

STATE OF MAINE  
LAND USE REGULATION COMMISSION

IN THE MATTER OF	)	Pre-Filed Direct Testimony of
DEVELOPMENT PERMIT APPLICATION DP 4886	)	R. Scott Bodwell, P.E.
BLUE SKY EAST, LLC	)	on Behalf of Blue Sky East

On behalf of Blue Sky East, LLC, R. Scott Bodwell is submitting this pre-filed direct testimony in support of DP 4886.

**I. QUALIFICATIONS AND BACKGROUND**

My name is Scott Bodwell. I am the founder and principal of Bodwell EnviroAcoustics, LLC (BEA). I received a BA in Engineering Sciences from Dartmouth College in 1982 and have been providing acoustic engineering and analysis services since 1987. I am a registered professional engineer in the State of Maine and in over 23 years of professional experience I have conducted more than one hundred sound assessments for a variety of industrial and commercial projects in Maine.

I have completed sound level assessments and operations testing for numerous energy projects in Maine recently including the Stetson I and II Wind Projects in Washington County, Oakfield Wind and Mars Hill Wind Farm in Aroostook County, Rollins Wind Project in Penobscot County, and Maritimes & Northeast Pipeline facilities in Washington and York Counties. As part of the Stetson II post-construction monitoring requirements, I worked with the Maine Department of Environmental Protection (DEP) and Land Use Regulation Commission (LURC), and Warren Brown from EnRad Consulting, to develop and implement a comprehensive sound testing protocol specific to wind turbines, and which incorporates the unique testing conditions when wind turbine sounds are most noticeable. Attached as Exhibit A is a statement of my qualifications.

The purpose of my testimony is to describe the scope and findings of the Sound Level Assessment completed by BEA in January 2011 for the proposed Bull Hill Wind Project to be located in Hancock County, Maine, which is included as Exhibit 17 of the Application, and to summarize the Project's compliance with applicable regulatory sound standards.

## **II. INVOLVEMENT WITH THE BULL HILL WIND PROJECT**

Blue Sky East, LLC (Blue Sky) proposes to construct and operate the Bull Hill Wind Project, which is located on Bull Hill and Heifer Hill ridges within Unorganized Township T16 MD. The primary objective of the Sound Level Assessment was to determine the expected sound levels from full operation of the Project and compare them with relevant sound standards set forth by the Maine DEP and implemented by LURC.<sup>1</sup> A summary of the results and information concerning sound levels from proposed wind turbine operations is provided below.

## **III. SUMMARY OF SOUND LEVEL ASSESSMENT**

The proposed Bull Hill Wind Project is located in a rural area of Hancock County and consists of 19 wind turbines with an output of 1.8 megawatts (MW) per turbine. The proposed wind turbines are Vestas Model V100 manufactured by Vestas American Wind Technology, Inc. The total generating capacity of the proposed Wind Project is 34.2 MW. Ten turbines would be arranged along Bull Hill Ridge to the north and nine turbines along Heifer Hill Ridge to the south. In addition to the turbine structures, the project includes construction of an operations and maintenance facility and substation located centrally in the project. The sources of sound from operation of wind turbines are mechanical noise from gears, motors and cooling equipment in the

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<sup>1</sup> Bull Hill Wind is located within an "expedited permitting area" as identified by LURC and defined by 35-A M.R.S.A. Chapter 34-A, Expedited Permitting of Grid-Scale Wind Energy Development. In accordance with special provisions established by 12 M.R.S.A. Section 685-B, a wind energy development (facility) located within the expedited permitting area must comply with noise control regulations established by the Board of Environmental Protection. These regulations were promulgated by the Maine Department of Environmental Protection (DEP) under authority of the Site Location of Development Law (38 MRSA Sections 481 – 490) and identified as Maine DEP Chapter 375.10, Control of Noise. As a result, Maine DEP 375.10 applies to Bull Hill Wind in lieu of Section F.1 Noise of LURC Chapter 10 Land Use Districts and Standards.

turbine nacelle and the aerodynamic effects of the rotor blades traveling through the air. When operating at or near full sound output, the primary noise source from a wind turbine is rotation of the rotor blades with more sound energy generated from the outer sections of the blade and blade tip.

The project area is primarily low elevation commercial forest, and the surrounding land uses consist mostly of undeveloped and commercial forestry land with sparse rural residential and seasonal properties. The majority of residential and seasonal properties nearest to the project are located west of the proposed wind turbines along Sugar Hill Road in the Town of Eastbrook, Maine. Exhibit B is a Project Location Map that shows the locations of the proposed wind turbines and other facilities in relation to surrounding topography and land uses.

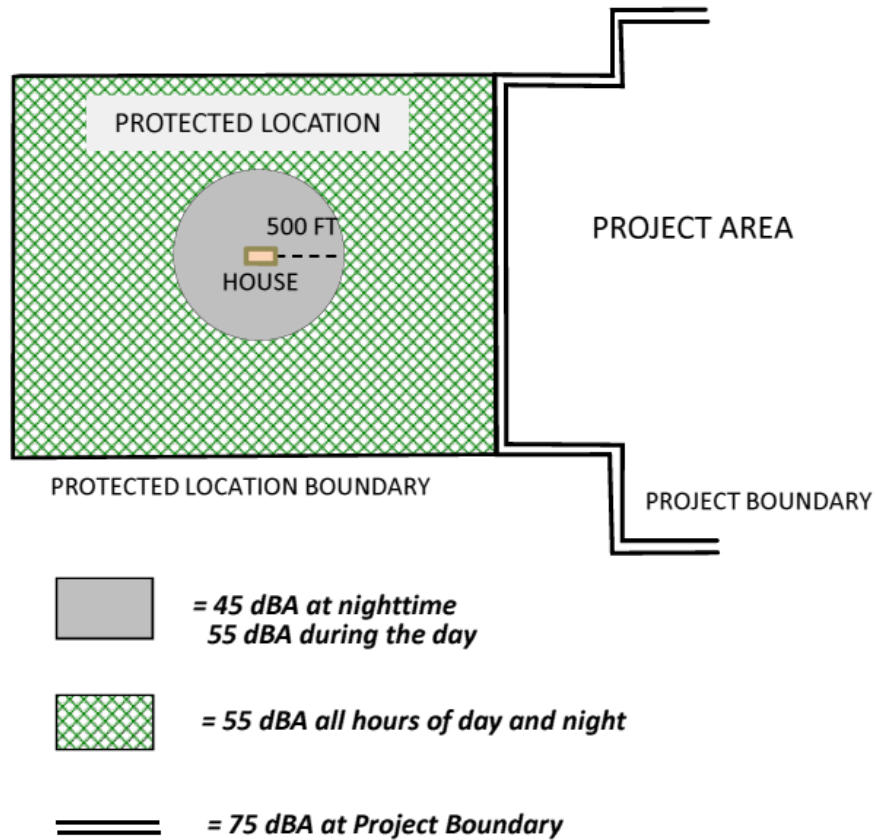
Excluding properties with a lease or sound easement, there are only four dwellings located within one mile of a proposed wind turbine. These dwellings are all on Sugar Hill Road with the nearest one at a distance of approximately 3,880 feet from the nearest proposed wind turbine. There are several year-round and seasonal dwellings located on Molasses Pond, which at its closest point is approximately 1.9 miles west of the nearest proposed turbine. Exhibit C highlights the Project area and closest residences.

