Summary of Public Input on
Draft *Kingston Wind Independence Turbine Acoustical Monitoring Study – Technical Report*
dated April 16, 2015

Compiled by the Consensus Building Institute
August 5, 2015

Background and Overview:

In response to noise complaints received by the Kingston Board of Health, the Massachusetts Clean Energy Center (MassCEC) was asked by the operator of the Kingston Wind Independence (KWI) turbine to commission a post-construction sound study. Due to the high level of interest in this undertaking and the requests from interested parties to have formal input in the study process, MassCEC has asked the Consensus Building Institute (CBI) to serve as a professional neutral and facilitator for including stakeholder input into the acoustical monitoring study. CBI's role is to help ensure that this study is conducted in a fair manner, that the results of the study are credible, legitimate, and salient, and that stakeholders have input into the design of the study and the presentation of findings. MassCEC selected Harris Miller Miller & Hanson Inc. (HMMH) to design and refine the scope and undertake the study.

On December 17, 2012, MassCEC and the Town of Kingston held a public meeting to take initial input on considerations for the design of the acoustical monitoring study. During that meeting and the weeks that followed, input was received from the public, the Board of Health, other Kingston town officials, and the KWI project operator. Based on that input, HMMH put together a Draft Scope for Acoustical Monitoring Study of the Kingston Wind Turbine(s), which was circulated by MassCEC to all stakeholders on February 14, 2013. Comments on the draft scope were accepted through February 28 and were collected by CBI, who compiled the comments in a summarized report. That report was used by HMMH and MassCEC to refine the study protocol and approach. HMMH then undertook monitoring between December 2013 – April 14, plus background ambient monitoring in September 2014. An interim report of findings was released on June 13, 2014, and a draft full Technical Report was released on April 16, 2015.

On June 18, 2015, the Town of Kingston Board of Health (BoH) held a public meeting during which HMMH presented the draft acoustical monitoring study (referred to by some commenters as the KWI-TR) and the public provided questions and comments on the report. During that meeting and the weeks that followed, input was received from the public and the BoH. Comments on the draft report were accepted through June 30 and were collected by CBI.

The following document summarizes the multiple comments provided by fourteen individuals or town officials including neighbors and members of the Board of Health at the June 18 meeting and directly to CBI subsequent to the Board of Health meeting. This input is compiled thematically below, which highlights the substantive concerns identified across the array of public input. Analogous points raised by multiple commenters are summarized together.

This report summarizes only comments relevant to the contents of the Technical Report; it does not include:

- Clarifying questions that were asked and discussed at the June 18 meeting (we anticipate that the Board of Health will issue minutes of the meeting; that document would constitute the record of the meeting);
- Comments relating to the funding, contracting, and management approach for the study; and
- Comments regarding remedies or next steps directed towards the BoH, MassCEC, or MassDEP that are unrelated to the technical study itself.

We have used font color to distinguish between comments provided by the following categories of individuals:

- Direct Stakeholders – Comments from Board of Health Members or Town residents are presented in plain black lettering.
- Indirect Stakeholders – Comments submitted by interested individuals who are not direct stakeholders of the KWI turbine, but rather are Massachusetts citizens from nearby towns who are interested in wind projects in general is indicated in grey lettering.
- Input received from both direct and indirect stakeholders is indicated in blue lettering.

A number of comments received are quite technical in nature and are similar to, if not identical to comments submitted directly to MassCEC. MassCEC has informed CBI that they have asked HMMH to prepare responses to several such technical comments and will circulate that information separately when it is available.

<u>Wind Speed, Power Output, and SCADA Data:</u>

1. In regard to electric power output versus sound power level: Part 1 showed that there is no need for hub-height wind speed. HMMH's Figure 1 for electric power output and Figure 2 for sound power level were plotted on one graph. Sound power level (log y-axis) and electric power output (log x-axis). A "line of best fit" was drawn through all data points with a straight line. KWI sound power level is determined from electric

power output. The chart and equation simplifies predicting KWI sound power levels. The assessment methodology used by HMMH, MassCEC and MassDEP is complex and unclear.

