		38.0	1260	T26
1	517036	4837283		37.9	859	T93
117	521591	4843007		37.9	1797	T76
292	522358	4853828		37.9	966	Alt_6
468	510139	4852424	Waltham	37.9	1141	T16
98	513811	4846396		37.8	770	T54
105	515229	4843009		37.8	885	T65
106	515751	4843043		37.8	1041	T66
334	521727	4849821		37.8	1441	T52
424	510154	4852206	Waltham	37.8	1085	T16
448	510112	4852477	Waltham	37.8	1183	T16

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
97	513780	4846326		37.7	778	T54
299	520084	4852860		37.7	1112	Alt_1
315	518607	4852412		37.7	1122	T44
425	510137	4852211	Waltham	37.7	1103	T16
469	510123	4852371	Waltham	37.7	1144	T16
2	516989	4837283		37.6	894	T93
15	522783	4848654		37.6	1386	T64
107	516483	4842924		37.6	1119	T67
335	522027	4850295		37.6	1280	T53
402	513226	4850325		37.6	1024	T37
422	510117	4852247	Waltham	37.6	1126	T16
449	510089	4852423	Waltham	37.6	1189	T16
467	510102	4852333	Waltham	37.6	1156	T16
257	520884	4845905		37.5	1571	T60
262	522724	4851335		37.5	1443	Alt_4
450	510081	4852404	Waltham	37.5	1191	T16
451	510080	4852391	Waltham	37.5	1190	T16
534	518122	4858838		37.5	909	T10
289	523029	4853707		37.4	909	Alt_6
426	510113	4852169	Waltham	37.4	1123	T16
470	510088	4852295	Waltham	37.4	1162	T16
14	522653	4848976		37.3	1363	T64
54	514511	4844798		37.3	1106	T65
100	514263	4847066		37.3	986	T54
363	514616	4849224		37.3	1279	T38
447	510041	4852461	Waltham	37.3	1246	T16
452	510063	4852352	Waltham	37.3	1198	T16
518	517991	4856744		37.3	972	T9
256	521215	4845880		37.2	1723	T60
423	510070	4852224	Waltham	37.2	1170	T16
446	510019	4852490	Waltham	37.2	1267	T13
453	510024	4852413	Waltham	37.2	1250	T16
101	514591	4843196		37.1	886	T65
140	516930	4837268		37.1	949	T93
302	516204	4857057		37.1	1161	T12
427	510061	4852123	Waltham	37.1	1173	T16
429	510056	4852188	Waltham	37.1	1181	T16
494	511352	4855111		37.1	1317	T15

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
513	515832	4856655		37.1	1096	T11
255	521439	4845220		37.0	1846	T74
266	524769	4850474		37.0	3242	Alt_6
301	516134	4857292		37.0	1398	T12
421	510023	4852241	Waltham	37.0	1220	T16
428	510047	4852158	Waltham	37.0	1189	T16
455	510009	4852374	Waltham	37.0	1255	T16
370	515307	4848827		36.9	1371	T45
444	510026	4852142	Waltham	36.9	1209	T16
420	509992	4852250	Waltham	36.8	1252	T16
431	510003	4852206	Waltham	36.8	1236	T16
454	509975	4852389	Waltham	36.8	1291	T16
457	509977	4852300	Waltham	36.8	1273	T16
503	510758	4856728		36.8	939	T4
517	518018	4856637		36.8	1074	T9
430	509985	4852214	Waltham	36.7	1255	T16
437	510006	4852094	Waltham	36.7	1229	T16
456	509955	4852339	Waltham	36.7	1301	T16
519	518369	4856736		36.7	989	T9
369	515387	4848664		36.6	1427	T45
436	509996	4852065	Waltham	36.6	1240	T16
443	509978	4852156	Waltham	36.6	1258	T16
459	509940	4852312	Waltham	36.6	1311	T16
483	509816	4853506		36.6	1185	T13
265	525043	4850754		36.5	3238	Alt_6
297	520169	4853247		36.5	1359	Alt_1
432	509951	4852226	Waltham	36.5	1290	T16
435	509985	4852037	Waltham	36.5	1252	T16
442	509959	4852163	Waltham	36.5	1277	T16
480	508810	4854715		36.5	1006	T1
495	511367	4855488		36.5	1208	T4
537	516787	4859849		36.5	1088	T8
99	513808	4846777		36.4	978	T54
419	509974	4852006	Waltham	36.4	1265	T16
438	509953	4852113	Waltham	36.4	1282	T16
440	509941	4852167	Waltham	36.4	1295	T16
458	509923	4852270	Waltham	36.4	1323	T16
418	509963	4851985	Waltham	36.3	1277	T16

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
434	509946	4852074	Waltham	36.3	1289	T16
439	509936	4852118	Waltham	36.3	1299	T16
441	509923	4852179	Waltham	36.3	1313	T16
460	509906	4852227	Waltham	36.3	1334	T16
512	515608	4856669		36.3	1259	T11
536	517736	4859295		36.2	1100	T8
16	523467	4848582		36.1	2054	T64
264	523745	4852689		36.1	1148	Alt_6
414	509953	4851942	Waltham	36.1	1292	T16
415	509928	4852019	Waltham	36.1	1310	T16
433	509899	4852095	Waltham	36.1	1336	T16
461	509882	4852191	Waltham	36.1	1356	T16
532	519356	4858085		36.1	914	T10
413	509936	4851918	Waltham	36.0	1312	T16
416	509913	4852002	Waltham	36.0	1325	T16
23	508824	4854605		35.9	1103	T1
267	523134	4850418		35.9	2200	T53
407	509927	4851901	Waltham	35.9	1323	T16
417	509905	4851969	Waltham	35.9	1336	T16
445	509838	4852208	Waltham	35.9	1400	T16
408	509917	4851875	Waltham	35.8	1338	T16
412	509897	4851928	Waltham	35.8	1349	T16
466	509806	4852334	Waltham	35.8	1447	T16
307	518472	4853335		35.7	1828	T36
411	509885	4851893	Waltham	35.7	1366	T16
21	518477	4853363		35.6	1837	T36
22	518446	4853366		35.6	1806	T36
308	518541	4853310		35.6	1841	T44
409	509873	4851878	Waltham	35.6	1381	T16
462	509797	4852221	Waltham	35.6	1442	T16
464	509779	4852232	Waltham	35.6	1461	T16
104	515332	4842510		35.5	1393	T65
410	509843	4851947	Waltham	35.5	1400	T16
463	509755	4852244	Waltham	35.5	1486	T16
18	510438	4850724		35.4	1309	T19
276	523749	4851105		35.4	2121	Alt_6
269	523821	4851198		35.3	2083	Alt_6
270	523835	4851197		35.3	2092	Alt_6

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
271	523808	4851201		35.3	2073	Alt_6
272	523836	4851162		35.3	2121	Alt_6
273	523891	4851157		35.3	2158	Alt_6
274	523856	4851109		35.3	2176	Alt_6
275	523800	4851102		35.3	2151	Alt_6
465	509717	4852263	Waltham	35.3	1526	T16
268	523847	4851255		35.2	2052	Alt_6
361	514894	4848260		35.2	1891	T55
525	514525	4858748		35.2	1080	T5
145	520174	4836404		35.1	1841	T98
306	518048	4854556		35.1	1612	T30
506	511413	4856404		34.9	1255	T4
545	516029	4860113		34.9	1403	T7
64	514958	4841401		34.8	1304	T77
293	521761	4854278		34.8	1624	Alt_6
303	514623	4856323		34.8	1848	T29
362	513820	4848991		34.8	1559	T37
526	514521	4858221		34.8	1188	T5
102	514401	4842925		34.7	1217	T65
548	515181	4859887		34.6	1253	T5
288	523396	4853941		34.5	1303	Alt_6
482	509361	4853504		34.5	1635	T13
103	514327	4842925		34.4	1263	T65
295	520088	4853849		34.3	1929	Alt_1
524	514636	4857686		34.3	1408	T5
294	520155	4853935		34.2	1982	Alt_1
277	525023	4851687		34.1	2695	Alt_6
500	508412	4856714		34.1	1338	T1
544	516821	4860179		34.0	1419	T8
13	513766	4848580		33.9	1970	T37
143	516295	4837283		33.9	1490	T93
278	524953	4851790		33.8	2587	Alt_6
279	524287	4852707		33.8	1682	Alt_6
280	524368	4852586		33.7	1780	Alt_6
364	512159	4849524		33.7	1819	T19
522	519436	4857024		33.7	1381	T10
32	515238	4860083		33.6	1423	T5
549	514981	4859942		33.6	1382	T5