### **APPLICABLE SOUND LIMITS**

A complete discussion of the applicable sound limits is included in Sections 2.4 and 5.0 of the Sound Level Assessment. In recognition of the quiet rural area, Blue Sky has elected to apply the more stringent “quiet” area limits of 45 dBA during the nighttime and 55 dBA during the daytime. As a result, the relevant hourly equivalent sound level limits include the following:

- 75 dBA at the Project boundary;
- 55 dBA during the daytime at protected locations;
- 45 dBA during the nighttime at locations within 500 feet of a residence on a protected location.

Protected locations include parcels of land that include a residence, seasonal camps, and conservation land. These limits are depicted visually in Figure 1 below:



**Figure1. Maine DEP Hourly Sound Level Limits**

### **PREDICTED SOUND LEVELS**

BEA prepared a sound level prediction model based on wind turbine specifications and topographic mapping of the project area to calculate sound levels expected from full operation of the Bull Hill Wind Project. The model, which is described in Section 6.0 of the Sound Level Assessment, incorporates a number of conservative assumptions, including the following:

- The turbines are assumed to be operating at full sound output with a sound power level of 105.0 dBA, plus an additional 2 dBA uncertainty factor, for an assumed sound power level of 107.0 dBA.
- An additional 3 dBA was added to take into account potential uncertainty in the modeling calculation method, resulting in an effective sound power level of 110.0 dBA, which is 5 dBA more than the full sound power level specified and warranted by Vestas.
- Sound levels are calculated as if the receiver locations were all simultaneously downwind from the sound sources, which is not a physical possibility.
- Although foliage has the effect of reducing sound levels at receiver points, no attenuation was calculated due to trees or other foliage.
- Ground attenuation was calculated based on a ground absorption factor of 0.5, which represents a mix of hard and soft ground; surface water bodies, however, were mapped and assigned a ground absorption factor of 0.0, similar to hard ground for an acoustically reflective surface.

These same modeling assumptions have been used in a number of other wind power projects in Maine, including the Stetson I and Stetson II projects previously approved by LURC, and the Rollins, Record Hill, and Oakfield projects, each of which was approved by the Maine DEP. Importantly, we now have post-construction monitoring data from the Stetson I and Stetson II projects, which allow us to compare the predicted levels with the operating levels and, in effect, allow us to calibrate the model. The post-construction monitoring data from the Stetson I and II projects demonstrates that the model typically overpredicts actual hourly sound levels by 2-4 dBA. This is not surprising in light of the conservative assumptions built into the model.

The maximum predicted sound levels from the Project are reflected in the sound contour maps attached as Exhibit D hereto. Receptor points are the locations in any direction from the Project with the greatest potential to exceed the applicable Maine DEP sound limits, and are identified as P1, P2, and P3 on Exhibit D. As depicted in Exhibit D and shown in the Table 1

below, when operating at full sound output, the Project will meet the DEP quiet nighttime limits at all protected locations.

Receptor Point	Description	Distance to Nearest Turbine (ft)	Estimated Hourly Sound Level, dBA	Maine DEP Sound Level Limit, dBA	
				Daytime	Nighttime
P1	500 feet from Dwelling	4,340	37.2	55	45
P2 <sup>2</sup>	Lot Line of Residential Parcel	3,705	39.6	55	45
P3	Conservation Area	6,160	35.4	55	55

**Table 1. Estimated Daytime and Nighttime Sound Levels from Wind Turbine Operations at Receptor Points**

The sound level estimates in Table 1 indicate that the highest expected sound levels downwind from full operation of Bull Hill Wind will be approximately 5 dBA below the 45 dBA nighttime limit at the lot line of the nearest dwelling on a protected location as represented by receptor point P2. Further, the sound level estimates indicate that sound levels from Bull Hill Wind will be nearly 8 dBA below the daytime and nighttime limit of the nearby regulated protected location represented by receptor point P1. The nighttime limit at the Conservation Area represented by receptor point P3 is 55 dBA because this point is more than 500 feet from sleeping quarters. Estimated sound levels at P3 are approximately 20 dBA below the applicable limit of 55 dBA.

The Maine DEP regulation requires an adjustment to the measured sound level at a protected location if the development generates certain types of sound that are considered to be more annoying than relatively steady sound with no prominent tones or frequencies. These regulated types of sound are 1) tonal sounds and 2) short duration repetitive sounds.

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<sup>2</sup> P2 represents the closest protected location. The dwelling is 3,880 feet to the closest turbine, and the quiet nighttime limit applies.

Tonal sounds are similar to prominent discrete tones that may be audible from a development at a protected location. Based on the Sound Level Performance Standard for the V100, as well as a measurement report by Delta (AV 172/10 29 October 2010),<sup>3</sup> the Vestas V100 turbines are not expected to generate regulated tonal sounds during routine operation.

Short duration repetitive (SDR) sounds are brief sound events that result in an increase in sound levels of 6 dBA or more before and after the event. For wind turbines, brief changes in sound levels occur as the passage of rotor blades, commonly referred to as "amplitude modulation." The highest sound levels are generally recognized to take place on the down stroke of each rotor blade which occurs at a rate of just over once per second at full rotational speed. Measurements of operating wind turbines at other projects in Maine and published literature concerning amplitude modulation from wind turbines indicates that sound level fluctuations during the blade passage of wind turbines typically range from 2 to 5 dBA, with occasional but infrequent events reaching 6 dBA or more.<sup>4</sup> If SDR events occur, a 5 dBA penalty is applied to the measured levels to determine compliance with the applicable limits. The post-construction monitoring program as described in Section 7.2 of the Sound Level Assessment is designed to measure compliance in conditions that are most likely to result in SDR events and, if they occur, the penalty will be applied when determining compliance. Even assuming that occasional SDR events over 6 dBA occur, and 5 dBA is added to the observed sound level for those events, the Project would still comply with the relevant sound level limits at all protected locations.