2. KWI-TR relied heavily on SCADA data for assessing noise levels. The study incorrectly centered on wind speed rather than electric power output. This is needless, since sound power level is directly related to electric power output. The KWI Deck SCADA system was observed on the night of May 6-7, 2015 from 6:45 PM to 3:45 AM. SCADA reported electric power output and wind speed, which were logged and plotted. This observation has no connection between KWI wind speed and electric power output. HMMH and MassCEC should explain the lack of a relationship. In addition, some points display seemingly contradictory concepts, including: "Power output remains high when wind speed drops to zero;" electric power output started at 0.4 MW with a wind speed of 3 m/s; electric power output steadily increases to essentially full power output at 3 m/s; power output remains high when wind speed drops to zero; full power produces the maximum sound power level, Lmax = 105 dBA; and zero wind speed represents the lowest ambient noise level: L90 = 33 dBA without KWI operating. This information does not support KWI-TR study's findings.
3. Wind speed is irrelevant for evaluating KWI noise measurements. All that is needed is electric power output to determine wind turbine sound power level. KWI measured baseline ambient noise level is L90=33 dBA. The MassDEP noise policy is 10 dB higher than the baseline L90 or 43 dBA. 0.3 MW electric power output minimum distance is about 900-ft, and 2.0 MW electric power output minimum distance is about 1700-ft.

<u>Wind Sheer and Hub Height:</u>

4. The lack of an independent measure of vertical wind speed and direction gradient (wind shear and veer) through LIDAR, SODAR, or a meteorological mast is a key limitation. Power curves reflect an average value of variable data impacted by shear and turbulence as well as a number of other factors.
5. Although the wind speed at the hub reflected in power generation is a better prediction of the acoustic emissions than the 10-meter wind speed, many jurisdictions have used the 10-meter standard in setting sound limits and this is the value most of the public is familiar with. Most importantly, it is the 10-meter or surface wind speed that will determine the potential for any masking. Moreover, the same wind speed at the hub under different wind shear conditions across the rotor has a pronounced effect on the character of turbine sound that many people find aversive (as thump or beating). Wind shear affects the propagation of the sound (especially at low frequencies) and turbine wake behavior, all of which can influence impact on neighbors more distant than the locations tested.
6. Wind shear shows the differences for ground level wind speed for a constant hub-height wind speed, as wind shear values vary and are dependent on differences in daytime and nighttime atmospheric conditions above ground surface roughness. KWI hub-height is 80 meters and the wind speed has been fixed at 12 meters per second. Four wind shear values were evaluated for wind speed at 80, 10, and 1-meter elevations, the latter approximating ground level. Ground level wind speed decreases from 6.0 to 0.2 meters

per second (calm). High wind shear produces full electric power output and maximum sound power level at low ground level wind speed. This indicates that the baseline nighttime ambient L90 is less than 30 dBA when KWI is shut down.

7. The KWI-TR uses wind shear values that are too low. The 10-meter wind speeds range from about 1 to 7 m/s. There is no correlation for 10- meter wind speed to hub-height. Therefore, there is no correlation to 10-meter wind speed, electric power output, and sound power level. There are, thus, flaws in the KWI noise measurement protocol. Baseline nighttime ambient L90s are expected to be below 30 dBA during high wind shear (0.4 to 1.0) when KWI is shut down.
8. Wind shear represents wind speed increasing with elevation, which varies considerably due to differences in daytime and nighttime atmospheric conditions above ground surface roughness. Wind turbine test-stand sites are positioned on flat plains far away from mountains, hills, buildings and trees. The KWI site has higher wind shear (RERL) due to uneven topography, hills, and trees. The reference height for wind speed is 10 meters (33-ft). KWI hub-height is 80 meters. The KWI Draft Technical Report relies on inferred hub height wind speed for noise predictions in place of noise measurements. HMMH should include all computer prediction models and input parameters. High wind shear has strong wind speeds at hub height and weak at ground level. This indicates that the baseline nighttime ambient L90 is less than 30 dBA when KWI is shut down.
9. Presuming that increases in wind-related sounds will mask turbine noise involve a tremendous amount of pre-construction monitoring, and prediction of the relationship between background noise as function of wind speed at 10-m is fraught with uncertainties. The prediction of the relation to hub wind speed is even more difficult because of the fact that wind shear is a variable (not fixed by roughness) function.

