

**Noise Monitoring Plan  
Sheffield Wind Project**  
Submitted by Vermont Wind, LLC

March 29, 2010; revised May 26, 2010

## **1.0 Introduction**

The noise emissions from the Sheffield Wind Project (“Project”) are subject to monitoring requirements and numeric limitations imposed by the Vermont Public Service Board by Orders dated August 8, 2007 and October 1, 2007 and the resulting Amended Certificate of Public Good (“CPG”). Condition 10 of the Amended CPG requires the following:

*[Vermont Wind] shall submit to the Board for review and approval a noise monitoring plan to be implemented during the first full year of operation. The Plan shall establish a monitoring program to confirm under a variety of seasonal and climactic conditions compliance with the maximum allowable sound levels described [in Condition 8].*

The Board expanded the scope of this plan in the October 1, 2007 Order: “We expect that the sound-monitoring plan will propose a process for dealing with noise complaints, including the need for indoor access to verify complaints. Residents who do not comply with the access provisions of an approved plan will not have their complaints addressed.”

The purpose of this Noise Monitoring Plan is to implement the CPG requirements as noted above. It has been prepared by Vermont Wind, LLC, in consultation with its outside noise consultant, Hessler Associates, Inc.

## **2.0 Applicable Noise Standard**

Noise emissions from the Project are limited in Condition 8 of the Amended CPG, as follows:

*[Vermont Wind] shall construct and operate the Project so that it emits no prominent discrete tones pursuant to ANSI standards at the receptor locations, and indoor sound levels at any existing King George School structures used for residential or instruction purposes and any existing surrounding residences do not exceed 30 dBA(Leq)(1).*

A “prominent discrete tone” as defined in ANSI S12.9/Part 3 1993 *Quantities and Procedures for Description and Measurement of Environmental Sound* is determined from the measurement of the 1/3 octave band frequency spectrum of a sound. Under the ANSI standard, a tone is said to exist if the 1/3 octave band containing the suspected tone exceeds the arithmetic average of the two adjacent bands by:

- 15 dB for all frequencies equal to or below 125 Hz
- 8 dB for all frequencies between 160 and 400 Hz
- 5 dB for all frequencies equal to or above 500 Hz

The term “30 dBA(Leq)(1)” means the equivalent energy average sound level (Leq) measured over a 1 hour period.

### **3.0 One Year Monitoring Plan**

The CPG requires implementation of a sound monitoring plan to be implemented during the first full year of operations. Vermont Wind proposes the following protocol:

#### **3.1 Monitoring Frequency**

Four rounds of monitoring will be conducted during the first operational year in January, April, July and October, weather and scheduling permitting, but in any event once per each quarter. This schedule will enable monitoring to be conducted under a variety of seasonal and climatic conditions (snow, leaves-on, leaves-off, etc.). Each round of monitoring will be conducted over a continuous (24 hours per day) two week period. All reasonable efforts will be made to conduct this monitoring when all turbines are operational (i.e. no turbines are under repair and wind speeds are adequate to enable the turbines to operate periodically), taking into account safety or equipment requirements. Any change in the operational status of the turbines will be noted in the report. To accomplish this continuous monitoring, sound monitors will be left in place at the monitoring locations.

#### **3.2 Monitoring Locations**

Based on previous background sound monitoring and sound modeling presented by Vermont Wind during the Section 248 process, monitoring would be conducted at 4 previously-identified locations that represent permanent residences and King George School dormitories, as reflected on the attached map (see Appendix B): P3 (north of Project Site), P8 (east of the Project Site), Dareios 1 (King George School, southeast of the Project Site) and Duck Pond 5 (west of the Project Site).<sup>1</sup> These locations were chosen in order to provide a regular geographic distribution and based upon their proximity to the Project, i.e., these locations had the highest predicted sound levels in their respective geographic areas.