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<sup>3</sup> The Delta report on the Vestas V100 turbine, which became available only after completion of the Sound Level Assessment, supports the conclusions in the Sound Level Assessment on tonal sounds and, also provides turbine sound levels that when modeled predict overall sound levels that are slightly less than what is reflected in the Sound Level Assessment.

<sup>4</sup> Observations and analysis of sound level measurements for Mars Hill Wind Farm and Stetson Wind Project, R. S Bodwell, P.E.; G.P. van den Berg, The Sounds of High Winds.

EnRad Consulting, acoustical consultant to LURC and the Maine DEP, reviewed the Sound Level Assessment and concluded that it was “reasonable and technically correct according to standard engineering practices required by LURC under 12 MRSA §685(4-B)(A) Regulations on Control of Noise (06-096 CMR 375.10).” Bull Hill Wind Project Sound Level Assessment – Peer Review (“Peer Review”) at Section 8.0, p.5 (a copy of the Peer Review is attached as Exhibit E). EnRad Consulting also concurred that sound levels from the project would be 5 dBA or more below applicable quiet limits of 45 dBA and 55 dBA, that tonal sounds are not expected to occur, and that SDR events are not expected to be frequently produced but if they were, the project has a buffer of at least 5 dBA between predicted levels and the applicable limits. Peer Review at Sections 6.3 and 8.0, p. 5.

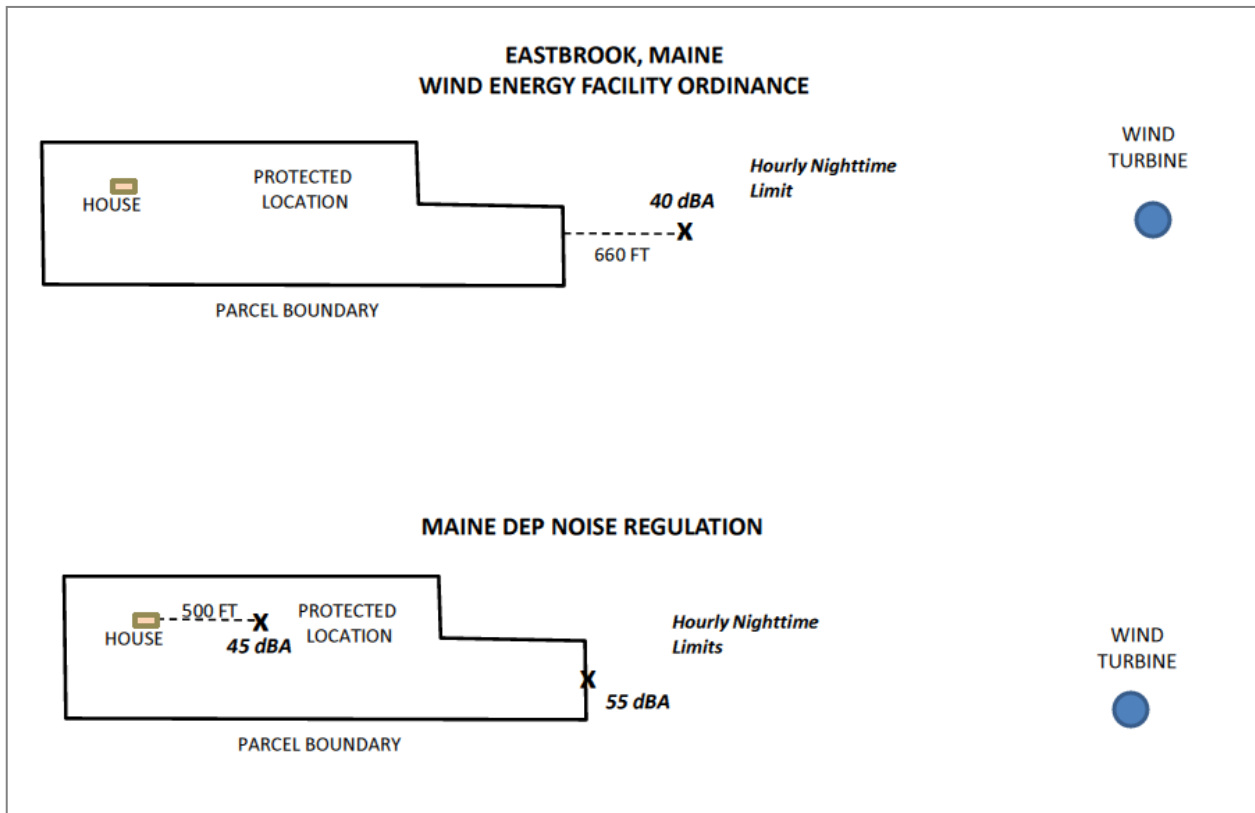
### **CONSIDERATION OF EASTBROOK SOUND LIMITS**

When sound produced by a facility is received in another municipality, the Site Law regulations require the Maine DEP to *consider* the quantifiable noise standards of the other municipality. This is in contrast to the requirement that the DEP *apply* the quantifiable sound limits duly enacted by the municipality in which the facility is located, as long as those limits are not more than 5 dBA above the DEP limits. In January 2011, Eastbrook adopted an ordinance for wind development that by its terms applies only to a wind project in the Town of Eastbrook. All of the wind turbines proposed for Bull Hill Wind are located in Township T16 MD. For informational purposes only, and to allow the Commission to consider the Eastbrook limits, BEA is providing information on the limits set forth in the Eastbrook ordinance and the predicted sound levels at key receptor locations within Eastbrook.

The Eastbrook Ordinance establishes a nighttime limit of 40 dBA at all locations on a parcel containing a residence and extending an additional 660 feet beyond the parcel boundary.



Figure 2 below depicts and provides a visual comparison of the Eastbrook and DEP limits. The Eastbrook Ordinance contains two additional quantifiable requirements: 1) the hourly sound level from a wind energy facility cannot exceed 35 dBA at any location greater than two miles from a turbine; and 2) 5 dBA may be added to measured sound levels for purposes of determining compliance if there are certain tonal sounds.