Traffic Acoustic Effects

10. The study's analysis of traffic noise raises the ambient sound levels. As traffic sound is a co-contaminant, it should not be used in this way to increase ambient sound levels.
11. Other noise sources, including traffic, will not mask the perturbing features of wind turbine noise. The L90 values with turbine-turbine off could be edited in the same way that turbine-operating were for traffic noise to establish the true baseline of community noise.
12. It would be very helpful to provide frequency spectra of screened ambient conditions (turbine off) that include traffic noise. This was done for KWI operating measurements during light traffic; representative periods of other traffic conditions (as shown in Figure 27); and representative locations further from Route 3.
13. The HMMH predictions for turbine impact appear to adjust ambient L90 for wind speed in a manner that may be incorrect (tables 40 and following tables). The adjustment factor appears to be derived from limited data shown in figure 29. This had the effect of adding 9.2 dB from lowest wind speed a-weighted level (33 dB) to those 10 m/s hub wind speed and above for 11 Leland Road with large consequences on the extent of exceedance by various metrics at night in light traffic. The recommendation of Keith et al (2008) should be followed, and the lowest value for background (uncontaminated by traffic) and in calm wind conditions should be used when predicting project impact.

Likewise for other traffic conditions, the smaller adjustments with wind speed should be removed. To a lesser extent, this concern also seems to apply to the estimates for Copper Beech Drive (Table 35 and following tables) where the wind-speed increase is smaller and predictions for turbine impact are given only to 10 m/s hub speed.

Additional Data Analysis and Reporting

14. It is unclear that any adjustment factor should be the same in the turbine off position when the rotating blades are not creating a velocity deficit or whether the same adjustment applies across the range of wind speeds.
15. The main part of the text directed towards "compliance" tabulated the Lmax and the L90 of turbine operating are concerning. Some industry consultants have argued for the use of this measure for a long time despite the fact that it simply does not work, and under-represents wind turbine noise when it is amplitude modulated at blade pass rate. The KWI project itself was considered for compliance using this measure even though manufacturers do not provide L90s, so there is no basis for estimating it. Furthermore, for this project, as for others, when it became apparent that acoustic impact was being underestimated because maximum sound power was not being used, this was corrected, but the ambient sound was also increased to portray the project as still predicted to be in compliance. This practice to conduct a piecemeal reduction dB has contributed to an underestimation of turbine sound impacts.
16. Since the G-weighted levels do include frequencies below 5.6 Hz, and since Leventhal now considers infrasound to be below 10 Hz (rather than 20 Hz), it may be preferable not to call it infrasound. It may still be a useful correlate of sensation of ear pressure or pain, which is the “perceived” response to frequencies below 20 Hz.
17. There seems to be relatively little data when KWI is operating at greater than 50% capacity, and in particular the production was low for the daytime measures at the school.

Release of Raw Data

18. Data collected by HMMH on December 13th and January 21st should be included in the study for transparency. A 2008 MTC study found that Kingston experiences 100 nights of wind shear a year, and some claim that HMMH collected notable incidences of wind shear sound and/or worst-case conditions on these two dates that would be exceedance events.
19. All of the raw data as it applies to the entire testing period, including all errors and any contaminated material, should be immediately released. This is a transparency and disclosure issue. This data must be released to the public to better be able to understand the entire scope of the testing and the methodology, failed and successful, for future use and education concerning the industrial wind turbine and noise and air pollution related issues. The release of this information would help the general public as well as the wind industry and developers.
20. There should be no additional expense to releasing this raw data without further accompanying analysis publically.

21. The data from the nights which were excluded because of auxiliary equipment operation can at least show comparison of the operating intervals to other dates and ambient. It could just be considered "supplemental."
22. It seems that the December 13th and January 21st data sets are irrelevant given the subsequent methodology change.