Upon approval of this sound protocol, Vermont Wind will approach the specified residences and the King George School to secure permission to conduct this monitoring. In the event that permission is not granted, Vermont Wind will select a comparable alternative location. Once

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<sup>1</sup> Duck Pond 5 was chosen because it is one of the closest structures to a turbine and is near a small cluster of structures on the west side of the Project. Potentially elevated background levels due to the proximity of this location to Interstate 91 can be isolated through L90 measurements as explained in Section 3.5. Careful attention will be paid to explaining background sound from I-91 and the potential influence this sound may have on the Project sound levels will be documented and addressed in the reports to be submitted to the PSB.

final permission from the landowners has been granted to conduct this monitoring, Vermont Wind will provide a map to the PSB that depicts: (1) the turbine and met tower locations and numbers; (2) the four proposed monitoring locations and background monitoring locations; (3) an approximately 1.5 mile buffer depicting the limits where complaints will be accepted; (4) the location of the “Acoustic Center” for the Project.

### **3.3 Monitoring Logistics**

Sound monitoring will be conducted outdoors approximately 25 feet from each structure. In addition, a site-specific sound test will be conducted in accordance with ASTM standard E966-04 (see section 3.4 below) to determine the actual amount of attenuation that occurs between exterior and interior sound levels at each of the 4 monitoring locations. The interior sound levels will then be calculated based upon exterior sound levels and the measured attenuation of the structures.<sup>2</sup>

### **3.4 Outside to Inside Noise Test**

During the first quarterly survey, the outside to inside level reduction (OILR) of the structures at each of the four test positions will be tested using the procedures detailed in ASTM E966-04 *Standard Guide for Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements* (2004).<sup>3</sup> In general, this test involves using a loudspeaker directed in a defined manner towards the exterior of the house (on the side facing the Project in this case) to generate a broadband source signal. Measurements are then taken outside and inside the structure and used to determine the noise reduction of the building. All microphone positions and calculation procedures are detailed in the standard. The results of these tests on the structures comprising the four principal measurement locations will be published in the first test report along with a physical description of each structure.<sup>4</sup>

### **3.5 Exterior Measurement Protocol**

Since the objective of the first year sound monitoring test is to measure the noise level exclusively due to the Project, any possible contamination from background noise must be accounted for. As demonstrated by background sound monitoring recently conducted by Vermont Wind, (see Appendix A, Figure 1), exterior background sound levels commonly exceed

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<sup>2</sup> This site-specific test using the ASTM standard thus does not rely on a generalized attenuation factor such as that utilized in the WHO Guidelines. Moreover, because 30 dBA is an extremely low threshold level and thus creates a strong probability of measuring false positive results if the monitoring were conducted within the residences themselves, direct interior monitoring of turbine-related sound levels is not reliable under the circumstances. See Appendix A for a further explanation of this issue.

<sup>3</sup> ASTM and ANSI Standard documents are copyrighted and thus cannot be publicly distributed; however, Vermont Wind can make them available for in-person review upon request of a party.

<sup>4</sup> The outside-to-inside sound test will be performed under both windows open and windows closed conditions, weather permitting.

45 dBA during windy conditions when the Project can be expected to generate its maximum sound level; consequently, a measurement taken outside of a residence on a windy day when the Project is in operation cannot be assumed to reflect only noise from the Project because the reading is likely to contain potentially comparable components of both Project and background noise. In essence, the contemporaneous background sound level at the time of any measurement must be determined and logarithmically subtracted from the total measured level in order to derive the Project-only sound level.

Two methods to be used in parallel are outlined below to determine the background sound level. The general test set up is as follows.

#### *Principal Measurement Position*

Set up a continuously recording integrating sound level meter, ANSI Type 2 or better, outside of the residence, but at least 25 ft. from any reflective wall surfaces, in the direction of the Project. This instrument must record the frequency spectrum in 1/3 octave bands to check for pure tone compliance for each measurement interval. Avoid any potential sources of contaminating noise such as air conditioning units, wind chimes, etc. Set the microphone height at this position and all others at 3 ft. above local grade. This relatively low height helps minimize the wind speed at the microphone and thereby minimizes wind-induced false-signal noise from wind blowing through the windscreen and over the microphone tip. In addition, all microphones shall be fitted with weather-proof, oversized (7" diameter, ACO Type WS7-80T, or similar) windscreens to further minimize wind-induced distortion.