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
142	516100	4837427		33.5	1626	T93
144	518653	4836040		33.5	2009	T94
403	511435	4849674		33.5	1602	T19
511	514008	4856590		33.5	2283	T29
27	513952	4856593		33.4	2309	T29
65	514068	4842936		33.4	1437	T65
499	508243	4856650		33.4	1398	T1
502	511144	4857087		33.4	1456	T4
17	510973	4849754		33.1	1647	T19
63	514532	4841398		33.1	1697	T77
367	512152	4849347		33.1	1987	T19
521	519358	4856631		33.1	1608	T9
281	524959	4852126		33.0	2467	Alt_6
368	513018	4848823		33.0	2067	T37
505	511874	4856602		33.0	1757	T4
66	513790	4843224		32.9	1508	T65
287	523538	4854289		32.8	1670	Alt_6
507	512614	4856415		32.8	2415	T4
365	510535	4849891		32.7	1756	T19
504	511757	4856805		32.7	1740	T4
508	512459	4856448		32.7	2270	T4
510	513574	4856730		32.7	2568	T28
550	514853	4860042		32.6	1531	T5
53	513353	4844523		32.5	1898	T65
283	525107	4852467		32.5	2529	Alt_6
497	507787	4855294		32.5	1463	T1
509	513061	4856600		32.5	2707	T28
542	517808	4860031		32.5	1637	T8
67	513698	4843111		32.4	1641	T65
282	525199	4852348		32.4	2642	Alt_6
366	510418	4849895		32.4	1828	T19
520	519590	4856548		32.2	1838	T9
26	519438	4855383		32.1	2649	T9
62	514633	4838974		32.1	1803	T79
547	516120	4860577		32.1	1838	T7
30	512655	4856802		32.0	2558	T4
31	519642	4858832		32.0	1462	T10
61	514601	4838974		32.0	1833	T79

GH GH ID	UTM Coordinates		Town	Calculated SPL at Receptor [dBA]	Distance to Nearest Pleasant Valley Turbine or Transformer [m]	Nearest Pleasant Valley Turbine or Transformer [Client ID]
	Easting [m][1]	Northing [m][1]				
96	512949	4847086		32.0	1853	T54
541	518251	4859861		31.9	1841	T8
20	525685	4852697		31.8	3076	Alt_6
19	526200	4852823		31.5	3586	Alt_6
284	526229	4852830		31.4	3614	Alt_6
12	512066	4848581		31.3	2718	T19
543	517735	4860361		31.3	1866	T8
28	507763	4856590		31.2	1731	T1
285	526212	4853153		30.9	3606	Alt_6
141	515191	4837397		30.8	2482	T79
404	510565	4849255		30.7	2274	T19
546	516099	4860811		30.7	2073	T7
11	511195	4848731		30.6	2571	T19
286	525031	4854025		30.5	2666	Alt_6
539	518998	4859864		30.4	1954	T10
10	510672	4848742		29.9	2697	T19
551	513880	4859858		29.9	2072	T5
481	507416	4854407		29.7	2175	T1
498	507203	4855136		29.6	2067	T1
540	518445	4860475		29.1	2393	T8
538	519263	4860495		27.1	2635	T10

1. Coordinates given in UTM Zone 15N, NAD 83 Datum.

ATTACHMENT 3

GL Garrad Hassan

SHADOW FLICKER ASSESSMENT
PLEASANT VALLEY WIND FARM,
MOWER AND DODGE COUNTIES, MINNESOTA

Client	Pleasant Valley Wind, LLC
Contact	Sean Flannery
Document No.	702501-USPO-R-01
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REVISION HISTORY

Issue	Issue Date	Summary
A	14 November 2013	Initial Issue for Review
B	15 November 2013	Reissuance based on Client Comments

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

Pleasant Valley Wind, LLC ("Client") has requested that Garrad Hassan America, Inc. ("GL GH") provide environmental and permitting services, including assessment of the impact of the shadow flicker effects in the vicinity of the proposed Pleasant Valley Wind Farm (the "Project"). The proposed Pleasant Valley Wind Farm is located in Mower and Dodge counties, approximately 160 km south of Minneapolis, MN. The wind farm consists of 100 turbines and six alternate turbine locations, at a hub height of 95 m, and a rotor diameter of 100 m.

These turbines can have an influence on the shadow flicker experienced at sensitive locations in the vicinity of the site. The purpose of this shadow flicker analysis is to calculate the predicted shadow flicker duration from the proposed Project at receptor locations. This report includes a brief description of the Project site, an explanation of the shadow flicker assessment methodology, results of the analysis including a map illustrating areas prone to shadow flicker, and concluding comments.

1.1 Shadow Flicker Definition

Shadow flicker is defined as the modulation of light levels resulting from the periodic passage of a rotating wind turbine blade between the sun and a viewer. The duration of shadow flicker experienced at a specific location can be determined using a purely geometric analysis which takes into account the relative positions of the sun throughout the year, the wind turbines at the site, and the viewer. This method has been used to determine the shadow flicker duration at sensitive locations in proximity to the Project.

It should be noted, as described in Section 3.3, that there are several simplifications and conservative assumptions inherent within the model, which may result in an overestimate of shadow flicker duration.

2 DESCRIPTION OF THE WIND FARM SITE

2.1 Site Description

The site is located in southern Minnesota approximately 160 km south of Minneapolis, near the border with Iowa. The proposed wind farm is situated in simple terrain, generally consisting of open farmland. Land cover on and near the site consists primarily of arable farmland, interspersed with farmhouses and outbuildings surrounded by small wind breaks of deciduous trees. The site elevation ranges from 390 m to 430 m.

2.2 Wind Farm Layout

The proposed turbine layout, which consists of 100 Vestas V100-2.0 MW wind turbine generators and six alternate turbine locations, has been supplied by the Client [1]. The precise coordinates of each turbine are presented in Appendix A.

2.3 Receptor Locations

A list of receptors to be considered as shadow flicker receptors has been provided by the Client [2]. Of the 551 receptors sent by the Client, the shadow flicker duration is calculated for 448 receptors located within 1,450 m (10 times the tip height, as explained in Section 3.2) of a turbine. Three additional receptors were included outside of this range, in the town of Waltham, in order to include all receptors within this town. The ID numbers and coordinates of these dwellings are listed in Appendix B.

2.4 Applicable State Guidance

The state of Minnesota has prepared the *Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota* ("Minnesota State Guidance"), which was used in the development of this report and states the following [3]:

> *8.4.3 Shadow Flicker*
> *Provide an analysis and discussion of shadow flicker based on the preliminary turbine layout. Include isopleths for 100, 50, and 25 hours / year of potential shadow flicker. List the assumptions and methodology used in the analysis. Provide a figure illustrating likely hours of shadow flicker/year at 1,000 feet and a table showing potential shadow durations/ day at 1,000 feet based.*

As discussed in Section 3.2, this assessment provides a more detailed and thorough estimate of the Project's shadow flicker impacts than required in the guidelines by including impacts out to 4,757 feet (1,450 m), rather than 1,000 feet (305 m). Figure 4-1 presents the shadow flicker duration isopleths for each turbine.

3 SHADOW FLICKER ASSESSMENT

3.1 Overview

Shadow flicker may occur under certain combinations of circumstances with regards to the sun's position and wind direction; when the sun passes behind the rotating blades of a wind turbine, a moving shadow is cast in front of or behind the turbine. When viewed from a stationary position, the moving shadows cause periodic flickering of the sunlight, otherwise known as the "shadow flicker" phenomenon.

The effect is most noticeable inside buildings, where the flicker appears through a window opening. The likelihood and duration of the effect depends on a number of variables, namely:

- Orientation of the building relative to the turbine;
- Wind direction: the shape and intensity of the shadow are determined by the position of the sun relative to the blades (the turbine rotor continuously yaws to face the wind so the rotor plane will always be perpendicular to the wind direction;
- Distance from turbine: the farther the observer from the turbine, the less pronounced the effect;
- Turbine height and rotor diameter: a larger turbine rotor diameter will cast a larger shadow, meaning a larger area will be prone to incidences of shadow flicker;
- Time of year and day: position of sun relative to the horizon;
- Weather conditions: cloud cover reduces the occurrence of shadow flicker;
- Vegetation and other obstacles that help to mask shadows;
- Operational status of turbines.

3.2 Assessment Methodology

The number of hours of shadow flicker is experienced annually at a given location can be calculated using a geometrical model which takes into account the sun's position, topography of the wind farm site, and wind turbine specifications such as rotor diameter and hub height.

The wind turbine has been modeled assuming all wind turbines are disc objects oriented perpendicular to the sun-turbine vector, representing the maximum duration for which there is potential for shadow flicker to occur.

Shadow flicker has been calculated at the subject receptors (i.e. residences) at a height of 2 m to represent ground floor windows. Rather than facing a particular direction, shadow flicker receptors (windows) are simulated as horizontal planes, meaning they experience shadow flicker over 360°; this assumption therefore represents a worst case scenario. Simulations have been carried out with a resolution of 1 minute; if shadow flicker occurs in any 1 minute period, the model registers this as 1 minute of shadow flicker.

It is generally accepted that shadow flicker from wind turbines does not occur beyond a distance, D, from a given wind turbine. The UK wind industry considers this distance to be equivalent to 10 rotor diameters [4], while the Danish wind industry suggests a value of between 500 and 1000 m [5]. GL GH has adopted a conservative approach and has assumed the length, D, that a shadow can be cast to be defined as follows:

D = 10 x (hub height + rotor radius)

Beyond this distance, a viewer does not perceive the turbine blade to be chopping the light, but rather as an object passing in front of the sun.

Shadow flicker calculations can be adjusted using an annual cloud coverage figure which is based on historical meteorological data and statistics. According to data gathered from meteorological stations, an annual cloud cover can be estimated and applied as a percentage. Further, using the site-specific wind rose to consider the probability of the turbines being oriented in a given direction could lead to significant further reduction in the annual shadow flicker occurrence.