Specific Revisions to the Report:

23. It is unclear how input and comments can alter HMMH's expert opinion as expressed in their report. Other than those that might be forthcoming and documented by HMMH, additional comments or suggested changes from outside sources altering the document taint the clarity and purity of the test results interpretation and analysis expressly attributable to HMMH. All other opinions must be in the form of an appendix to the report.
24. The final report should document personal "data" experienced by neighbors near KWI.
25. The concluding paragraph of section 10.4 "the most recent research" needs citation(s) and a little more clarity. The research on directivity is a mixed, in part perhaps because of various aspects of acoustic emissions and propagation are mixed. The report emphasizes downwind as that was what was measured appropriate to the industry standards being followed. However, that should not imply that residences will only be impacted when they are downwind and that should be addressed.
26. In the description of metrics, specifically Lmax on slow setting does not reflect amplitude modulation peaks with blade pass, so other terminology should be used (per acoustic consultants to Falmouth Turbine Options and WNTAG). The text should read "consistent with previous Mass DEP protocols" used in compliance testing at other turbine facilities," in the hopes that better methodology will be validated to measure amplitude modulation at blade pass rate (e.g., Bockstael et al, 2012). It would be useful to have the standard deviation along with the Lmax reported throughout the report.
27. The tables regarding "modulation depth" are confusing in contrast to the figures, which are clear. It would be useful to provide the rpm and blade pass rate for each, and production in addition to wind speed, which presumably has the HMMH correction (in legends so as not to require any change in the figures).
28. Sound power and level guarantees given by manufacturers are for certain atmospheric conditions only. More information on this for the KWI is required.
29. It would be useful to provide the manufacturers sound level warranty and any technical material that describes the conditions under which it applies, as well as the frequency spectrum and power for which it is given. If the wind speed at which blades start to pitch is known, the HMMH results on modulation depth could be better compared with other results.
30. The .wav files should be archived along with the screen capture of SCADA. The SCADA data should be available in digital format.
31. The data provided in the preliminary report shows that KWI's Sound Power Level of 105 dB(A) is understated. This point needs to be clarified for any modeling purposes that might try to incorporate the 105 dB(A) SPL.

General Acoustical Exceedance:

32. Measurements in the report suggest the KWI turbine exceeds Massachusetts' noise policy under some conditions. These measurements should not be construed to mean that the turbine's operation is not a nuisance under other conditions as well.
33. There is no evidence presented within the report that proves that KWI is in compliance with Massachusetts' Noise Regulations during the hours outside of the current Order of Abatement. .
34. The report seems to indicate acoustics above exceedance near Copper Beach Drive between the hours of 12 AM and 4AM.
35. When the shown standard transitions from 9 m/s to 4 m/s at 12 AM, it seems likely there is not a 10 dB exceedance.

Storm Acoustical Exceedance:

36. The noise levels that occur during winter storms (e.g. 2014 storms NEMO and Hercules) when KWI maintains full power production for many hours exceeds noise standards. In addition, traffic levels are reduced during winter storms, reducing ambient sound levels. Moreover, HMMH produced no evidence to support the claim that there are no noise violations during winter storm events.
37. The report makes no mention of winter icing conditions relative to KWI and how these conditions may relate to increased noise levels. Narratives from other wind projects seem to indicate that winter weather conditions can increase noise levels.
38. During storm events, no matter the season, KW produces more sound output when operating at full power.

Other Comments:

39. It is unclear why MassCEC has responsibility over MassDEP and contracted CBI as an impartial intercessor in this monitoring process. MassCEC could have potential conflicts of interest given its support of wind turbine development. It is important that the monitoring process remains neutral and independent.

List of Commenters and Meeting Participants

Participants in the June 18 Board of Health Meeting:

- **Nils Bolgen (MassCEC)**
- **John Breen (Kingston BoH)**
- **Eric Cox (HMMH)**
- **Toni Cushman (Kingston BoH Vice-Chair)**
- **Douglas Fine (MassDEP)**
- **William Kavol (Kingston BoH)**
- **Christopher Menge (HMMH)**
- **William Watson (Kingston BoH Chair)**

Direct Stakeholders:

- **David Kennedy**
- **Doreen Reilly**
- **Sean Reilly**
- **Jean White**

Indirect Stakeholders:

- **Stephen Ambrose**
- **Louis Grabowski**
- **Frank Haggerty**
- **Joanne Levesque**
- **Kathy Sherman**
- **Marie Stamos**