#### *Background Measurement Position 1*

Set up a similar continuously recording integrating sound level meter (ANSI Type 2 or better, with or without frequency capability) immediately behind the house, within 3 to 8 ft., on the side facing away from the Project to shield it from Project-related noise. Avoid any potential sources of contaminating noise such as air conditioning units, wind chimes, etc.

#### *Background Measurement Positions 2 and 3*

Set up at least two continuously recording integrating sound level meters (ANSI Type 2 or better, with or without frequency capability) at locations roughly 2 miles away from the nearest turbine in physical settings similar to or representative of all four of the Principal Measurement Positions in terms of nearby foliage, exposure to the wind and any significant sources of man-made or natural sound unrelated to the Project. The exact location of these background measurement positions are difficult to prescribe in advance and the suitability of candidate locations will need to be determined from a field inspection just prior to initial testing. In addition to other factors, permission from landowners will likely need to be obtained.

At the present time one location is envisioned in the vicinity of or just beyond Position P24 (see Appendix B), approximately 2 miles southwest of the Project, to capture the background sound levels likely to be present specifically at the Duck Pond 5 location, which is located near I-91. A background monitoring station the same distance from the highway as the house at Duck Pond 5 would be the ideal location assuming other factors such as topography and ground cover are

similar. A second position southeast of the Project along Morey Road near Position P12 appears to be suitable pending a field inspection. A third location northeast of Position P1 along Wheeler Mountain Road may also be appropriate as a background position for Position P3, which is approximately 975 ft. from Rt. 5. A location equidistant from Rt. 5, if feasible, may be appropriate.<sup>5</sup>

Allow the instruments at these locations to run for a period of approximately two weeks to capture a wide variety of wind speeds, directions and atmospheric conditions. Set all instruments to record the Leq and L90 statistical sound level in 10 minute intervals throughout the survey. One hour periods as prescribed in the Certificate of Public Good are likely to contain a number of contaminating noise events, such as cars passing by or planes flying over, and a finer 10 minute resolution is recommended not only to facilitate interpretation of the data after the fact but also to record the sound data in synchronization with the wind speed and direction measurements recorded by the meteorological towers and turbine nacelle anemometers, which are always stored at 10 minute intervals coinciding with the top of the hour (e.g. 1:00, 1:10, 1:20 etc.).

The background sound levels recorded at all background positions theoretically should be similar but will not be identical. Assuming a general consistency, the arithmetic average of all background positions can be used to correct the total measured level for each 10 minute period of the survey at the Principal position for background noise in accordance with the following formula – yielding the approximate Project-only sound level outside the house.

$$L_{p\text{Project}} = 10 \log [10^{(L_{p\text{Total}}/10)} - 10^{(L_{p\text{Ave. Background}}/10)}], \text{ dBA}$$

This formula will only hold in instances where the total sound level,  $L_{p\text{Total}}$ , is greater than the average background level,  $L_{p\text{Ave. Background}}$ . If the background level is higher, then the Project-only level is indeterminate for that measurement period. Equivalent descriptors, either the Leq or L90, must be used uniformly for all quantities in this calculation. A more conclusive set of results is likely to derive from the use of the L90 measure because it has the quality of filtering out sporadic noise events, such as cars passing by on Interstate 91, planes flying over, dogs barking, etc. whereas the Leq is strongly influenced (skewed upwards) by these contaminating events. Nevertheless, both Leq and L90 results will be reported, since CPG Condition 8 is expressed as an Leq value.

The data will be plotted in comparison to the concurrent wind speed and general weather conditions as measured by an on-site met tower or nacelle anemometer in a manner similar to Figure 1 in Appendix A. The wind speed measured by the met mast or nacelle anemometers on

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<sup>5</sup> To address the potential of the monitors immediately behind the homes near I-91 and Rt. 5 being adversely affected by traffic noise, the data collected at these two positions will be evaluated for contamination by comparing the results to the remote monitor data and by using the L90 statistical measure, which tends to filter out intermittent traffic noise. Vermont Wind will also consider locating the principal measurement position so that it is equidistant from the roadways and has the same exposure to them but is not shielded from project noise by the houses.

