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NOISE INVESTIGATION TEST PLAN PROPOSAL - Project: 13228.00

South Kent Wind Farm
Proposal for Additional Noise Measurements

Chatham-Kent, Ontario

Prepared for:

South Kent Wind LP
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Revision History

Version	Description	Author	Reviewed	Date
- -	Test Proposal	MAD	PA	February 13, 2019

Important Notice and Disclaimer

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1 Introduction

Aercoustics Engineering Limited was retained by South Kent Wind LP to complete the acoustic audit outlined in the Renewable Energy Approval (REA) for the South Kent Wind Farm (SKWF).The SKWF operates under REA #2871-8UKGPC, originally issued on June 15, 2012.

In response to Section G of the REA, Emission Audits were undertaken at 6 SKWF turbines and test reports were submitted to the Ministry of the Environment, Conservation and Parks (MECP). Some updates to the reports have been made since the original submittal, based on MECP feedback. At the date of putting together this proposal, the most up-to-date Emission reports that have been submitted are as follows:

1) **T 002**: REPORT ID: 13228.00.T002.RP5, South Kent Wind Farm – Turbine T002 IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 1;

2) **T 034**: REPORT ID: 13228.00.T034.RP5, South Kent Wind Farm – Turbine T034 IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 5;

3) **T 038**: Acoustic Measurement Report, project number: 13228.00, South Kent Wind Farm, Turbine T038 - IEC 61400-11 measurement dated November 21, 2014 Revision 2;

4) **T 060**: REPORT ID: 13228.00.T060.RP5, South Kent Wind Farm – Turbine T060, IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 5;

5) **T 093**: REPORT ID: 13228.00.T093.RP3, South Kent Wind Farm – Turbine T093, IEC 61400-11 Edition 3.0 Measurement Report 21 December 2018 – Revision 3; and

6) **T 108**: REPORT ID: 13228.00.T108.RP5, South Kent Wind Farm – Turbine T108, IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 5.

Based on these reports, the MECP has provided further feedback and has requested that additional supporting measurements be conducted at receptor locations close to each test turbine. This feedback was delivered in an email dated January 4, 2019 and further clarified on a call on January 14, 2019. Mr. Denton Miller provided the following summary of the E-Audit test results previously submitted.

Table 1 - MECP E-Audit Summary

Turbine		Sound Power			Max Tonal Audibility (dB)	Freq. (Hz)	Missing Data (Y/N)	6 dB Signal to Noise Ratio met
ID	Type	REA (dBA)	Audit (dBA)	Excess (dB)	Audit Report (dB)			
2	2.221-101	105	105.9	0.4	0.9	428	y	N/A
34	2.221-101	105	105.8	0.3	3.1	516	N/A	N/A
38	2.824-101	101	101	N/A	3	433	N/A	n
60	2.126-101	104	104.9	0.4	5.8	478	y	N/A
93	1.903-101	102	102.1	N/A	4.5	434	y	N/A
108	2.126-101	104	104.5	N/A	5.3	492	N/A	N/A

This report has been prepared to provide a detailed proposal for the methodology and measurement locations for the additional measurements that have been requested.

2 Assessment Locations

Receptor locations have been selected based on the closest receptors to each subject turbine, while keeping the prevailing southwesterly wind direction in mind when possible. A wind rose has been included in Appendix B. These proposed measurement locations are preliminary at this time. If the MECP is in agreement with our proposed approach, land access permissions will need to be obtained for each site. If land access cannot be obtained for any of these locations, the MECP will be consulted regarding any alternative plan. The following locations have been selected:

Table 2 - Proposed Receptors for Additional Monitoring

Test Turbine	Point of Reception ID	Nearest Turbine	Distance to Nearest Turbine (m)	Predicted Overall Sound Level (dBA)	Predicted Partial Sound Level from **test turbine** only* (dBA)	Wind Direction from Test Turbine	Notes
T002	R4266	T002	742	38.9	34.5	CW	Not downwind
	R4368	**T002**	**755**	**39.4**	**34.3**	**DW**	**Proposed[1]**
T034	**R3282**	**T034**	**594**	**39.3**	**36.8**	**DW**	**Proposed[2]**
T038	R3179	T038	551	40	33.6	CW	Not downwind, shielded by greenhouses
	R3167	**T038**	**724**	**38.2**	**30.8**	**DW**	**Proposed[3]**
T060	R5208	T060	554	39	36.6	CW	Not downwind
	R2742	T060	570	38.9	36.3	CW	Not downwind
	R2736	T060	572	38.8	36.3	CW	Not downwind
	R2794	**T060**	**604**	**39.1**	**35.7**	**DW**	**Proposed[4]**
T093	R4248	T166	595	39.7	33.7	CW	T093 is ***not*** closest turbine

Test Turbine	Point of Reception ID	Nearest Turbine	Distance to Nearest Turbine (m)	Predicted Overall Sound Level (dBA)	Predicted Partial Sound Level from **test turbine** only* (dBA)	Wind Direction from Test Turbine	Notes
	R4159	**T093**	**614**	**38.1**	**33.5**	**UW**	**Not downwind, but Proposed[5]**
	R4284	T093	802	39.3	30.7	DW	Can't reach 30 dBA due to proximity to Talbot Wind Farm, contribution from T093 is too low
T108	**R3306**	**T108**	**618**	**39.4**	**35.5**	**DW**	**Measurements have already been conducted at this location**

[1] R4368 is in the predominant downwind direction from T002, and has a higher overall predicted level
[2] R3282 is the closest receptor to T034, and is in the predominant downwind direction
[3] R3167 is in the predominant downwind direction and is a much more measurable location compared to R3179. R3179 is surrounded by greenhouses which makes taking representative noise measurements in its vicinity virtually impossible
[4] R2794 is in the predominant downwind direction from T060, and has a higher overall predicted level
[5] R4159 appears to be the best option in this case, but is located in the predominant upwind direction, which means that collecting sufficient data within a 6 week time frame is unlikely
* These values are predicted based on the manufacturer specified sound power level for each turbine, not the measured sound power levels. They are included to be indicative of the relative contribution of the turbine of interest at each location

Detailed site plans showing the turbine and receptor locations, and each proposed measurement location, are shown in Appendix A.1-6.

The closest receptor to R108 is R3306, which is located in the downwind direction. R3306 was used for the Immission audits required by the REA, which were conducted in the fall of 2014 and the spring of 2015. Given that long term monitoring data has already been collected at this location, and that tonality is the only concern for T108, Aercoustics plans to reprocess the existing data set for Tonal Audibility in accordance with ISO/PAS 20065 instead of repeating monitoring in the vicinity of T108. Based on this approach, the additional monitoring would only be carried out in the vicinity of the remaining 5 (five) turbines.

3 Detailed Noise Audit Methodology

The following methodology will be applied in conducting the acoustic assessment at the locations indicated above in Section 2. The proposed methodology is based on unattended measurements and is in accordance with Part D of the Compliance Protocol for Wind Turbine Noise; NPC 350, April 2017.

Based on the summary of the MECP review of the E-Audit reports replicated in Table 1 of this document, either a RAM I-Audit Analysis (Section 3.5 of this document) and/or a tonal audibility assessment (Section 3.6 of this document) will be conducted at the receptor selected closest to each relevant turbine, as described in the following table. Sections 3.1-3.4 of this document are relevant to both audit types.