**Figure 2. Comparison of Eastbrook and Maine DEP Hourly Sound Level Limits**

As shown in Exhibit F, the closest dwellings (referenced as P1 and P2 therein) are in Eastbrook and are located 3,880 and 4,860 feet from the closest turbine. Sound levels at both of these dwellings readily meet the nighttime 45 dBA DEP noise standard and the more stringent 40 dBA limit set forth in the Eastbrook ordinance (35.8 dBA and 39.3 dBA, respectively). Additionally, sound levels will not exceed 40 dBA at any location on the P1 or P2 parcels and, in

light of the conservative nature of the model, it is likely that actual (in contrast to predicted) sound levels at locations 660 feet beyond these two parcels will also be 40 dBA or less.<sup>5</sup> Finally, sound levels from the Project will be below 35 dBA at locations two miles from a turbine and, as discussed above, tonal sounds are not expected.

### **POST CONSTRUCTION MONITORING PROTOCOL**

Sound level testing of wind turbine operations is a complex and critical component of the proper and responsible operation of a wind energy facility. The most difficult aspect of wind turbine sound testing is to perform the required measurements under the proper site and weather conditions. Operation of wind turbines at full sound output requires a significant level of wind acting on the turbine hubs for an extended period of time. Often when hub wind speeds are at the required levels, surface winds will also be high enough to cause extraneous sound levels from wind forces acting on terrain and vegetation. These extraneous sound levels can make it difficult to isolate turbine sound.

However, during nighttime periods, the winds aloft along the project ridges and wind turbine hubs can remain strong while the surface winds at lower elevations near protected locations can diminish to light or nearly calm. These conditions are commonly referred to as a “stable atmosphere” and are the best conditions under which to measure the sound level contributions of wind turbines for several reasons. First, the ambient (non-wind turbine) sound levels from wind and daytime activities are reduced so that the sound levels from wind turbines become more prominent and easier to quantify. Second, technical literature concerning wind

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<sup>5</sup> EnRad Consulting, which utilized a similar methodology, predicted that during full sound output of the project, the sound level 660 feet beyond the property line of P1 would be 41.5 dBA and the sound level 660 feet beyond the property line of P2 would be 39.6 dBA. See Bull Hill Project Sound Level Assessment – Peer Review Addendum, attached as Exhibit G. As noted above, actual sound levels at the Stetson I and Stetson II projects have been on average 2-4 dBA less than predicted levels, and therefore it is likely that sound levels 660 feet beyond P1 and P2 will be consistently below 40 dBA.

turbine noise emissions indicates that the potential for amplitude modulation increases under these conditions. Therefore, full sound output under a stable atmosphere is the preferable condition for measuring worst case sound levels and determining the presence of short duration repetitive sounds.

I have worked closely with LURC, the Maine DEP and EnRad Consulting to develop a specific and detailed testing protocol for measuring sound levels from wind turbines in Maine. The purpose of this protocol is to measure wind turbine sound levels to evaluate compliance with Maine DEP sound level limits including appropriate adjustments for tonal and short duration repetitive sounds. The most recent version of this Sound Testing Protocol prepared by BEA was submitted to and approved by LURC in support of the Stetson II Wind Project in Washington County, Maine. It is contained in the Bull Hill Sound Level Assessment report as Exhibit 2. The Stetson II Protocol was supplemented by Protocol Details & Calculation Methods prepared by BEA that provides details and examples for assessing penalties for short duration repetitive and tonal sounds. This supplement was reviewed and approved by LURC and EnRad Consulting and is presented as Exhibit 3 of the Sound Level Assessment report. These approved test protocols will be used to develop a similar protocol for sound level testing of turbine operations for Bull Hill Wind.

## **CONCLUSION**

In conclusion, the results of the Sound Level Assessment indicate that with all wind turbines operating simultaneously at full capacity, sound levels from operation of the Bull Hill Wind Project will be less than relevant Maine DEP noise standards during both daytime and nighttime periods. Specifically, model estimates show that sound levels from full operation of Bull Hill Wind will be approximately 5 dBA or more below the applicable Maine DEP nighttime sound level limits at all protected locations.

Date: 4/21/11

R. Scott Bodwell  
R. Scott Bodwell

STATE OF MAINE  
County of Cumberland

Date: 4/21/2011

Personally appeared before me the above named R. Scott Bodwell, who, being duly sworn, did testify that the foregoing testimony was true and correct to the best of his knowledge and belief.

Before me,

Cari M. DeHak

Notary Public

My commission expires: 10/21/2017

Bodwell Pre-Filed Direct Testimony Exhibits

- Exhibit A: BEA Qualifications
- Exhibit B: Project Location Map
- Exhibit C: Residences in Project Vicinity
- Exhibit D: Predicted Sound Levels
- Exhibit E: Bull Hill Wind Project Sound Level Assessment – Peer Review
- Exhibit F: Sound Model Estimates at Nearest Protected Locations
- Exhibit G: Bull Hill Wind Project Sound Level Assessment – Peer Review Addendum

## **EXHIBIT A. Qualifications**

**R. Scott Bodwell, P.E.**

**Principal**

**Bodwell EnviroAcoustics, LLC**

### **Summary**

R. Scott Bodwell, P.E. is the founder and principal of Bodwell EnviroAcoustics, LLC, an engineering consulting firm that services the energy and industrial sector and specializes in Environmental Acoustics.

### **Professional Experience**

Mr. Bodwell has over 23 years of experience in environmental assessments, project engineering and design, and regulatory permitting for major utility, energy production, and transmission projects in the northeast United States.

As a consulting engineer in Maine since 1987, Mr. Bodwell has conducted acoustic studies on hundreds of industrial development projects and is recognized as a leading authority on Environmental Acoustics in Maine. Mr. Bodwell was the lead acoustical engineer on the first two utility-scale wind energy facilities in Maine at Stetson Mountain in Washington County and Mars Hill Wind Farm in Aroostook County. He also conducted the acoustic study for the wind turbine installation at University of Maine at Presque Isle.

Mr. Bodwell has worked closely with the Maine Department of Environmental Protection and Maine Land Use Regulation Commission and independent acoustical consultants to develop and refine procedures and methods for assessment and measurement of sound from wind turbines. Specialized measurement techniques were developed based on several hundred hours of sound testing for operating wind turbines in Maine and are considered to be some of the most advanced and thorough testing procedures in the United States.