No attempt has been made to account for vegetation or other shielding effects around each shadow receptor in the calculations of shadow flicker duration. Similarly, neither turbine operational shut-down nor the site specific wind rose have been considered in this analysis. Consideration of these factors could lead to a significant reduction of the levels of shadow flicker predicted.

3.3 Simplification and Conservative Assumptions

Shadow flicker duration calculated in the manner described above has several limitations and may over-estimate the annual number of hours of shadow flicker experienced at a specified location for several reasons, namely:

- The modeling of the wind turbine blades as discs rather than individual blades may result in an overestimate of shadow flicker duration.

  Turbine blades are of non-uniform thickness with the thickest part of the blade (maximum chord) close to the hub and the thinnest part (minimum chord) at the tip. Diffusion of sunlight, as discussed above, results in a limit to the maximum distance that a shadow can be perceived. This maximum distance will also be dependent on the thickness of the turbine blade and the human threshold for perception of light intensity variation. As such, a shadow cast by the blade tip will be shorter than the shadow cast by the thickest part of the blade [6].

- The wind turbine will not always be yawed such that its rotor is perpendicular to the sun-turbine vector). Any other rotor orientation will reduce the area of the projected shadow, and thus the incidence of shadow flicker. Additionally, the orientation of windows on a given house has not been taken into account, i.e. the model assumes that a window is always facing the turbine(s). The wind speed and direction frequency distribution, or wind rose, at the site can be used to determine probable turbine orientation in order to calculate the resulting reduction in shadow flicker duration; however this has not been done in this study.

- Aerosols (moisture, dust, smoke, etc.) in the atmosphere have the ability to influence shadows cast by a wind turbine. The length of the shadow cast by a wind turbine is dependent on the degree that direct sunlight is diffused, which in turn is dependent on the amount of dispersants (humidity, smoke and other aerosols) in the path between the light source (sun) and the receiver [6].

- Modeling the sun as a point light source rather than a disc results in an overestimate of the shadow flicker duration. The fact that the light source is a disc results in a shadow which is less well defined and of lower intensity as compared to a point light source.

- The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker.

Cloud cover measurements recorded at nearby meteorological stations may be used to estimate probable levels of cloud cover, and to provide an indication of the resulting reduction in shadow flicker duration (see Section 3.4).

- The presence of vegetation or other physical barriers around a shadow receptor location may shield the view of the wind turbine, and therefore reduce the incidence of shadow flicker.
- Periods where the wind turbine is not in operation due to low winds, high winds, or for operational and maintenance reasons will also reduce shadow flicker occurrence.

In light of the reasons listed above, it is likely that the shadow flicker durations presented in Section 4 can be regarded as conservative.

3.4 Current Analysis

The shadow flicker assessment for the proposed Project has been conducted for 100 Vestas V100-2.0 MW turbines and six alternate turbine locations using the method Section 3.2. The wind turbines have been modeled assuming all wind turbines are disc objects oriented perpendicular to the sun-receptor vector, representing the maximum duration for which there is potential for shadow flicker to occur.

All receptors in Mower and Dodge counties located distance D, defined in Section 2.3, have been included in the study. For the Vestas V100-2.0 MW wind turbine generator this equates to 1,450 m.

In order to render more realistic shadow flicker results, cloud cover statistics have been considered. According to data gathered from the Rochester meteorological station, it has been estimated that the cloud cover is sufficient to nullify shadow flicker occurrence 63.2 % of the time on average.

The model does not take into account any obstacles; for example vegetation, mountains, or other shielding effects, around each shadow receptor in calculating the shadow flicker duration. Similarly, neither turbine operational shut-down nor the site-specific wind rose have been considered in this analysis. Consideration of these factors could lead to a significant reduction of the levels of shadow flicker predicted.

4 RESULTS

An analysis has been conducted to determine the duration of shadow flicker predicted for receptors in the vicinity of the Pleasant Valley Wind Farm in MN. This analysis was undertaken specifically for the V100-2.0 MW wind turbine with a blade tip height of 145 m.

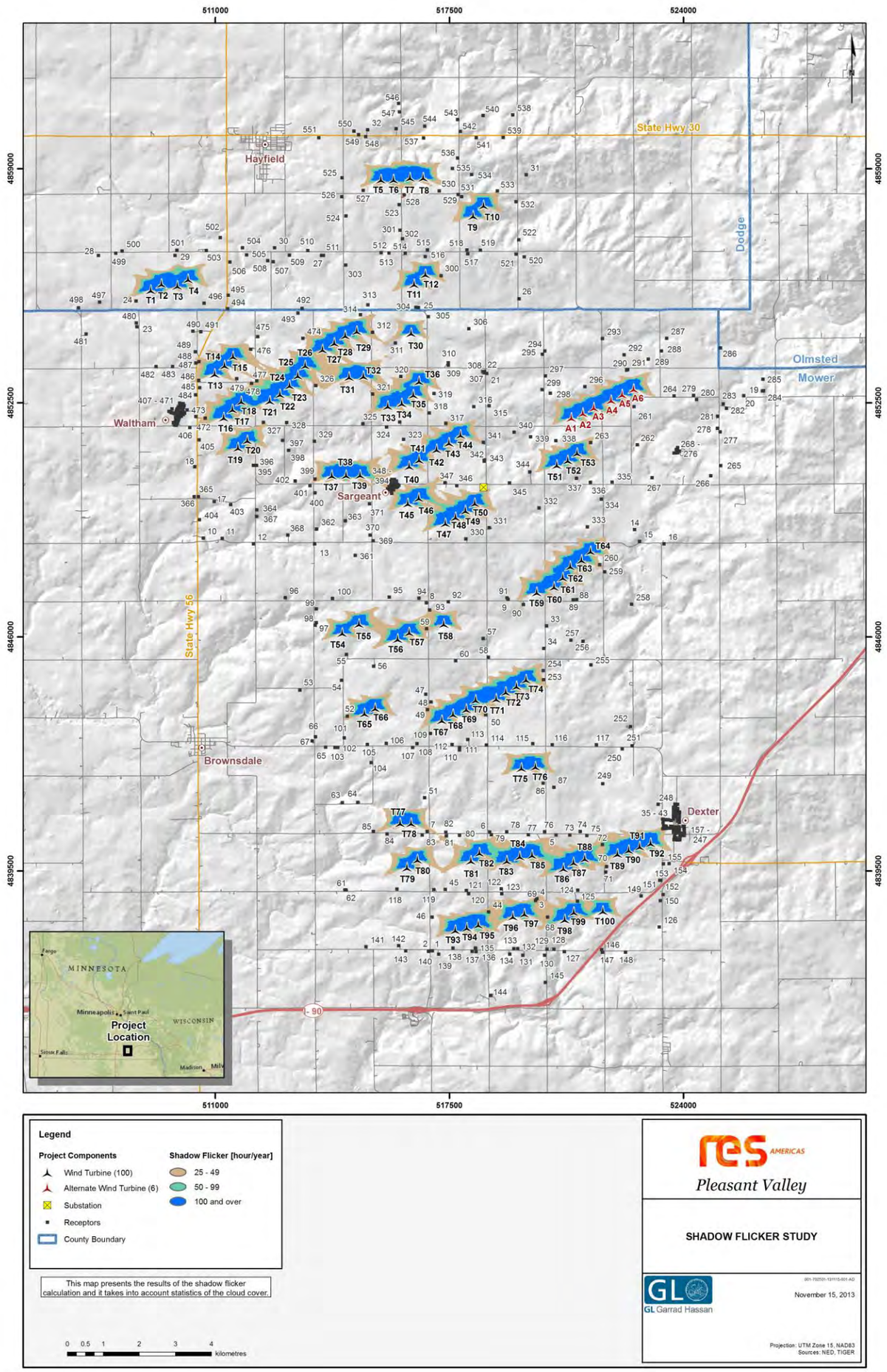
A map illustrating predicted shadow flicker duration at receptors in the vicinity of the Pleasant Valley Wind Farm is presented in Figure 4-1. This map takes into account average annual cloud cover. For illustrative purposes shadow flicker is shown at isopleths of 25, 50, and 100 hours of flicker per year, taking into account annual cloud cover.

The results of the shadow flicker assessment are presented for the 448 receptors that are located within 1,450 m of a turbine, as well as the three additional receptors in the town of Waltham (in terms of maximum minutes per day and total hours per year) in tabular format in Appendix B.

The receptor that is predicted to experience the most hours of shadow flicker in one year is receptor 72. The predicted duration of shadow flicker at this receptor is 50 hours per year, taking into account annual cloud cover. Receptor 387 experiences the most anticipated days of flicker exposure at 234 days; however, the overall amount of exposure is anticipated to be 39 hours per year with cloud cover. Receptor 69 has the highest predicted value of maximum minutes of shadow flicker in one day, with a total of 98 minutes, predicted to occur on January 23.

Results in hours per year take into account the cloud cover from the NOAA meteorological station at Rochester, but as described in Section 3.3, these results are still considered to be conservative.

Figure 4-1: Modeled hours of shadow flicker at Pleasant Valley Wind Farm



5 CONCLUSION

An analysis has been conducted to predict the duration of shadow flicker to be experienced at receptors in the vicinity of the Pleasant Valley Wind Farm. This analysis was undertaken specifically for the Vestas V100-2.0 MW wind turbine with a blade tip height of 145 m.