the top of the mountain is directly related to turbine operation, whereas the wind speed at the monitoring locations may be significantly lower or non-existent. In addition, the Project operating parameters, such as the number of units in operation and the overall power output, will also be compared to the sound level data. Since the intention of the test is to quantify the maximum Project sound levels, every effort shall be made to ensure that all units will be operational during each test period; however, it is not uncommon for isolated units to be periodically unavailable for maintenance reasons. If one or two units are not operating at any point during a sound test this fact shall be clearly stated in the test report. If three or more units are non-operational the test shall be rescheduled for another time. This test will not be run if the turbine(s) closest to the structure is not operating.<sup>6</sup>

Any inexplicable noise spikes in the data at any position that occur without a similar spike in wind speed shall be discarded as extraneous. The measurements made during periods of rain, as measured within the test area either by the met mast or another temporary weather station, shall also be discarded.<sup>7</sup>

The corrected Project-only sound level (with the exterior-interior adjustment accounted for, as described above) shall be compared to a criterion of 30 dBA (interior) to evaluate whether the Project is in compliance with CPG Condition 8. Compliance with the tonal provisions of Condition 8 shall be evaluated from the 1/3 octave band spectra recorded at the Principal Measurement Position at times when Project noise appears to be at a maximum.<sup>8</sup>

### **3.6 Reporting**

A report shall be submitted by the sound consultant describing the circumstances of the test, (including the architectural character and form of the residences/structures on which the attenuation factor will be based and the range of attenuation factors) its results and the rationale for all conclusions. The report will contain specific information collected during the monitoring, including wind speed and direction, operational status of the turbines and the

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<sup>6</sup> The data will not be used in measuring sound compliance at these locations if the corresponding turbines are not operational for extended periods of time -- Duck Pond 5/ Turbine 2; Dareios 1/Turbine 5; P8 /Turbines 3 and/or 6; and P3/Turbines 3 and/or 8. During the two week monitoring period, Vermont Wind will not remove turbines from operation for any reason other than safety to personnel or equipment. However, it is plausible that the turbines could automatically remove themselves from operation for short periods of time for various reasons. If these short periods of non-operation occur, Vermont Wind will work to return turbines to operation within a reasonable amount of time. Such downtime will be recorded by Operations staff so it can be accounted for in the sound monitoring reports and if necessary the measurement period may be extended by a day or two to compensate for this downtime.

<sup>7</sup> In addition, Vermont Wind may experiment with supplementing the monitoring by making digital audio recordings at the key positions west and south of the Project to identify sporadic noise spikes.

<sup>8</sup> "Maximum" is defined as a time period when an appropriate number of turbines are operating, i.e., the closest turbine to structures are operating, 13 or more turbines are operating, and the turbines are operating at maximum sound power levels for sustained periods of time during the 2 week monitoring period.

sound levels. Reports will be submitted to the PSB within one month of the last day of sound monitoring during each season.

#### 4.0 Complaint Monitoring

As mentioned previously, Vermont Wind is also required to implement a process for responding to complaints about Project-generated noise. Vermont Wind anticipates that this complaint process will be in place for a minimum of two years from COD and a maximum of five years unless an exceedance of the PSB noise limit is recorded during this time period at which point it will be extended until there are no more exceedances. The process will end after 2 years if there have been no verified exceedances of the PSB noise limit.

In the event that a complaint about Project noise is received via a 1-800 number that will be listed on the Sheffield Wind website ([www.sheffieldwind.com](http://www.sheffieldwind.com)) and provided to the local municipalities, Vermont Wind will investigate the complaint and evaluate compliance with the CPG noise limit if, based on the results of the quarterly tests (where detailed measurements will be made at the likely locations of maximum noise), there appears to be a reasonable possibility that the Project sound level is within 3 dBA of the CPG noise limit at the complaint location; i.e. the complaint location is within 1.5 miles of the nearest turbine. The A-weighted sound level from the closest monitoring location, as detailed in Section 3.2, shall be extrapolated to the complaint location by means of the following basic relationship to see if the sound level there is likely to be within 3 dBA of the sound limit:

$$L_{pc} = L_{pm} + 20 \log (D_m/D_c), \text{ dBA}$$

Where,

$L_{pc}$  = Estimated Interior Sound Pressure Level at the Complainant Location, dBA

$L_{pm}$  = Interior Sound Pressure Level determined at the nearest Monitoring Location, dBA

$D_m$  = Distance from the Acoustic Center of the Project to the Relevant Monitoring Location, ft.