Mr. Bodwell has provided expert testimony at state hearings and municipal reviews in successful support of major industrial and energy projects in Maine including Stetson Wind Project, Rollins Wind Project, Maritimes & Northeast Pipeline, Bath Iron Works, and Waste Management of Maine. He also developed and conducted an Environmental Acoustics seminar for project managers and technical staff at the Maine Department of Environmental Protection.

Mr. Bodwell has conducted peer reviews of environmental assessments by others for the Maine DEP, the Saco River Corridor Commission and several municipalities in Maine, and assisted municipalities with the development of noise control ordinances.

### **Education and Credentials**

Mr. Bodwell is an Engineering Sciences graduate of Dartmouth College and has completed numerous graduate and continuing education courses in engineering and acoustics.

Mr. Bodwell has been a licensed professional engineer in Maine since 1994.

## EXHIBIT B. Project Location Map



**Stantec**

**Stantec Consulting Services Inc.**  
 30 Park Drive  
 Topsham, ME USA  
 04086  
 Phone (207) 729-1199  
 Fax: (207) 729-2715  
 www.stantec.com

**Legend**

- Turbine Layout (9-15-10)
- Proposed Access Road (9-23-10)

**Client/Project**  
 Blue Sky East  
 Bull Hill Wind Project  
 T16 MD, Maine

**Figure No.**

**1**

**Title**

Project Site Map

195600500







Note:  
1. Dwelling field verification performed by Stantec May 2010.

195600500



**Stantec Consulting Services Inc.**  
30 Park Drive  
Topsham, ME USA  
04086  
Phone (207) 729-1199  
Fax: (207) 729-2715  
www.stantec.com

**Legend**

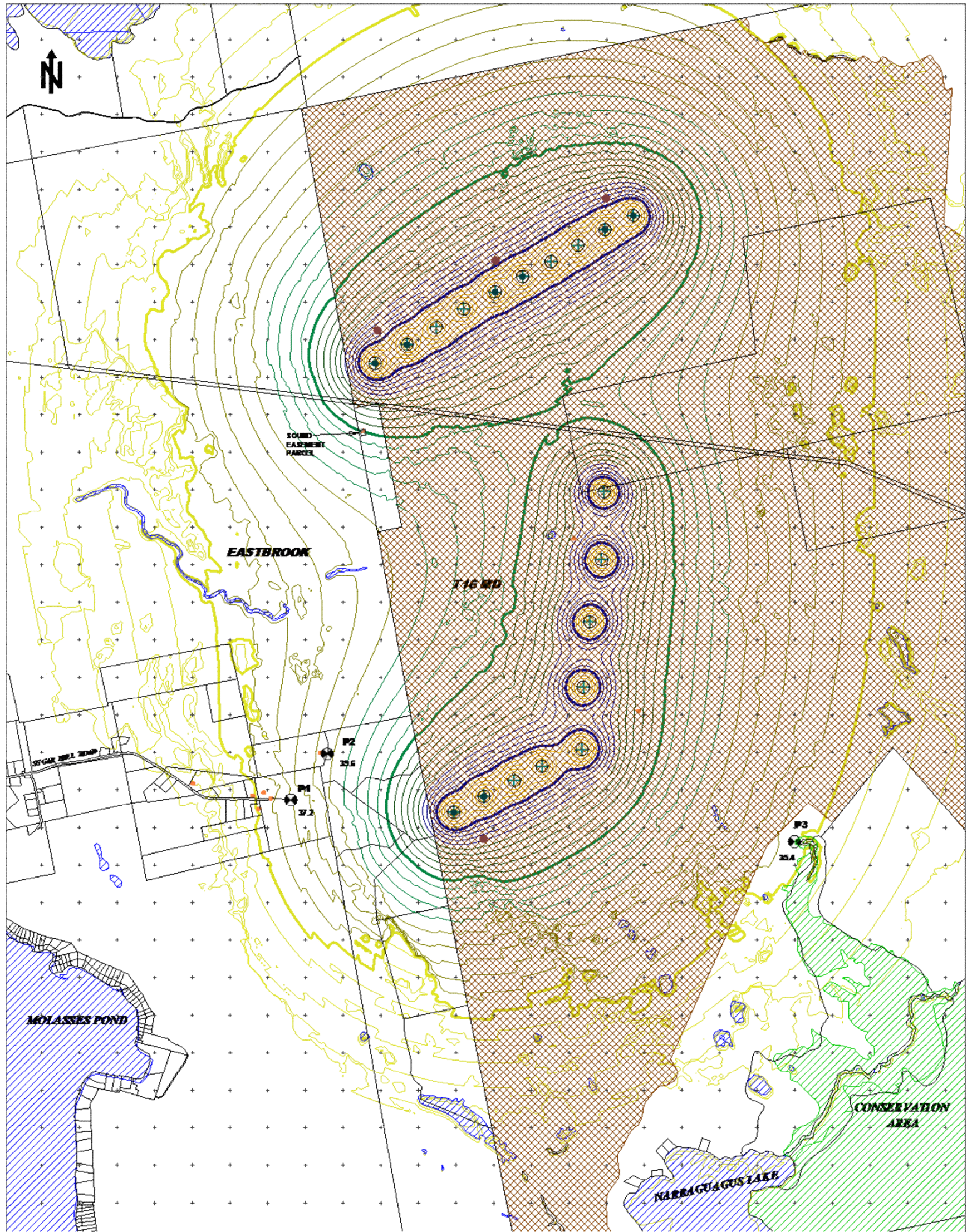
-  Turbine Layout (IFP)
-  Field Verified Dwellings (Stantec)

**Client/Project**  
**Blue Sky East Wind Project**  
**Eastbrook and T16 MD, Maine**

Exhibit  
**C**

Title  
Nearest Non-Participating Dwelling  
April 25, 2011

**EXHIBIT D. Predicted Sound Levels from Wind Turbine Operation**



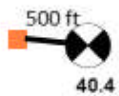
Parcel Leased or Owned by Blue Sky



Wind Turbine



Dwelling



Receptor Point & Estimated Sound Level



Permanent Met Tower



Temporary Met Tower

Coordinate Grid Spacing = 1000 ft

Sound Level Contour Interval = 1 dBA

55 dBA (Daytime Limit)

45 dBA (Nighttime Limit)

35 dBA

# Bull Hill Wind Project Sound Level Assessment -- Peer Review

TOWNSHIP T 16 MD, MAINE

Warren L. Brown  
John L. Adams

March 25, 2011

Submitted by:

EnRad Consulting  
516 Main Street  
Old Town, Maine 04468

Submitted to:

Donald Murphy, Project Manager  
Land Use Regulation Commission  
Maine Department of Conservation  
Augusta ME 04333 – 0022

# Bull Hill Wind Project Sound Level Assessment Peer Review

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## **Review Basis**

Blue Sky East, LLC (Blue Sky) proposes to construct and operate a wind energy facility to operate 19 utility-scale wind turbines in Township T16 MD area of Hancock County, Maine. At the request of the Land Use Regulation Commission (LURC) a peer review is undertaken to determine if the noise study is reasonable and technically correct according to standard engineering practices and the Commission Regulations on Control of Noise (12 MRSA §685-B(4-B)(A)).