The participating receptor that is predicted to experience the most hours of shadow flicker in one year is receptor 72. The predicted duration of shadow flicker at this receptor is 50 hours per year, taking into account annual cloud cover. Receptor 387 experiences the most anticipated days of flicker exposure at 234 days; however, the overall amount of exposure is anticipated to be 39 hours per year with cloud cover. Receptor 69 has the highest predicted value of maximum minutes of shadow flicker in one day, with a total of 98 minutes, predicted to occur on January 23.

Detailed results for each of the 448 receptors that are located within 1,450 m of a turbine and three that are beyond 1,450 m of a turbine can be found in Appendix B. The duration experienced in hours per year takes into account average yearly cloud cover from the NOAA meteorological station at Rochester. Nevertheless, as described in Section 3.3, several other conservative assumptions have been made in this analysis.

6 REFERENCES

[1] Turbine locations sent by email, S. Flannery, Pleasant Valley Wind, LLC., to E. Crivella, GL GH, 16 October 2013, “Pleasant Valley Wind – GLGH Noise and Shadow Flicker Data Package.zip”

[2] Receptor Locations sent by email, S. Flannery, Pleasant Valley Wind, LLC., to E. Crivella, GL GH, 29 October 2013, “13-10-29 HOUSE SHAPE FILES.shp”

[3] Minnesota Department of Commerce, Office of Energy Security-Energy Facilities Permitting, “Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota,” http://mn.gov/commerce/energyfacilities/documents/LWECS_APP_Guide_AUG2010.pdf, August 2010.

[4] Department for Business Enterprise & Regulatory Reform, UK, “Onshore Wind: Shadow Flicker”, http://www.berr.gov.uk/whatwedo/energy/sources/renewables/planning/onshore-wind/shadow-flicker/page18736.html, viewed 23 July 2010.

[5] Danish Wind Industry Association, "Shadow variations from Wind turbines", http://guidedtour.windpower.org/en/tour/env/shadow/shadow2.htm, viewed 22 July 2010.

[6] Freud H-D, Kiel F.H., "Influences of the opaqueness of the atmosphere, the extension of the sun and rotor blade profile on the shadow impact of wind turbine", DEWI Magazine No. 20 pp 43-51, Feb 2002.

APPENDIX A TURBINE LAYOUT

Client Turbine ID	Easting [m][1]	Northing [m][1]
T1	509209	4855639
T2	509502	4855812
T3	509947	4855760
T4	510247	4855940
T5	515604	4858708
T6	515954	4858708
T7	516408	4858761
T8	516775	4858761
T9	518159	4857702
T10	518448	4857989
T11	516523	4855804
T12	516833	4856081
T13	510985	4853310
T14	511257	4853546
T15	511495	4853801
T16	511235	4852105
T17	511481	4852329
T18	511726	4852551
T19	511630	4851264
T20	511887	4851472
T21	512519	4852567
T22	512798	4852749
T23	513063	4852991
T24	513289	4853268
T25	513496	4853547
T26	513978	4853994
T27	514303	4854172
T28	514608	4854379
T29	514929	4854501
T30	516440	4854446
T31	514718	4853229
T32	515115	4853249
T33	515794	4852419
T34	516180	4852501
T35	516500	4852736
T36	516659	4853107

Client Turbine ID	Easting [m][1]	Northing [m][1]
T37	514236	4850493
T38	514630	4850503
T39	515025	4850508
T40	516384	4850756
T41	516663	4850932
T42	517152	4851215
T43	517493	4851403
T44	517814	4851619
T45	516349	4849719
T46	516656	4849872
T47	517389	4849165
T48	517671	4849336
T49	517945	4849520
T50	518206	4849721
T51	520484	4850787
T52	520788	4850915
T53	521048	4851119
T54	514529	4846117
T55	514994	4846371
T56	516068	4845950
T57	516384	4846138
T58	517350	4846371
T59	519931	4847249
T60	520408	4847403
T61	520652	4847657
T62	520861	4847971
T63	521168	4848147
T64	521422	4848389
T65	515143	4843890
T66	515439	4844036
T67	517291	4843699
T68	517604	4843862
T69	517968	4844005
T70	518233	4844265
T71	518804	4844292
T72	519072	4844484
T73	519361	4844642
T74	519635	4844826

Client Turbine ID	Easting [m][1]	Northing [m][1]
T75	519503	4842372
T76	519894	4842413
T77	516135	4840840
T78	516443	4840840
T79	516322	4839606
T80	516611	4839827
T81	518100	4839797
T82	518334	4840019
T83	519102	4839796
T84	519455	4839915
T85	519799	4839958
T86	520667	4839583
T87	520950	4839754
T88	521264	4839854
T89	522170	4839988
T90	522478	4840091
T91	522786	4840191
T92	523094	4840286
T93	517665	4837869
T94	517988	4837935
T95	518307	4838023
T96	519262	4838251
T97	519583	4838328
T98	520709	4838166
T99	520954	4838369
T100	521763	4838399
Alt 1	520890	4852095
Alt 2	521207	4852221
Alt 3	521512	4852373
Alt 4	521997	4852581
Alt 5	522301	4852744
Alt 6	522615	4852897

1. Coordinate system is UTM Zone 15N, NAD 83 datum.

APPENDIX B RECEPTOR LOCATIONS AND ASSOCIATED SHADOW FLICKER

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
72	521761	4840229		211	9-Nov	96	137	50	T86 T87 T88 T89 T90 T91 T92	475	T89
44	518599	4838363		163	19-Jan	79	133	49	T93 T94 T95 T96 T97	448	T95
59	516877	4846226		207	11-May	48	122	45	T56 T57 T58	494	T58
69	519901	4838677		126	23-Jan	98	110	40	T96 T97 T98 T99	472	T97
387	515958	4850085	Sargeant	234	7-Jan	47	105	39	T38 T39 T45 T46	535	T45
390	515909	4850083	Sargeant	233	23-Nov	44	103	38	T38 T39 T45 T46	571	T45
3	519940	4838726		119	28-Nov	92	100	37	T96 T97 T98 T99	535	T97
4	519932	4838726		118	27-Nov	92	100	37	T96 T97 T98 T99	529	T97
389	515916	4850112	Sargeant	232	7-Jan	43	99	36	T38 T39 T45 T46	584	T45
357	515863	4850129	Sargeant	229	25-Nov	40	97	36	T38 T39 T45 T46	635	T45
358	515888	4850130	Sargeant	229	7-Jan	41	96	35	T38 T39 T45 T46	617	T45
125	521068	4838660		120	18-Dec	73	94	35	T99 T100	313	T99
198	523433	4840674	Dexter	94	16-Jan	73	92	34	T89 T90 T91 T92	515	T92
68	520233	4838216		115	10-Sep	68	92	34	T96 T97 T98 T99	479	T98
472	510723	4852072		217	15-Apr	45	91	33	T16 T17 T18 T19 T20	513	T16
355	515828	4850170	Sargeant	226	10-Jan	37	91	33	T38 T39 T45 T46	689	T45
388	515851	4850085	Sargeant	221	24-Jan	40	86	32	T38 T39 T45 T46	618	T45
260	521684	4848003		206	11-May	45	85	31	T60 T61 T62 T63	466	T64
399	513770	4850380		161	6-May	49	83	31	T37 T38 T39	479	T37

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
263	521427	4851395		128	26-Jan	62	81	30	T51 T52 T53	468	T53
312	515372	4854454		151	21-Aug	53	81	30	T27 T28 T29 T30	446	T29
321	515372	4852740		198	23-Jan	45	81	30	T33 T34 T35 T36	530	T33
486	510541	4853125		145	20-Jun	69	80	30	T13 T14 T17 T18	481	T13
49	516893	4843979		173	29-Jan	48	80	30	T67 T68 T69 T70	486	T67
199	523493	4840688	Dexter	92	19-Jan	68	79	29	T90 T91 T92	566	T92
386	515957	4850134	Sargeant	191	1-Jan	43	79	29	T38 T39 T45 T46	571	T45
197	523525	4840678	Dexter	96	25-Jan	68	77	29	T90 T91 T92	583	T92
393	515877	4850170	Sargeant	197	15-Dec	39	77	28	T38 T39 T45 T46	652	T45
71	521875	4839620		153	2-Jul	49	76	28	T86 T87 T88 T92	472	T89
488	510546	4853639		166	24-Jan	43	76	28	T13 T14 T15	549	T13
359	515891	4850026	Sargeant	189	6-Nov	44	75	28	T38 T39 T45 T46	551	T45
356	515789	4850114	Sargeant	199	13-Nov	36	75	28	T38 T39 T45 T46	685	T45
50	518515	4843833		166	23-Jul	42	74	27	T67 T68 T69	517	T70
477	512156	4853106		213	15-Apr	37	73	27	T13 T14 T22 T23 T24 T25	649	T21
52	514674	4843795		89	4-May	70	72	27	T65 T66	478	T65
196	523551	4840692	Dexter	96	22-Jan	64	72	27	T90 T91 T92	611	T92
317	517408	4851926		161	22-Jan	47	72	27	T34 T44	509	T44
478	512009	4853038		189	4-Jan	37	72	26	T13 T21 T22 T23 T24	563	T18
300	517275	4856024		121	14-Aug	53	70	26	T11 T12	446	T12
392	515908	4850173	Sargeant	182	18-Dec	40	70	26	T38 T39 T45 T46	632	T45