$D_c$  = Distance from the Acoustic Center of the Project to the Complainant Location, ft.

The acoustic center of the Project is essentially the geographic center of the turbine array - where the Project could theoretically be combined into, and represented as, a single point source with respect to receiver positions located thousands of feet away from the Project.

Complainants will be requested to provide Vermont Wind with the following information, so that subsequent monitoring can be completed during a time that best replicates the conditions present during the time of the complaint.

- a. Location of residence
- b. Time and Date
- c. Weather Conditions (snow cover, cloud cover, direction of wind, etc.)
- d. Direction of sound and qualitative description

If testing is warranted, monitors will be set up by an acoustical engineer at the Principal and Background Position 1 locations (only) as described in Section 3.5 and programmed to measure continuously in 10 minute increments for approximately two weeks. The resulting exterior Project-only L90 sound level after correction for background will be converted to an interior level based on the typical ASTM E966-04 test result found at similar structures at one or more of the primary test positions unless the complaint location structure is clearly of a different construction, in which case an additional sound test of the property may be necessary. The complainant will be asked to note any times during this test period, along with the wind and weather conditions, when the noise is similar in nature to that which triggered the complaint.

Vermont Wind will respond to complaints within 1-2 business days: (i) that originate from existing permanent residences (i.e., in existence at the time the CPG was issued), or King George School structures used for residential or instructional purposes; (ii) that are located close enough (within 1.5 miles of the nearest turbine) to the Project that there is a reasonable possibility that Project noise is above the allowable interior sound limit of 30 dBA (Leq 1 hr); (iii) where the complainant allows access to their residence/property and otherwise cooperates as needed during the monitoring; and (iv) that involves properties that are not under agreement with Vermont Wind as part of the Project. If any complaints are received prior to the start of routine monitoring the test schedule may need to be advanced to more promptly respond to the complaint(s). Because of the complexity of the situation, complaints cannot be properly investigated without going through the full test procedure outlined above.

Monitoring will be conducted once per residence. The official results of the monitoring, i.e., the sound consultant's final report, will be shared with the complainant and the PSB. This report will contain specific information collected during the complaint monitoring, including wind speed and direction, operational status of the turbines, sound levels and the raw sound data collected by the sound engineer conducting the tests.