### **1.0 Introduction**

The stated objective of the sound assessment is to demonstrate that the Blue Sky T16 MD Township wind project utilizing 19 Vestas V 100 turbines will meet MDEP/LURC sound level limits. Only mention is made of the Eastbrook, Maine Wind Energy Facility Ordinance. Sound levels from the construction activity, and operation of the substation and other electrical transmission facilities are briefly discussed.

The routine operation sound level estimates are compared to the Maine DEP sound level limits to demonstrate that the Blue Sky wind project will meet applicable sound level limits. The Town of Eastbrook, Maine has adopted a Wind Energy Facility Ordinance to regulate the siting, construction and operation of Wind Energy Facilities in the Town of Eastbrook, Maine. This ordinance does not directly address wind energy facility sounds received in Eastbrook from outside municipalities.

### **2.0 Environmental Acoustics**

Informational

### **3.0 Project Description**

The wind turbine portion of the project consists of 19 Vestas model 100 1.8 MW turbines located along Bull Hill Ridge to the north and Heifer Hill Ridge to the south. The immediate project area and closest protected locations P1, P2 and P3 are located in low elevation forest. The western end of the southern array of turbines (Heifer Hill Ridge) is approximately 600 feet east of the Eastbrook town line, 4300 feet from P1 and 3700 feet from P2. The Vestas model 100 has a total height above ground level of 476 feet. Molasses Pond year-round and seasonal dwellings lie approximately 1.9 miles and greater from the southwestern terminus of the project.

The operation of the proposed substation and O&M building (approximately 2 miles from nearest protected location) are not expected to generate significant sound levels and are thus not included in sound level estimates for the wind project facility.

Blue Sky has purchased or leased property from landowners to install and operate wind turbines at the proposed locations. Easements have been entered into with landowners

who may experience sound levels from the project that have the potential to exceed applicable sound level limits (MDEP Chap 375.10)

## **4.0 Vestas Wind Turbine Sound Levels**

Blue sky proposes to utilize a three blade, up wind Vestas 100-1.8 MW wind turbine. Manufacturer sound power levels determined in accordance with IEC 61400 – 11 range from 94 to 105 dBA (9.3-16.6 RPM or 3-14 m/s) with an uncertainty of 2.0 dBA at full operation. Dominant frequencies range from 125-1000 Hz.

## **5.0 Noise Standards And Guidelines**

Sound level limits were determined at protected locations and property lines based on land owner agreements and land uses. Blue Sky proposes to accept the most conservative regulation levels of 55 dBA daytime and 45 dBA nighttime. Tonal, SDRS, construction, and exempt sounds are appropriately referenced. The Eastbrook wind energy ordinance is noted but not addressed in the report (see addendum).

The reviewer notes that Chapter 375.10 (B)(1) specifies "... This regulation applies to developments located within one municipality, when the noise produced by the development is received in another municipality and, in these cases, the board will also take into consideration the municipalities quantifiable noise standards, If any."

The reviewer will provide the board with a compliance review based on the Eastbrook ordinance in a sperate addendum for consideration in this project.

## **6.0 Sound Assessment**

### **6.1 Construction Sound Levels**

Standard discussion

### **6.2 Operating Sound Levels**

The wind project prediction model (ISO 9613-2) is based on CADNA/A software, with user input of the following prediction assumptions:

- individual wind turbine hub level spherical wave fronts,
- 3-D topography,
- ground surface absorption factor,  $G = 0.5$  – bodies of water  $G = 0$ ,
- atmospheric attenuation for 10°C, 70% RH,
- no attenuation due to foliage,
- all wind turbines modeled at maximum sound power output and
- under moderate downwind conditions simultaneously.

The model incorporates an uncertainty factor of + 2 dBA for equipment specification uncertainty and + 3 dBA for prediction algorithm accuracy (ISO 9613-2).

Operating sound level estimates were predicted for the three nearest protected locations indicating hourly level equivalents at or below 40 dBA. It is noted that the conservation area operating sound level estimate is approximately 20 dBA below the applicable limit of 55 dBA.

### **6.3. Tonal and Short Duration Repetitive Sounds**

Vestas has issued a Sound Level Performance Standard that warrants the V 100 will not produce a steady tonal sound as defined by the MDEP 375.10 standard. The proposed Vestas V 100 are not expected to generate regulated tonal sounds during routine operation.

Short duration repetitive sounds are not expected to be frequently produced by the Vestas V 100. In the event that significant penalties are applied for SDRS, the project has a predicted margin of 5 dBA between routine operating sound levels and MDEP limits.

## **7.0 Sound Level Testing**

### **7.1 Construction**

Construction of the project as planned primarily for daylight and daytime hours. No construction sound level testing is planned.

### **7.2 Wind Turbine Operations**

Stable atmospheric required compliance conditions are discussed. tonal and SDRS calculation methodologies are reiterated based on previous compliance reporting requirements.

## **8.0 Summary Of Findings**

Bull Hill wind project is predicted to produce routine operating sound levels below (5 dBA or more) sound level limits based on chapter 375.10 "quiet limits -- 45 dBA nighttime/55 dBA daytime" (up to 500 feet of residence).

### **Conclusion - (Peer Review)**

In my opinion the Bull Hill Wind Project noise assessment is reasonable and technically correct according to standard engineering practices required by LURC under 12 MRSA §685-B(4-B)(A) Regulations on Control of Noise (06-096 CMR 375.10).

The wind project prediction model based on CADNA/A software, based on the following prediction assumptions:

- individual wind turbine spherical wave fronts,
- mixed ground cover attenuation (general) and reflective water surfaces,
- atmospheric attenuation based on 10°C, 70% RH,
- no attenuation due to foliage or barriers,
- all wind turbines operating at maximum sound power output and
- all wind turbines operating under moderate downwind conditions simultaneously.