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
195	523595	4840689	Dexter	100	28-Jan	62	67	25	T90 T91 T92	643	T92
200	523526	4840741	Dexter	85	4-Dec	59	66	24	T90 T91 T92	627	T92
253	520116	4844811		142	27-Aug	49	66	24	T71 T72 T73 T74	481	T74
360	515906	4849985	Sargeant	171	7-Feb	45	66	24	T38 T39 T45 T46	516	T45
93	516954	4846743		84	23-Dec	72	63	23	T56 T57 T58	543	T58
201	523493	4840747	Dexter	80	15-Dec	61	61	23	T90 T91 T92	610	T92
394	515839	4850230	Sargeant	172	19-Dec	34	61	23	T38 T39 T45 T46	722	T45
353	515970	4850167	Sargeant	163	22-Dec	38	60	22	T38 T39 T45 T46	586	T45
5	520468	4840495		96	4-Jan	54	59	22	T84 T85 T88	857	T85
341	518448	4851399		155	18-Jul	36	59	22	T42 T43 T44	672	T44
391	515920	4850194	Sargeant	164	18-Dec	35	59	22	T38 T39 T45 T46	640	T45
327	512342	4851958		162	21-Dec	39	58	21	T16 T17 T19 T20	634	T21
206	523653	4840738	Dexter	96	14-Nov	54	57	21	T90 T91 T92	719	T92
354	515991	4850165	Sargeant	159	18-Dec	35	57	21	T38 T39 T45 T46	572	T45
476	511987	4853986		133	10-Oct	45	56	21	T13 T14 T15	526	T15
347	517385	4850282		160	30-Jan	43	56	21	T40 T45 T46 T50	837	T46
326	513796	4852981		174	2-Apr	32	56	21	T21 T22 T23 T24 T31 T32	583	T24
529	517223	4858381		192	2-Jun	29	56	20	T6 T7 T9 T10	587	T8
487	510466	4853602		128	30-Oct	41	53	20	T13 T14 T15	595	T13
202	523457	4840749	Dexter	76	14-Dec	59	53	19	T90 T91 T92	588	T92
533	518840	4858381		78	1-Jan	45	51	19	T9 T10	554	T10

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
81	517423	4840477		160	23-Dec	35	51	19	T77 T78 T79 T80 T81 T82	959	T81
84	515779	4840526		118	24-Jun	34	50	18	T78 T80	474	T77
479	511598	4853165		134	2-May	38	48	18	T13 T21 T22	512	T14
346	517709	4850195		136	19-Dec	37	48	18	T40 T45 T46 T50	687	T50
318	516948	4852212		161	12-May	29	48	18	T33 T34 T44	689	T35
401	513637	4850200		121	22-Jun	36	47	17	T37 T38 T39	666	T37
352	516040	4850153	Sargeant	124	15-Feb	34	47	17	T39 T45 T46	533	T45
474	513437	4854287		116	10-Feb	39	45	17	T26 T27 T28	615	T26
80	517791	4840492		115	11-Dec	35	45	17	T78 T80 T82	720	T82
350	516033	4850327	Sargeant	133	17-Jan	32	45	17	T38 T39 T46	554	T40
205	523704	4840730	Dexter	90	30-Jan	52	45	16	T90 T91 T92	754	T92
261	522631	4852388		120	10-May	37	44	16	A2 A3 A4	485	A5
349	515984	4850372	Sargeant	124	13-Jan	30	44	16	T38 T39 T46	554	T40
254	520115	4845064		84	20-Oct	43	43	16	T72 T73 T74	536	T74
530	517748	4858283		139	23-Oct	31	43	16	T7 T8 T10	712	T9
78	519099	4840590		75	1-Jan	45	42	16	T81 T82 T85	763	T84
7	516885	4840600		100	19-Jun	36	42	16	T77 T78	504	T78
203	523680	4840691	Dexter	71	4-Feb	55	41	15	T90 T91 T92	712	T92
320	516161	4853231		81	9-Mar	44	41	15	T31 T32 T36	513	T36
305	516922	4854890		74	2-Jan	39	41	15	T30	656	T30
473	510469	4852118		154	30-Mar	30	41	15	T16 T17 T18 T19	766	T16

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
531	517848	4858222		115	23-Feb	36	40	15	T8 T10	606	T9
204	523698	4840695	Dexter	67	4-Nov	53	39	14	T90 T91 T92	729	T92
379	516036	4850272	Sargeant	109	30-Jan	34	38	14	T38 T39 T46	596	T40
85	515392	4840596		119	1-Aug	31	38	14	T77 T78 T80	781	T77
319	517077	4852758		85	6-Sep	40	37	14	T33 T34 T35	545	T36
385	516103	4850205	Sargeant	93	5-Feb	38	37	14	T39 T46	544	T45
48	516996	4844193		107	6-Feb	35	37	14	T68 T69 T70	575	T67
259	521819	4847806		108	12-Jun	30	37	14	T61 T62 T63	705	T64
382	515951	4850224	Sargeant	125	28-Oct	29	37	14	T38 T39 T45 T46	642	T45
484	510456	4852719		118	6-Jan	26	37	14	T16 T17 T18	793	T13
381	516039	4850179	Sargeant	113	11-Feb	34	36	13	T38 T39 T45 T46	555	T45
378	516002	4850275	Sargeant	106	28-Jan	32	36	13	T38 T39 T46	614	T40
375	515974	4850322	Sargeant	110	15-Nov	31	36	13	T38 T39 T46	597	T40
383	516006	4850223	Sargeant	108	4-Feb	31	36	13	T38 T39 T46	609	T45
348	515933	4850369	Sargeant	112	18-Nov	29	36	13	T38 T39 T46	593	T40
384	516074	4850224	Sargeant	93	2-Feb	36	35	13	T39 T46	575	T45
46	517025	4838217		99	5-Feb	33	35	13	T93 T94 T95	728	T93
377	515974	4850272	Sargeant	106	30-Jan	30	35	13	T38 T39 T46	634	T40
214	523843	4840878	Dexter	80	17-Jan	37	34	13	T91 T92	955	T92
374	515933	4850326	Sargeant	105	12-Nov	29	34	13	T38 T39 T46	622	T40
376	515902	4850267	Sargeant	107	6-Feb	28	34	13	T38 T39 T46	687	T40

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
373	515902	4850370	Sargeant	106	23-Jan	28	34	13	T38 T39 T46	617	T40
351	515879	4850289	Sargeant	105	11-Aug	28	34	13	T38 T39 T46	688	T40
380	516070	4850173	Sargeant	90	11-Feb	36	34	12	T39 T46	532	T45
372	515880	4850326	Sargeant	103	29-Jan	27	34	12	T38 T39 T46	662	T40
47	516847	4844408		125	10-Jan	26	34	12	T68 T69 T70	836	T67
79	518671	4840506		102	10-Jan	26	32	12	T84 T85	592	T82
475	512180	4854335		76	11-Jan	29	31	12	T14 T15	869	T15
209	523738	4840685	Dexter	56	8-Feb	49	31	11	T90 T91 T92	757	T92
217	523890	4840909	Dexter	78	17-Jan	34	31	11	T91 T92	1011	T92
215	523891	4840876	Dexter	84	18-Nov	35	30	11	T91 T92	992	T92
207	523733	4840651	Dexter	52	28-Oct	49	29	11	T90 T91 T92	735	T92
208	523737	4840666	Dexter	52	11-Feb	49	29	11	T90 T91 T92	747	T92
344	519739	4850580		61	1-Aug	42	29	11	T51 T52 T53	773	T51
216	523837	4840933	Dexter	68	5-Jan	33	29	11	T91 T92	985	T92
123	518958	4838870		65	1-Jan	30	29	11	T97	690	T96
218	523894	4840941	Dexter	72	27-Nov	32	28	10	T91 T92	1034	T92
82	517403	4840575		108	30-Apr	25	28	10	T77 T78 T80 T82	997	T78
339	519763	4851550		135	24-Jan	20	28	10	A1 T52 T53	1050	T51
194	523733	4840628	Dexter	50	13-Feb	48	27	10	T90 T91 T92	725	T92
296	521266	4852945		93	8-Feb	29	27	10	A4 A5 A6	622	A3
124	521068	4838965		67	4-Jan	28	27	10	T100	607	T99