Table 3 - Type of Acoustic Assessment by Turbine

Turbine	RAM I-Audit (3.5)	Full Tonal Audibility (3.6)
T002	Y	N
T034	Y	Y
T038	Y	Y
T060	Y	Y
T093	Y	Y
T108	N	Y*

*Analysis will be completed on previously collected dataset

3.1 Acoustic Instrumentation and Location:

- One (1) sound level meter will be located at each assessment location. Each sound level meter will be a Type 1 meter and will meet specifications outlined in section D2.1 Acoustic Instrumentation of the Part D Protocol.
- A secondary windscreen will be utilized at each measurement location. The secondary windscreens that will be used have been tested and have a documented insertion loss (1/3 Octave band data).
- The microphone will be placed at a measurement height of 4.5m above grade, which is consistent with the receptor height modelled during the approval process.
- The microphone will be located appropriate to site specific constraints and will adhere to the following guidelines:
    - The microphone will be located away from any large reflecting surfaces (at least 5m away).
    - The microphone will be in a location such that it is not shielded from the turbine.
    - The microphone will be located as far away as practically possible from deciduous trees or foliage that may impact noise measurements.

3.2 Non-acoustic Instrumentation and Location

- One (1) anemometer will be utilized at each assessment location. The anemometers will be located 10m above grade, as defined by Section D3.4 and will comply with performance specifications defined in Section D.2.2 of the Part D Protocol.

3.3 Acoustic Measurements

- Overall sound pressure level analysis will be based on 10-second or 1-minute L_{eq} measurements conducted for both turbine operational and turbine parked conditions.[1]
- Tonality analysis will be based on 10-second or 1-minute narrow band spectra, ranging from 20 Hz to 3000Hz and 1Hz frequency resolution.[2]
- Audio recordings will be taken should additional post-processing or listening be required.

3.4 Measurement Procedure

- Measurement data (acoustic and anemometer) will be logged simultaneously to provide synchronous data capture.
- Measurements will be conducted only between 10pm and 5am. This is intended to provide the lowest ambient noise conditions possible and yield the highest signal to noise ratio.
- Data will be acquired for both "turbines operational" and "turbines parked". For "turbines parked" measurements, turbines in the vicinity of the measurement locations will be parked such that the predicted level is less than 30 dBA (i.e. insignificant compared to overall level). The number of turbines that require parking will be verified in the acoustic model used to obtain the facility's approval.
- Turbine SCADA data will be supplied in 1 minute intervals for the duration of the measurements. Parameters such as nacelle wind speed, active power output, nacelle yaw angle and RPM will be recorded.

3.5 Data Processing and Analysis – RAM I-Audit

- Measurement data will be filtered using the following approach for the "turbines operational" data sets:
    - Measurement data with precipitation within an hour of the measurement period will be excluded from the analysis.
    - Measurements will be filtered based on wind direction. Only downwind data will be considered in the analysis. With reference to the turbine location, downwind directions are ± 45 degrees from the line of sight between the

[1] The Compliance Protocol stipulates 1-minute intervals, but during a telephone conversation on January 14, 2019, Denton Miller communicated that a 10-second interval be used for these measurements. The decision as to whether 10-second or 1-minute intervals are used will be made based on the quality and quantity of data that is collected at each site.

[2] See footnote (1) for explanation.

turbine and measurement location. The downwind direction will be based on the yaw angle of the turbine.

- Measurements will be filtered based on the nearest turbine's power output. Only data points during which the nearest turbine was generating at least 85% of it's rated power output will be included in the analysis.

- Additional filtering may be relied upon, if needed due to low-signal to noise ratios. Should this be required the MOECP will be consulted.

- Valid data points will be sorted into interval wind bins based on the measured 10 m height wind speed, with an aim to collect 60 "turbines operational" data points and 30 "turbines parked" data points, respectively, in 3 wind bins between 1 and 7 m/s, or 2 wind bins between 1 and 4 m/s.[3]

- The presence of tones in the noise at different wind speeds shall be determined on the basis of narrowband analysis outlined in ISO/PAS 20065:2016

- Measurement data will be filtered using the following approach for the "turbines parked" data sets:
  - Measurement data with precipitation within an hour of the measurement period will be excluded from the analysis.
  - Additional filtering may be relied upon, if needed due to low-signal to noise ratios. Should this be required the MOECP will be consulted.