Incorporation of an uncertainty factor of + 5 dBA for maximum equipment specification uncertainty under stable atmospheric conditions and prediction methodology accuracy resulted in a reasonable prediction model.

I recommend required routine operation noise compliance measurements at a minimum of two protected locations designated in the application noise assessment as "Receiver Points" P2 and P3. These particular sites represent the southern turbine array from two directions and elevations. Please note specific recommendations (pending landowner agreement) for some locations. The reviewer notes that the northern array of turbines has no nearby protected locations.

Receiver Point	Recommendation/s
P2	Receiver point P2 is the most sensitive (39.6 dBA), and appears to have an open field nearby for potential compliance confirmation.
P3	This location will require a proxy measurement point as it is largely a wetland with wooded surroundings. Aerial photos indicate that there are several potential proxy locations to confirm projected sound levels.

Compliance should be demonstrated, based on following outlined conditions for 12, 10-minute measurement intervals per monitoring location meeting 06-096 CMR 375.10 requirements.

Background ambient monitoring may be required in the areas where extraneous sounds could potentially or do complicate routine operation compliance assessment. If required, background ambient monitoring locations and times will be determined with concurrence from the MDEP.

- a. Compliance will be demonstrated when the required operating/test conditions have been met for twelve 10-minute measurement intervals at each monitoring location.
- b. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable, i.e. when the measurement location is downwind of the development and maximum surface wind speeds  $\leq 6$  mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from



reported data. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines.

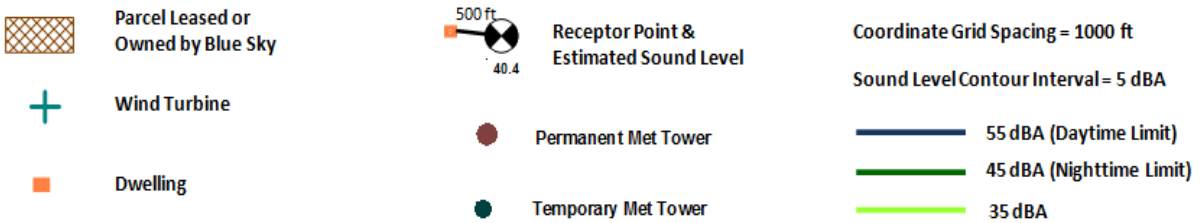
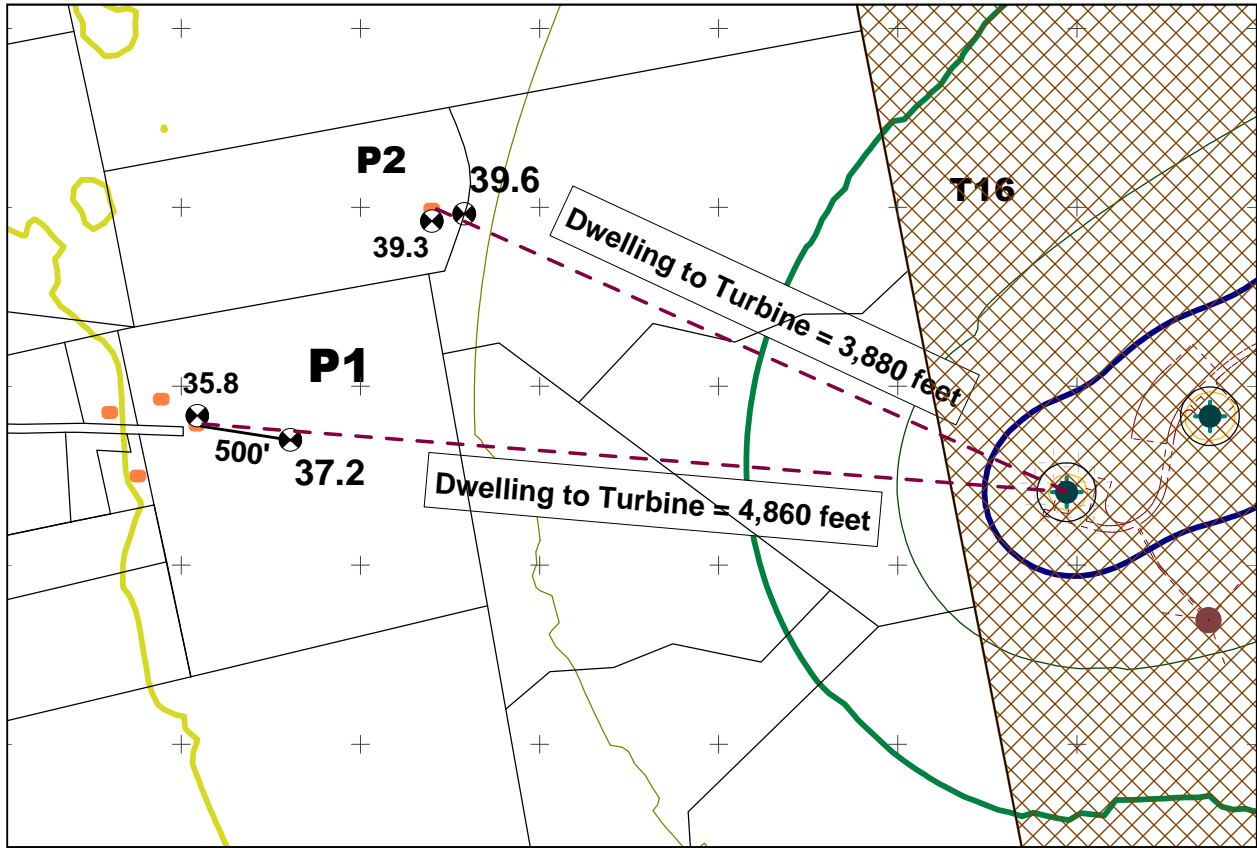
c. Sensitive receiver sound monitoring locations should be positioned to most closely reflect the representative protected locations for purposes of demonstrating compliance with applicable sound level limits, subject to permission from the respective property owner(s). Selection of monitoring locations should require concurrence from MDEP.

d. Meteorological measurements of wind speed and direction should be collected using anemometers at a 10-meter height above ground at the center of large unobstructed areas and generally correlated with sound level measurement locations. Results should be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum should be reported from surface stations. MDEP concurrence on meteorological site selection is required.

e. Sound level parameters reported for each 10-minute measurement period, should include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events should be characterized by event duration and amplitude. Amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms. For each 10-minute measurement period short duration repetitive sound events should be reported by percentage of 50 ms or less intervals for each observed amplitude integer above 4 dBA. Reported measurement results should be confirmed to be free of extraneous noise in the respective measurement intervals to the extent possible and in accordance with (b).

f. Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol will be submitted to the Department for review and approval prior to the end of the first year of facility operation. Reported and unreported compliance data for each location will be submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.