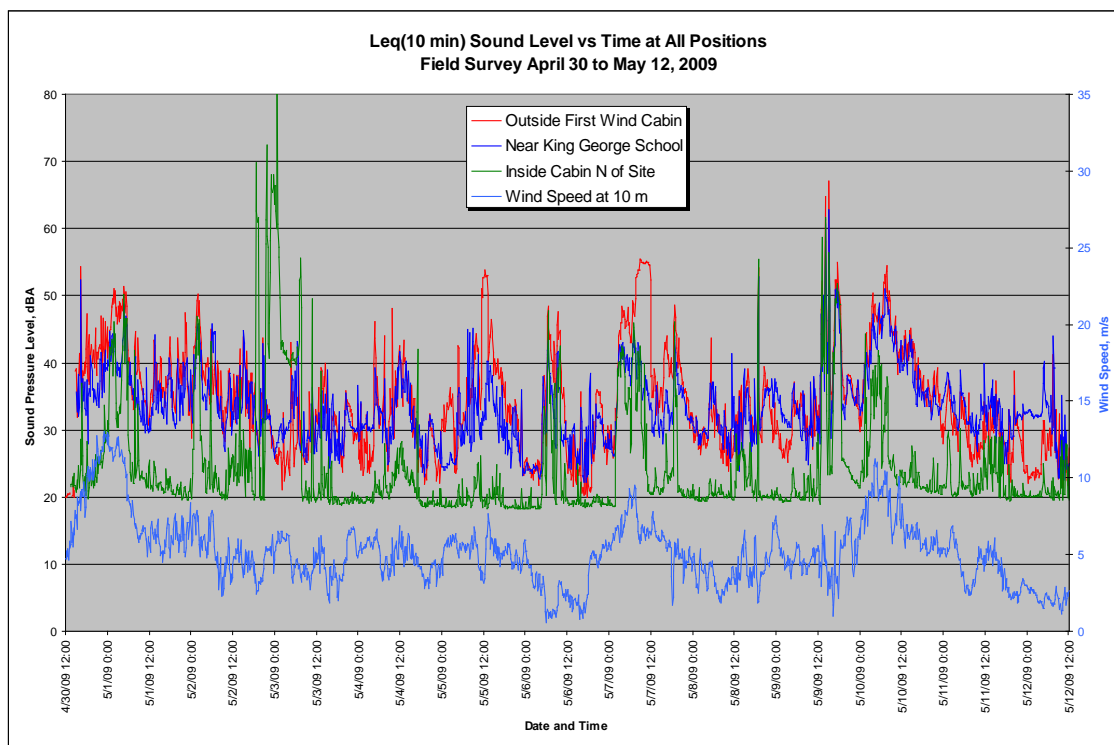
If it is found that the Project sound level at any permanent residence or at the King George School structures used for residential or instructional purposes is above the allowable limit, Vermont Wind will take all remedial steps necessary to bring the sound levels produced by the turbine(s) into compliance with allowable levels, as required by CPG Condition 9. However, if the Project sound level at any permanent residence or at the KGS structures used for residential or instructional purposes is below the allowable limit, then the location will be determined to be compliant.



## Sheffield Wind Project Noise Monitoring Plan Appendix A – Addendum to Section 3.3

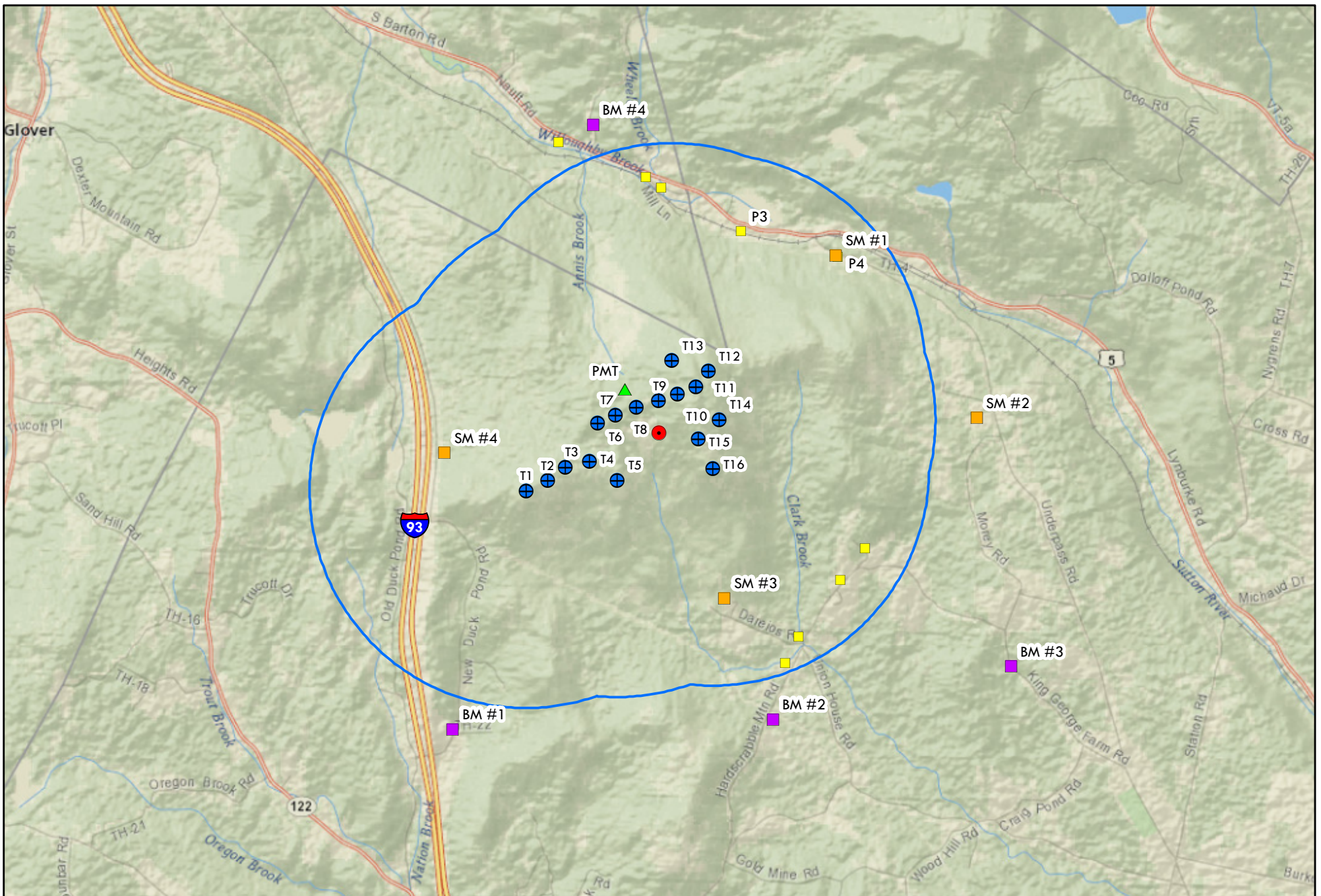
Almost any activity inside a normal home will generate a sound level of more than 30 dBA and many outdoor sources both natural and man-made, such as rain, wind rustling leaves, lawn mowing, etc., can also easily lead to interior sound levels above 30 dBA. Consequently, measurement of interior sound levels for any extended period of time, e.g., 1 hour to several weeks, is almost certain to contain many “false positive” readings that would incorrectly imply non-compliance with the Project noise limit of 30 dBA.