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
210	523785	4840693	Dexter	50	30-Oct	45	26	10	T90 T91 T92	802	T92
212	523796	4840729	Dexter	55	7-Nov	42	26	10	T91 T92	830	T92
159	523750	4840365	Dexter	67	19-Sep	35	26	10	T90 T91 T92	660	T92
406	510296	4851815		94	12-May	27	26	10	T16 T17 T19	983	T16
6	518623	4840583		87	4-Jan	25	26	10	T84 T85	634	T82
213	523890	4840847	Dexter	74	14-Nov	36	26	9	T91 T92	973	T92
76	520148	4840586		73	13-Dec	29	26	9	T83 T84 T88	719	T85
192	523733	4840597	Dexter	47	15-Feb	45	25	9	T90 T91 T92	710	T92
338	520462	4851450		54	30-Oct	35	25	9	T53	627	T52
36	523666	4840903	Dexter	66	20-Dec	32	25	9	T90 T91 T92	841	T92
309	517473	4853539		86	5-Feb	26	25	9	T35 T36	922	T36
343	518477	4850910		89	3-Jun	23	25	9	T42 T43	971	T44
193	523728	4840573	Dexter	48	18-Feb	45	24	9	T90 T91 T92	696	T92
211	523788	4840675	Dexter	48	11-Feb	44	24	9	T90 T91 T92	795	T92
160	523774	4840370	Dexter	65	20-Mar	34	24	9	T90 T91 T92	685	T92
527	515117	4858399		78	26-Jul	28	24	9	T6 T7	576	T5
158	523753	4840421	Dexter	58	11-Mar	34	23	8	T90 T91 T92	672	T92
43	523440	4840840	Dexter	54	14-Dec	35	22	8	T90 T91	653	T92
161	523799	4840371	Dexter	63	21-Mar	33	22	8	T90 T91 T92	710	T92
219	523735	4840932	Dexter	56	22-Dec	34	21	8	T91 T92	910	T92
162	523835	4840359	Dexter	61	22-Mar	31	21	8	T90 T91 T92	744	T92

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
98	513811	4846396		66	17-Oct	30	21	8	T54 T55	770	T54
38	523599	4840915	Dexter	57	1-Jan	29	21	8	T90 T91	806	T92
489	510452	4853918		66	12-Feb	28	21	8	T14 T15	808	T13
189	523786	4840588	Dexter	42	18-Feb	41	20	7	T90 T91 T92	755	T92
179	523842	4840693	Dexter	44	9-Feb	38	20	7	T91 T92	851	T92
156	523759	4840470	Dexter	49	4-Mar	34	20	7	T90 T91 T92	690	T92
157	523806	4840418	Dexter	55	29-Sep	33	20	7	T90 T91 T92	724	T92
97	513780	4846326		64	4-Mar	30	20	7	T54 T55	778	T54
163	523870	4840357	Dexter	59	18-Sep	30	20	7	T90 T91 T92	779	T92
226	523892	4841011	Dexter	58	15-Dec	29	20	7	T91 T92	1078	T92
70	521851	4839468		70	5-May	26	20	7	T86 T87	610	T89
116	520361	4843008		70	26-Nov	24	20	7	T75	756	T76
99	513808	4846777		68	18-Dec	24	20	7	T54 T55	978	T54
190	523784	4840545	Dexter	42	22-Feb	38	19	7	T90 T91 T92	737	T92
191	523787	4840567	Dexter	42	20-Feb	38	19	7	T90 T91 T92	747	T92
182	523840	4840664	Dexter	42	11-Feb	37	19	7	T91 T92	836	T92
83	516752	4840499		46	16-Jun	30	19	7	T77	460	T78
331	518610	4849029		69	3-Aug	25	19	7	T47 T48	802	T50
75	521326	4840484		67	28-Jan	25	19	7	T89 T90	633	T88
155	523448	4839696		77	22-Jul	24	19	7	T89 T90	687	T92
491	510603	4854475		64	3-Dec	24	19	7	T15	1118	T15

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
342	518476	4850873		78	16-Jun	22	19	7	T42 T43	998	T44
177	523893	4840729	Dexter	42	2-Nov	36	18	7	T91 T92	913	T92
9	519136	4847046		46	29-Apr	34	18	7	T59 T60	821	T59
485	510570	4852920		72	21-Jan	23	18	7	T17 T18	569	T13
535	517588	4859008		41	4-Mar	38	18	6	T7 T8	850	T8
181	523839	4840635	Dexter	41	14-Feb	35	18	6	T91 T92	822	T92
184	523836	4840604	Dexter	41	17-Feb	35	17	6	T91 T92	807	T92
91	519106	4847080		42	25-Apr	34	17	6	T59 T60	842	T59
178	523887	4840687	Dexter	42	11-Feb	34	17	6	T91 T92	888	T92
164	523904	4840368	Dexter	49	21-Mar	29	17	6	T91 T92	814	T92
310	517476	4853611		64	27-Jan	26	17	6	T35 T36	960	T36
336	521425	4850289		52	19-Jun	24	17	6	T51	893	T52
345	519175	4850270		77	30-Jan	22	17	6	T49 T50 T51	1114	T50
114	518536	4842996		88	21-Jan	21	17	6	T67 T75	1151	T75
186	523839	4840571	Dexter	40	21-Feb	35	16	6	T90 T91 T92	797	T92
180	523890	4840662	Dexter	40	14-Feb	34	16	6	T91 T92	880	T92
39	523567	4840922	Dexter	51	17-Dec	27	16	6	T90 T91	793	T92
532	519356	4858085		56	18-Mar	26	16	6	T9 T10	914	T10
298	520308	4852768		67	27-Jan	24	16	6	A2 A3	890	A1
398	513044	4851177		81	15-Aug	21	16	6	T19 T20 T37	1195	T20
493	513303	4854987		67	26-Dec	20	16	6	T27 T28	1201	T26

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
183	523888	4840620	Dexter	38	18-Feb	33	15	5	T91 T92	861	T92
165	523910	4840419	Dexter	45	14-Mar	27	15	5	T91 T92	826	T92
185	523888	4840599	Dexter	37	19-Oct	31	14	5	T91 T92	854	T92
188	523893	4840549	Dexter	37	25-Feb	30	14	5	T91 T92	841	T92
166	523910	4840451	Dexter	43	10-Mar	29	14	5	T91 T92	832	T92
323	516235	4851482		54	28-Feb	25	14	5	T42 T43	696	T41
40	523543	4840919	Dexter	48	23-Dec	25	14	5	T90 T91	776	T92
227	523895	4841046	Dexter	50	20-Dec	24	14	5	T91 T92	1104	T92
221	523732	4840963	Dexter	47	16-Dec	22	14	5	T91	930	T92
495	511367	4855488		64	15-May	20	14	5	T3 T4	1208	T4
328	512991	4851950		74	27-Oct	19	14	5	T18 T20	777	T21
335	522027	4850295		65	3-Jun	19	14	5	T52	1280	T53
167	523914	4840492	Dexter	40	6-Mar	27	13	5	T91 T92	845	T92
397	512875	4851453		52	9-Sep	24	13	5	T19 T20	989	T20
471	510218	4852299	Waltham	51	8-Mar	23	13	5	T16 T17	1035	T16
536	517736	4859295		56	31-Jan	22	13	5	T7 T8	1100	T8
526	514521	4858221		55	19-Jul	22	13	5	T5	1188	T5
54	514511	4844798		45	22-Dec	22	13	5	T66	1106	T65
325	515108	4851916		53	19-Jun	20	13	5	T34	850	T33
322	516125	4851962		61	10-Jan	19	13	5	T42	542	T34
313	515241	4855218		75	19-Jul	16	13	5	T11 T30	782	T29

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
175	523997	4840739	Dexter	36	11-Feb	30	12	5	T91 T92	1010	T92
92	517474	4846973		52	5-Jan	19	12	5	T57	615	T58
371	515287	4849693		44	11-Sep	23	12	4	T45 T46	856	T39
74	521139	4840600		60	27-Jan	21	12	4	T89 T90	756	T88
311	516003	4854162		56	6-Aug	21	12	4	T28 T29	520	T30
222	523795	4841010	Dexter	44	15-Dec	20	12	4	T91	1007	T92
154	523606	4839703		60	7-May	19	12	4	T90 T91	776	T92
400	513772	4849997		59	14-May	17	12	4	T38 T39	679	T37
174	524025	4840743	Dexter	35	12-Feb	28	11	4	T91 T92	1037	T92
187	523952	4840550	Dexter	35	26-Feb	28	11	4	T91 T92	897	T92
168	523969	4840491	Dexter	38	5-Mar	26	11	4	T91 T92	898	T92
172	523974	4840548	Dexter	36	26-Feb	26	11	4	T91 T92	918	T92
402	513226	4850325		42	24-Aug	24	11	4	T37 T38	1024	T37
514	516277	4856647		35	14-Dec	23	11	4	T12	793	T12
405	510560	4851467		49	9-Mar	22	11	4	T19 T20	929	T16
425	510137	4852211	Waltham	49	18-Mar	21	11	4	T16 T17	1103	T16
73	520854	4840497		48	5-Feb	21	11	4	T85 T89	749	T87
424	510154	4852206	Waltham	48	18-Mar	21	11	4	T16 T17	1085	T16
468	510139	4852424	Waltham	47	27-Feb	21	11	4	T16 T17	1141	T16
57	518444	4845951		42	25-Jul	20	11	4	T58	1172	T58
41	523510	4840922	Dexter	42	11-Dec	19	11	4	T90	760	T92