## EXHIBIT F. Sound Model Estimates at Nearest Protected Locations



**Bull Hill Wind Project Sound Level Assessment -- Peer Review**  
**April 4, 2011**

**Addendum**

This addendum to the applicant's noise assessment review addresses the sound limits pursuant to the Maine Wind Energy Facility Ordinance Town of Eastbrook, Maine for the siting, construction and operation of Wind Energy Facilities in the Town of Eastbrook, Maine. The reviewer provides this information for the commission to "take into consideration" the neighboring municipal quantifiable sound ordinance (Chapter 375 (10)(B)(1)). No inference should be concluded regarding the reviewer's opinion regarding ordinance applicability to the Bull Hill Project.

The noise assessment as submitted by Blue Sky East, LLC (Blue Sky) will be re-evaluated in this addendum beginning in section 5 (**Noise Standards and Guidelines**).

**Eastbrook Wind Energy Facility Ordinance (Ordinance)**

Section 3.0. Purpose.

The purpose of this ordinance is to regulate the siting, construction and operation of Wind Energy Facilities in the Town of Eastbrook, Maine in order to protect the public health, safety and welfare.

Subsection 20.1 Noise Standards

The applicant shall notify the Planning Board at least 30 days prior to conducting the study (post construction) and the town may observe all field work and shall be given an opportunity to review the study's methodology and results. A second study must be performed during the same period in the second year and at least every three years thereafter.

The project boundary hourly sound level limit of 75 dBA Leq<sub>(1)</sub> was satisfactorily demonstrated in the LURC application noise assessment.

Ordinance sound level limits at 660 feet from protected locations are compared with estimated project sound levels in Table 1.

**Table 1**

Location	Ordinance day limit dBA Leq <sub>(1)</sub>	Ordinance night limit dBA Leq <sub>(1)</sub>	SDRS <sup>d</sup>	Tonal <sup>e</sup>	Project estimate <sup>f</sup> dBA
P1 <sup>a</sup> @660'	55	40	No	No	41.5
P2 <sup>a</sup> @660'	55	40	No	No	39.6
LF <sup>b</sup> @2mi	35	35 <sup>c</sup>	No	No	28.5

<sup>a</sup> Protected locations based on the ordinance and the Bull Hill Wind Project Sound Level Assessment

<sup>b</sup> lakefront properties along Molasses Pond are assumed by the reviewer to be protected locations at distances greater than 2 miles

<sup>c</sup> Ordinance limits at protected locations at distances greater than 2 miles (Appendix B A.1.a)

<sup>d</sup> not expected to be problematic, but the planning board may find occurrences as particularly annoying penalizing with additional 5 dBA (Appendix B A.1.c.ii)

<sup>e</sup> not expected to be problematic, as demonstrated by manufacture specifications, but may be penalized (Chapter 375.10 criteria) by 5 dBA added to the  $Leq_{(t)}$  (Appendix B A.1.b)

<sup>f</sup> As estimated by the reviewer employing ISO 9613-2:1996(E) assuming simultaneous operation of all wind turbines, winter frozen-ground conditions ( $G = 0$ ), each turbine emitting the maximum sound power level guaranteed by the manufacturer for all wind speeds, including the uncertainty level (K factor) for sound measurement uncertainty and turbine production uncertainty (IEC technical specification 61400-14) (Appendix B B.f). Total sound power uncertainty is conservatively assumed at 2 dBA given the independent DELTA testing of the Vestas V90 and very limited production specifications of the V100.

In addition to footnote "d" of Table 1, Section C of the ordinance – Terms and Conditions the planning board reserves the right to require the applicant to:

- enclose equipment or operations,
- impose limits or extent of operating hours,
- require specific design technologies,
- site design,
- modes of operation, or
- traffic patterns,
- document no unreasonable disturbance of wildlife, or
- adversely affect wildlife populations, or
- lower sound level limits for the protection of wildlife resources.

The above paragraph appears to be based in part on subjective criteria that do not allow the predictions of two evaluators to necessarily arrive at the same outcomes.

The proposed project as designed does not comply with the ordinance quantifiable nighttime limit of 40 dBA for protected location P1 at 660 feet from property boundary.

Additional subjective SDRS compliance requirements cannot be anticipated at this time.

#### Appendix B (A.2) Construction Sound Level Limits

Ordinance nighttime (6 PM-7 AM) construction sound level limits are similar to chapter 375.10 requirements, except for the limit levels (Ordinance – 40 dBA@660 feet from the property boundary: Chapter 375.10 – 45 dBA up to 500 feet from a residence on a protected location).

Ordinance daytime construction (7 AM-6 PM) sound level limits are markedly below the chapter 375.10 limits that were repealed by 38 MRSA 484. Ordinance daytime

construction sound level limits are compared with previously held MDEP limits in Table-2 for perspective.

**Table 2** Ordinance Daytime Construction Sound Level Limits Compared With Previously Held MDEP Limits

<b>Eastbrook Ordinance</b>		<b>Repealed Chapter 375.10</b>	
<b>Duration of activity</b>	<b>Hourly Sound Level Limit</b>	<b>Duration of activity</b>	<b>Hourly Sound Level Limit</b>
>6 hours	80 dBA	12 hours	87 dBA
		8 hours	90 dBA
2 to 6 hours	85 dBA	6 hours	92 dBA
		4 hours	95 dBA
		3 hours	97 dBA
>1 hour but <2 hours	95 dBA	2 hours	100 dBA
One hour or less	105 dBA	1 hour or less	105 dBA

Since daytime construction sounds are exempt from chapter 375.10 (38 MRSA 484), the applicant made no estimates of impact. Hence, the reviewer has insufficient construction information and must also follow suit. It is noted that the ordinance daytime construction sound level limits are markedly below those of the former application of chapter 375.10.

Appendix B Section D Measurement Procedures

SDRS duration and frequency of occurrence of events must be measured (D.4.2.d).

**Review Conclusion**

The Eastbrook ordinance parallels chapter 375.10 in many aspects. The reviewer has attempted to highlight only areas of marked exception between the two regulations.

It is the reviewer's opinion that the Eastbrook ordinance is not entirely quantifiable and provides an insufficient basis for estimating acceptable wind project design.