As an example, a preliminary survey of sound levels at one indoor and two outdoor locations representative of the nearest potentially sensitive noise receptors to the Sheffield Project site was carried out in late April/early May of 2009. Continuously recording sound monitors measured the average, or Leq, sound level in 10 minute intervals day and night for about 13 days. The results are plotted below in Figure 1 relative to the concurrent wind speed measured by an on-site met tower. This plot illustrates that interior sound levels (in this case in a cabin that was unoccupied for most of the survey period) frequently rise above 30 dBA, particularly when it is windy, and exterior levels frequently rise above 45 dBA even though no wind project exists. The interior levels of 40 dBA or more measured during windy periods would appear, very plausibly, as violations of the permit conditions if these measurements were recorded with the Project in operation.

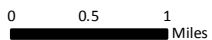


**Figure 1**

In addition, reliable interior sound monitoring is difficult to achieve due to the complexity of devising a process that accurately removes background sound from the inside of houses. As explained in Section 3.5, the objective of the first year sound monitoring is to measure the sound level exclusively due to the Project. Section 3.5 recommends a process to obtain background noise levels using monitors 2 miles from the Project to ensure that Project related sound is not captured. This can usually be done with reasonable accuracy, because it is relatively easy to find exterior locations that have nearly similar background levels in the outside environment. However, it is not possible to determine what the background sound level is inside of a house with the Project in operation, since the background measurement must be made simultaneously to keep all other factors unrelated to the Project constant (such as the interior audibility of wind in the trees outside or man-made sounds inside the house). It is for these reasons that Outside-Inside Noise Test as described in Section 3.4 will be performed.



### Sheffield Wind Farm Sound Monitoring Locations



- Residences
- Background Sound Monitoring Locations (approx.)
- Residential Sound Monitoring Locations
- Acoustic Center (approx.)
- 1.5 Mile Compliant Monitoring Buffer
- ▲ Permanent Met Tower
- ⊕ Turbine Layout



Map Scale  
1 centimeter = 780 meters

### Vermont Wind LLC

Project: Sheffield, VT

Drawn By: TM

Date: 01/20/2012