3.6 Data Processing and Analysis –Tonal Assessment

- This tonal audibility assessment will be conducted at the I-audit locations for which the nearest turbine had measured tonal audibility values of 3 dB or greater during the original E-Audits
- Measurement data will be filtered using the following approach for the "turbines operational" data sets. The "turbines parked" data set likely won't be used in the tonal audibility analysis, unless it is required to investigate any tones of questionable origin:
  - Measurement data with precipitation within an hour of the measurement period will be excluded from the analysis.

[3] This in in accordance with the RAM-I Audit data count requirements listed in Section E5.5 of the protocol, except that the time interval for these measurements might be 10-seconds instead of 1-minute, as discussed on the conference call with Denton Miller on January 14, 2019.

- Measurements will be filtered based on wind direction. At a minimum, downwind data will be considered in the analysis. If sufficient data is collected, other wind directions may be assessed separately. With reference to the turbine location, downwind directions are ± 45 degrees from the line of sight between the turbine and measurement location. The downwind direction will be based on the yaw angle of the turbine.

- Measurements will be filtered based on the measured hub-height wind speed/electrical power output. Data will only be included in the analysis when the hub-height wind speed/electrical power output matches conditions representative of the wind speeds at which high tonal audibility values were measured during the Emission testing.

- Valid data points will be sorted into interval wind bins based on the measured 10 m height wind speed, with an aim to collect 5 valid data points in 3 wind bins between 1 and 7 m/s, or 2 wind bins between 1 and 4 m/s.[4]

- The presence of tones in the noise at different wind speeds shall be determined on the basis of narrowband analysis outlined in ISO/PAS 20065:2016

4 Schedule

Mobilization time is expected to be delayed because of a recent increase in demand for test equipment caused by multiple MECP requests for additional testing across multiple projects. Based on our current equipment availability, Fall 2019 is likely the earliest that this additional testing can begin.

If Fall 2019 is deemed to be unacceptable by the MECP, Aercoustics is open to finding an alternative solution. One option might be to deploy equipment at the receptor near T60 (the turbine with the highest tonal audibility and the highest sound power level) this Spring, and then deploy at the remaining four or five locations next fall. Given that the scheduling conflicts are related to other MECP testing requests, Aercoustics is open to prioritizing the requested work in consultation with the MECP.

Regarding the duration of the test, if sufficient data is not acquired within the first six weeks of monitoring, alterations to the proposed data filters may be considered, in consultation with the MECP. Denton Miller indicated on the call on January 14, 2019 that the requirement to test beyond the six week time frame was unlikely.

[4] This in in accordance with the RAM-I Audit data count requirements listed in Section E3.8.3 of the protocol, except that the time interval for these measurements will be 10-seconds instead of 1-minute.

5 Conclusion

We hope this test plan provides the MOECP a clear indication of our approach and methodology for the additional testing requested for the South Kent Wind Farm. If there are any questions or concerns, please don't hesitate to contact the authors of this test plan.

Appendix A
Maps Indicating Proposed Monitor Locations

Legend

- Turbine
- Receptor
- Proposed Monitor Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T002

Appendix A.1

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Legend

- Turbine
- Receptor
- Proposed Monitor Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T034

Appendix A.2

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Legend

- Turbine
- Receptor
- Proposed Monitor Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T038

Appendix A.3

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Legend

- Turbine
- Receptor
- Proposed Monitor Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T060

Appendix A.4

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Legend

- SKWPP Turbine
- Talbot WPP Turbine
- Receptor
- Proposed Monitor Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T093

Appendix A.5

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Legend

- SKWPP Turbine
- Talbot WPP Turbine
- Receptor
- Participating Receptor
- Previous Monitoring Location