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
522	519436	4857024		55	17-Jun	17	11	4	T9	1381	T10
176	524022	4840683	Dexter	34	23-Oct	27	10	4	T91 T92	1010	T92
173	524027	4840637	Dexter	32	19-Oct	27	10	4	T91 T92	997	T92
169	524023	4840485	Dexter	36	3-Oct	25	10	4	T91 T92	949	T92
171	524008	4840549	Dexter	34	28-Feb	25	10	4	T91 T92	951	T92
89	520940	4847028		34	21-Apr	23	10	4	T59	650	T60
422	510117	4852247	Waltham	47	26-Sep	22	10	4	T16 T17	1126	T16
88	521039	4847033		45	19-Apr	22	10	4	T59 T60	731	T60
469	510123	4852371	Waltham	47	8-Oct	21	10	4	T16 T17	1144	T16
467	510102	4852333	Waltham	45	8-Mar	21	10	4	T16 T17	1156	T16
18	510438	4850724		48	19-Jul	20	10	4	T19	1309	T19
264	523745	4852689		48	18-Apr	20	10	4	A5 A6	1148	A6
426	510113	4852169	Waltham	48	22-Mar	20	10	4	T16 T17	1124	T16
449	510089	4852423	Waltham	46	28-Feb	20	10	4	T16 T17	1189	T16
448	510112	4852477	Waltham	47	16-Oct	19	10	4	T16 T17	1183	T16
470	510088	4852295	Waltham	46	11-Mar	19	10	4	T16 T17	1162	T16
496	510693	4855268		48	24-May	18	10	4	T2	807	T4
228	523893	4841077	Dexter	42	13-Dec	18	10	4	T91	1124	T92
170	524033	4840550	Dexter	33	11-Oct	24	9	3	T91 T92	976	T92
24	508803	4855324		37	12-May	21	9	3	T3	514	T1
423	510070	4852224	Waltham	47	18-Mar	20	9	3	T16 T17	1170	T16

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
450	510081	4852404	Waltham	46	2-Mar	20	9	3	T16 T17	1191	T16
451	510080	4852391	Waltham	46	8-Oct	20	9	3	T16 T17	1190	T16
428	510047	4852158	Waltham	45	23-Mar	20	9	3	T16 T17	1189	T16
452	510063	4852352	Waltham	45	7-Mar	20	9	3	T16 T17	1198	T16
427	510061	4852123	Waltham	44	14-Sep	20	9	3	T16 T17	1173	T16
95	515834	4847105		34	22-Dec	20	9	3	T55	1112	T57
483	509816	4853506		44	30-Sep	19	9	3	T13 T14	1185	T13
447	510041	4852461	Waltham	43	26-Feb	19	9	3	T16 T17	1246	T16
220	523730	4840993	Dexter	37	16-Dec	19	9	3	T91	951	T92
429	510056	4852188	Waltham	44	21-Mar	18	9	3	T16 T17	1181	T16
513	515832	4856655		36	30-Jan	21	8	3	T12	1096	T11
58	518586	4845433		35	30-Jan	20	8	3	T74	1066	T72
525	514525	4858748		28	25-Mar	24	7	3	T5 T6	1080	T5
490	510378	4854487		35	25-Jan	19	7	3	T15	1288	T14
100	514263	4847066		29	24-Dec	19	7	3	T55	986	T54
500	508412	4856714		33	19-Dec	17	7	3	T2	1338	T1
225	523792	4841047	Dexter	32	17-Dec	17	7	3	T91	1032	T92
133	519293	4837344		40	23-May	16	7	3	T94	908	T96
149	522829	4838804		28	18-Feb	20	6	2	T100	1140	T100
506	511413	4856404		26	15-Feb	19	6	2	T4	1255	T4
492	513414	4855121		34	24-Jan	18	6	2	T28	1260	T26

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
299	520084	4852860		31	30-Jan	17	6	2	A2	1112	A1
42	523460	4840929	Dexter	30	18-Dec	17	6	2	T90	739	T92
45	517391	4838990		39	16-Jun	14	6	2	T79	1074	T81
444	510026	4852142	Waltham	24	17-Sep	20	5	2	T16	1209	T16
453	510024	4852413	Waltham	24	10-Oct	20	5	2	T16	1250	T16
418	509963	4851985	Waltham	24	3-Sep	19	5	2	T16	1277	T16
420	509992	4852250	Waltham	24	16-Mar	19	5	2	T16	1252	T16
421	510023	4852241	Waltham	24	16-Mar	19	5	2	T16	1220	T16
435	509985	4852037	Waltham	24	3-Apr	19	5	2	T16	1252	T16
436	509996	4852065	Waltham	24	1-Apr	19	5	2	T16	1240	T16
437	510006	4852094	Waltham	24	13-Sep	19	5	2	T16	1229	T16
442	509959	4852163	Waltham	23	24-Mar	19	5	2	T16	1277	T16
457	509977	4852300	Waltham	23	30-Sep	19	5	2	T16	1273	T16
518	517991	4856744		30	30-Jan	18	5	2	T12	973	T9
64	514958	4841401		27	8-Feb	18	5	2	T77	1304	T77
121	518036	4838870		27	4-Nov	18	5	2	T96	889	T95
14	522653	4848976		26	1-Nov	18	5	2	T64	1363	T64
517	518018	4856637		25	10-Feb	18	5	2	T12	1074	T9
413	509936	4851918	Waltham	24	13-Apr	18	5	2	T16	1312	T16
414	509953	4851942	Waltham	24	11-Apr	18	5	2	T16	1292	T16
419	509974	4852006	Waltham	24	5-Sep	18	5	2	T16	1265	T16

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
443	509978	4852156	Waltham	24	23-Mar	18	5	2	T16	1258	T16
446	510019	4852490	Waltham	24	24-Feb	18	5	2	T16	1267	T13
431	510003	4852206	Waltham	23	22-Sep	18	5	2	T16	1236	T16
438	509953	4852113	Waltham	23	14-Sep	18	5	2	T16	1282	T16
455	510009	4852374	Waltham	23	5-Mar	18	5	2	T16	1255	T16
432	509951	4852226	Waltham	22	19-Mar	18	5	2	T16	1290	T16
434	509946	4852074	Waltham	22	31-Mar	18	5	2	T16	1289	T16
454	509975	4852389	Waltham	22	5-Mar	18	5	2	T16	1291	T16
407	509927	4851901	Waltham	24	27-Aug	17	5	2	T16	1323	T16
408	509917	4851875	Waltham	24	16-Apr	17	5	2	T16	1338	T16
415	509928	4852019	Waltham	24	4-Apr	17	5	2	T16	1310	T16
430	509985	4852214	Waltham	24	18-Mar	17	5	2	T16	1255	T16
416	509913	4852002	Waltham	23	5-Sep	17	5	2	T16	1325	T16
409	509873	4851878	Waltham	24	15-Apr	16	5	2	T16	1381	T16
411	509885	4851893	Waltham	24	15-Apr	16	5	2	T16	1366	T16
223	523728	4841022	Dexter	25	18-Dec	15	5	2	T91	972	T92
90	519562	4846899		26	15-Jun	14	5	2	T60	509	T59
417	509905	4851969	Waltham	24	2-Sep	18	4	2	T16	1336	T16
440	509941	4852167	Waltham	23	23-Mar	18	4	2	T16	1295	T16
456	509955	4852339	Waltham	23	3-Oct	18	4	2	T16	1301	T16
439	509936	4852118	Waltham	22	15-Sep	18	4	2	T16	1299	T16

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
458	509923	4852270	Waltham	22	16-Mar	18	4	2	T16	1323	T16
512	515608	4856669		26	8-Feb	17	4	2	T12	1259	T11
433	509899	4852095	Waltham	22	29-Mar	17	4	2	T16	1336	T16
459	509940	4852312	Waltham	22	30-Sep	17	4	2	T16	1311	T16
460	509906	4852227	Waltham	22	19-Mar	17	4	2	T16	1334	T16
441	509923	4852179	Waltham	21	22-Mar	17	4	2	T16	1313	T16
412	509897	4851928	Waltham	23	11-Apr	16	4	2	T16	1350	T16
15	522783	4848654		21	8-Mar	16	4	2	T64	1386	T64
410	509843	4851947	Waltham	22	9-Apr	17	4	1	T16	1400	T16
534	518122	4858838		21	19-Sep	17	4	1	T8	909	T10
445	509838	4852208	Waltham	21	22-Sep	16	4	1	T16	1400	T16
461	509882	4852191	Waltham	21	22-Mar	16	4	1	T16	1356	T16
462	509797	4852221	Waltham	20	19-Mar	15	4	1	T16	1442	T16
466	509806	4852334	Waltham	20	11-Mar	14	3	1	T16	1447	T16
232	523794	4841070	Dexter	22	17-Dec	12	3	1	T91	1051	T92
37	523429	4840941	Dexter	12	18-Dec	8	1	0	T90	736	T92
51	516821	4841534		11	18-Dec	8	1	0	T77	790	T78
87	520409	4841819		15	16-Jun	6	1	0	T75	785	T76
224	523728	4841047	Dexter	8	21-Dec	6	1	0	T91	991	T92
132	519405	4837344		7	16-Jun	2	0	0	T95	918	T96
229	523842	4841125	Dexter	2	20-Dec	2	0	0	T91	1124	T92

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
1	517036	4837283		-	-	-	-	-		859	T93
2	516989	4837283		-	-	-	-	-		894	T93
8	516868	4846940		-	-	-	-	-		746	T58
23	508824	4854605		-	-	-	-	-		1103	T1
25	516574	4855153		-	-	-	-	-		654	T11
29	509890	4856591		-	-	-	-	-		743	T4
32	515238	4860083		-	-	-	-	-		1423	T5
33	520200	4846300		-	-	-	-	-		986	T59
34	520126	4845680		-	-	-	-	-		985	T74
35	523729	4841134	Dexter	-	-	-	-	-		1060	T92
55	514649	4845510		-	-	-	-	-		619	T54
56	515403	4845184		-	-	-	-	-		1014	T56
60	517679	4845338		-	-	-	-	-		1085	T58
65	514068	4842936		-	-	-	-	-		1437	T65
77	519704	4840505		-	-	-	-	-		556	T85
86	520111	4841938		-	-	-	-	-		522	T76
94	516658	4847069		-	-	-	-	-		971	T57
101	514591	4843196		-	-	-	-	-		886	T65
102	514401	4842925		-	-	-	-	-		1217	T65
103	514327	4842925		-	-	-	-	-		1263	T65
104	515332	4842510		-	-	-	-	-		1393	T65

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
105	515229	4843009		-	-	-	-	-		885	T65
106	515751	4843043		-	-	-	-	-		1041	T66
107	516483	4842924		-	-	-	-	-		1119	T67
108	516608	4843032		-	-	-	-	-		954	T67
109	516980	4843317		-	-	-	-	-		492	T67
110	517789	4842860		-	-	-	-	-		976	T67
111	517789	4842924		-	-	-	-	-		921	T67
112	517580	4843014		-	-	-	-	-		744	T67
113	518013	4843149		-	-	-	-	-		822	T68
115	519823	4843035		-	-	-	-	-		626	T76
118	516047	4838993		-	-	-	-	-		672	T79
119	517071	4838978		-	-	-	-	-		966	T80
120	517975	4838960		-	-	-	-	-		847	T81
122	518945	4839007		-	-	-	-	-		804	T83
127	520699	4837259		-	-	-	-	-		907	T98
128	520408	4837331		-	-	-	-	-		888	T98
129	520218	4837325		-	-	-	-	-		974	T98
130	520151	4837162		-	-	-	-	-		1149	T98
131	519549	4837161		-	-	-	-	-		1127	T96
134	519182	4837187		-	-	-	-	-		1067	T96
135	518226	4837361		-	-	-	-	-		621	T94

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
136	518246	4837260		-	-	-	-	-		723	T94
137	518139	4837263		-	-	-	-	-		689	T94
138	517602	4837355		-	-	-	-	-		518	T93
139	517211	4837187		-	-	-	-	-		819	T93
140	516930	4837268		-	-	-	-	-		949	T93
146	521756	4837243		-	-	-	-	-		1156	T100
147	521737	4837309		-	-	-	-	-		1090	T100
148	522397	4837245		-	-	-	-	-		1316	T100
152	523370	4839243		-	-	-	-	-		1078	T92
153	523350	4839243		-	-	-	-	-		1074	T92
230	523899	4841141	Dexter	-	-	-	-	-		1174	T92
231	523731	4841078	Dexter	-	-	-	-	-		1016	T92
233	523796	4841095	Dexter	-	-	-	-	-		1070	T92
234	523729	4841116	Dexter	-	-	-	-	-		1045	T92
235	523737	4841155	Dexter	-	-	-	-	-		1081	T92
236	523795	4841142	Dexter	-	-	-	-	-		1106	T92
237	523794	4841172	Dexter	-	-	-	-	-		1129	T92
238	523736	4841177	Dexter	-	-	-	-	-		1098	T92
239	523796	4841214	Dexter	-	-	-	-	-		1163	T92
240	523845	4841166	Dexter	-	-	-	-	-		1157	T92
241	523845	4841211	Dexter	-	-	-	-	-		1191	T92

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
242	523845	4841239	Dexter	-	-	-	-	-		1213	T92
243	523789	4841290	Dexter	-	-	-	-	-		1221	T92
244	523727	4841219	Dexter	-	-	-	-	-		1128	T92
245	523728	4841263	Dexter	-	-	-	-	-		1164	T92
246	523768	4841357	Dexter	-	-	-	-	-		1265	T92
247	523843	4841351	Dexter	-	-	-	-	-		1302	T92
248	523305	4841353		-	-	-	-	-		1088	T92
262	522724	4851335		-	-	-	-	-		1443	A4
288	523396	4853941		-	-	-	-	-		1303	A6
289	523029	4853707		-	-	-	-	-		909	A6
290	522429	4853406		-	-	-	-	-		542	A6
291	522456	4853421		-	-	-	-	-		548	A6
292	522358	4853828		-	-	-	-	-		966	A6
297	520169	4853247		-	-	-	-	-		1359	A1
301	516134	4857292		-	-	-	-	-		1398	T12
302	516204	4857057		-	-	-	-	-		1161	T12
304	516646	4855144		-	-	-	-	-		672	T11
314	515039	4854942		-	-	-	-	-		454	T29
315	518607	4852412		-	-	-	-	-		1122	T44
316	518186	4852393		-	-	-	-	-		859	T44
324	515764	4851828		-	-	-	-	-		592	T33

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
329	513756	4851434		-	-	-	-	-		1056	T37
330	517961	4848721		-	-	-	-	-		680	T48
332	519999	4849580		-	-	-	-	-		1301	T51
333	521336	4849055		-	-	-	-	-		672	T64
334	521727	4849821		-	-	-	-	-		1441	T52
337	521035	4850401		-	-	-	-	-		570	T52
363	514616	4849224		-	-	-	-	-		1279	T38
369	515387	4848664		-	-	-	-	-		1427	T45
370	515307	4848827		-	-	-	-	-		1371	T45
395	512064	4850758		-	-	-	-	-		667	T19
396	512152	4850758		-	-	-	-	-		727	T19
463	509755	4852244	Waltham	-	-	-	-	-		1486	T16
464	509779	4852232	Waltham	-	-	-	-	-		1461	T16
465	509717	4852263	Waltham	-	-	-	-	-		1526	T16
480	508810	4854715		-	-	-	-	-		1006	T1
494	511352	4855111		-	-	-	-	-		1317	T15
499	508243	4856650		-	-	-	-	-		1398	T1
501	509937	4856732		-	-	-	-	-		850	T4
503	510758	4856728		-	-	-	-	-		939	T4
515	516900	4856739		-	-	-	-	-		661	T12
516	516832	4856557		-	-	-	-	-		476	T12

GL GH ID	UTM Coordinates		Town	Number of days per year	Worst day	Max mins per day [min/day]	Total Hours in Year [hrs/yr]		Turbine ID contributing to the events	Closest turbine	
	Easting [m][1]	Northing [m][1]					without cloud cover	taking into account the cloud cover		Distance [m]	ID
519	518369	4856736		-	-	-	-	-		989	T9
523	516114	4858000		-	-	-	-	-		726	T6
524	514636	4857686		-	-	-	-	-		1408	T5
528	516248	4858272		-	-	-	-	-		515	T7
537	516787	4859849		-	-	-	-	-		1088	T8
544	516821	4860179		-	-	-	-	-		1419	T8
545	516029	4860113		-	-	-	-	-		1403	T7
548	515181	4859887		-	-	-	-	-		1253	T5
549	514981	4859942		-	-	-	-	-		1382	T5

1. Coordinate system is UTM Zone 15N, NAD 83 datum.

In the Matter of the Application of Pleasant Valley Wind LLC for a LWECS Site Permit for the 300 MW Pleasant Valley Project in Dodge and Mower Counties

Docket No. IP-6828/WS-09-1197

CERTIFICATE OF SERVICE

Catherine M. Wood, certifies that on **November 22, 2013** she served true and correct copies of the **PLEASANT VALLEY WIND, LLC'S PETITION FOR MODIFICATION OR AMENDMENT TO SITE PERMIT** upon the following parties via e-filing and/or U.S. Mail:

Person	E-mail Address	Company	Address	Method of Service
Burl W. Haar	burl.haar@state.mn.us	MN Public Utilities Commission	121 7th Place East Suite 350 St. Paul, MN 55101-2147	Electronic Service
Sharon Ferguson	Sharon.ferguson@state.mn.us	MN Department of Commerce	85 7th Place East Suite 500 St. Paul, MN 55101-2198	Electronic Service
Julia Anderson	Julia.anderson@state.mn.us	MN Office of the Attorney General	1400 BRM Tower 445 Minnesota Street St. Paul, MN 55101-2131	Electronic Service
John Lindell	agorud.ecf@state.mn.us	OAG-RUD	900 BRM Tower 445 Minnesota Street St. Paul, MN 55101-2130	Electronic Service
Brian Meloy	brian.meloy@leonard.com	Leonard, Street and Deinard	150 South 5th Street Suite 2300 Minneapolis, MN 55402	Electronic Service
Joe Grennan	joe.grennan@resamericas.com	Pleasant Valley Wind	c/o RES 11101 W 120th Ave, Ste. 400 Broomfield, CO 80021	Electronic Service
Jamie Schrenzel	Jamie.schrenzel@state.mn.us	MnDNR		Electronic Service
James Hartson			59931 300th Street Waltham, MN 55982	U.S. Mail
Peter Reinarts		Olmsted Wind Truth	11748 Hwy 30 SW Hayfield, MN 55940	U.S. Mail

/s/ *Catherine M. Wood*
Catherine M. Wood