N

Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	As Indicated

South Kent WPP
T108

Appendix A.6

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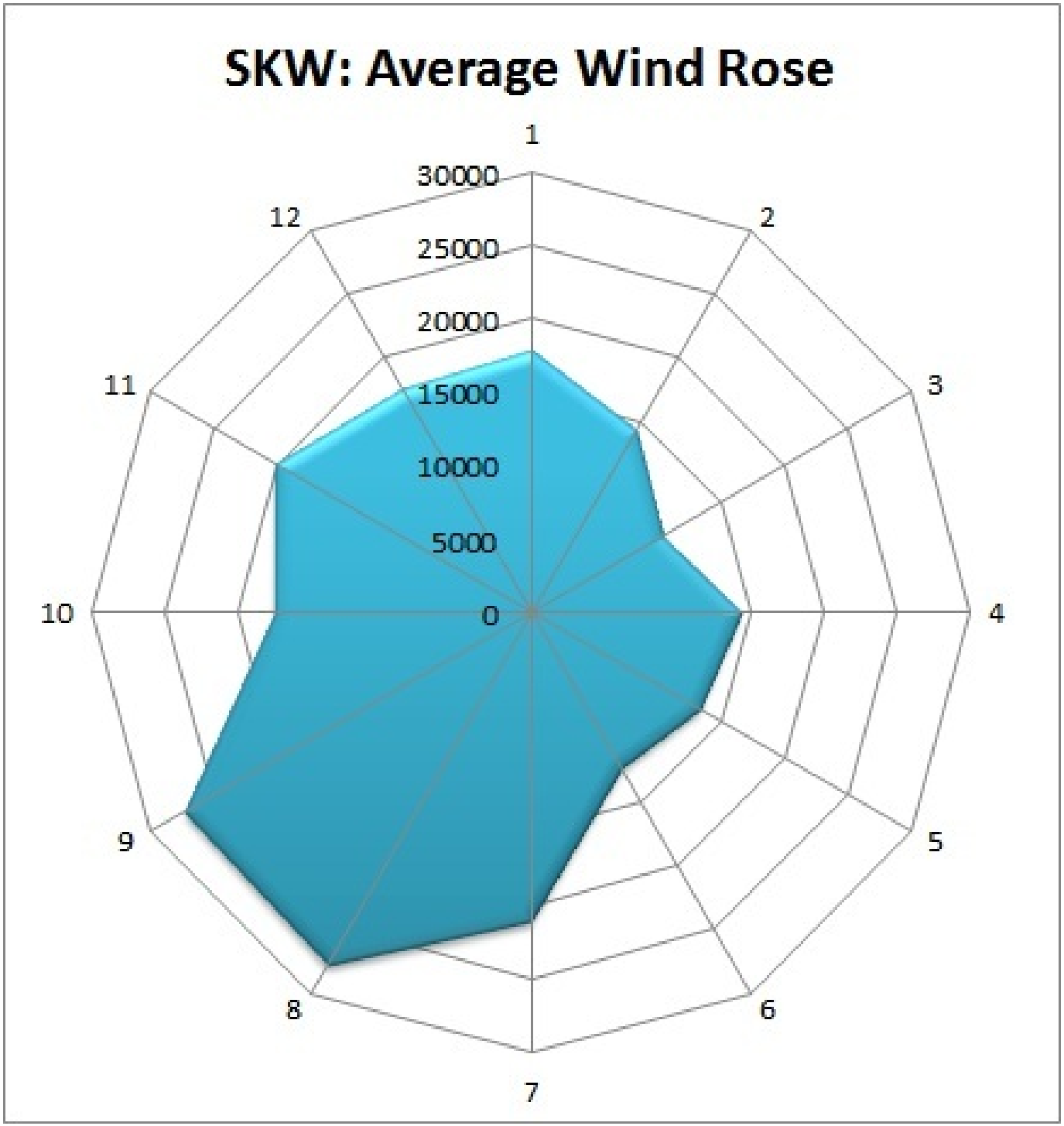
Appendix B
Wind Rose



Project ID:	13228.01
Drawn by:	MAD
Reveiwed by:	PA
Date:	Jan 17, 2019
Revision:	1
Scale:	NA

South Kent WPP
Wind Rose

Appendix B.1

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End of Report