

Project: 16227.00

Niagara Region Wind Farm Project – O0085

Phase 3 Acoustic Immission Audit – Summary Report

Prepared for:

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as general partner for and behalf of FWRN L.P.

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28 May 2020

Executive Summary

Aeroustics Engineering Limited (“Aeroustics”) has been retained by 1021702 B.C. Ltd as general partner for and on behalf of FWRN L.P. to complete the acoustic immission audit outlined in the Renewable Energy Approval (“REA”) for the Niagara Region Wind Farm (“NRWF”). NRWF operates under REA #4353-9HMP2R, issued on November 6, 2014.

During the Phase 2 audit the measured levels were found to be non-compliant with the applicable sound level limits at receptor O0085. Boralex in partnership with the turbine manufacturer Enercon has undertaken a noise abatement action plan dated June 4, 2019 which has been approved by the Ministry of Environment Conservation and Parks (“MECP”).

The noise abatement action plan included the following mitigation details:

- Curtailment of the closest turbine, T08 during specific hub height wind speeds to three modes of operation (Mode 1500kW, Mode II (3.0 MW) and Mode 1000kW).
- The curtailment applies during the night-time from 10pm – 5am and to the wind direction range of 150° – 240° only, referencing North with 0°.

Details of the implemented noise abatement action plan and mitigation details are provided in Appendix A.

Measurements have recently been concluded at the site to verify compliance after the implementation of the noise abatement action plan. This report details the 3rd measurement campaign of the NRWF immission audit near to receptor O0085 after mitigation. Monitoring near receptor O0085 spanned the following dates:

Location	Monitoring Start Date	Monitoring End Date
O0085	November 29 th , 2019	May 3 rd , 2020

The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the “*MECP Compliance Protocol for Wind Turbine Noise*” (Updated: April 21, 2017).

The measured turbine-only noise impact for each curtailment mode at the audit location was compared to the Ministry of Environment Conservation and Parks (“MECP”) sound level limits. The measured turbine-only levels were found to be in compliance with the applicable sound level limits for the Mode 1500kW. The measured turbine-only levels were found to be non-compliant with the applicable sound level limits for the Mode II (3.0MW). Insufficient data was available to make an assessment for the Mode 1000kW, this is due to the infrequent occurrence of the necessary conditions for Mode 1000kW.

1 Introduction

Aercoustics Engineering Limited (“Aercoustics”) has been retained by 1021702 B.C. Ltd as general partner for and on behalf of FWRN L.P. to complete the acoustic immission audit outlined in the Renewable Energy Approval (“REA”) for the Niagara Region Wind Farm (“NRWF”). NRWF operates under REA #4353-9HMP2R, issued on November 6, 2014, further modified on November 23, 2015, May 6, 2016 and May 12, 2016 [1].

During the Phase 2 audit the measured levels were found to be non-compliant with the applicable sound level limits at receptor O0085. Boralex in partnership with the turbine manufacturer Enercon has undertaken a noise abatement action plan dated June 4, 2019 which has been approved by the Ministry of Environment Conservation and Parks (“MECP”).

The noise abatement action plan included the following mitigation details:

- Curtailment of the closest turbine, T08 during specific hub height wind speeds to three modes of operation (Mode 1500kW, Mode II (3.0 MW) and Mode 1000kW).
- The curtailment applies during the night-time from 10pm – 5am and to the wind direction range of 150° – 240° only, referencing North with 0°.

Details of the implemented noise abatement action plan and mitigation details are provided in Appendix A.

The report has been prepared to facilitate submission to the MECP, in compliance with acoustic audit conditions outlined in the facility’s REA (#4353-9HMP2R) section E (Wind Turbine Acoustic Audit – Immission). The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the Ontario Ministry of Environment, Conservation and Parks “*MECP Compliance Protocol for Wind Turbine Noise*” (Updated: April 21, 2017). This report outlines the measurement methodology, results, and a comparison of the turbine-only sound contribution to the MECP sound level limits.

2 Audit Details

The acoustic audit was conducted at receptor O0085¹. Monitoring at O0085 spanned the following dates, summarized in Table 1.

Table 1: Monitoring Period for Each Receptor

Location	Monitoring Start Date	Monitoring End Date
O0085	November 29 th , 2019	May 3 rd , 2020

¹ Receptor IDs taken from the Noise Assessment Report by K. Ganesh and K. Mallinen, dated April 08, 2016 [3]

2.1 Measurement Location

Receptor O0085 was originally chosen to be representative of the worst-case impact of the facility. The location was one of five locations that were chosen based on the MECP selection requirements communicated in the NRWF REA. The receptor is located in the predominant downwind direction of the facility. O0085 has a predicted impact of 39.5 dBA as per the sound pressure level predicted from an “As Built” noise model based on the original CadnaA noise prediction model. The following describes the measurement location M0085 in relation to the receptor:

- M0085: Measurement equipment was placed in an open field on the property of and to the west of O0085, 540 m to the closest turbine (T08), on the south side of Concession Road Three. The predicted level based on the acoustic model at M0085 is 39.7 dBA.

The following table provides a summary of the receptor locations.

Table 2: Receptor Measurement Locations

Audit Receptor ID		O0085
Nearest Turbine ID		T08
Receptor	UTM Coordinates (X,Y)	17T 614752mE 4765425mN
	Distance to Nearest Turbine	554m
	Predicted Level dBA*	39.5
Monitor	UTM Coordinates (X,Y)	17T 614682mE 4765434mN
	Distance to Nearest Turbine	540m
	Predicted Level dBA**	39.7

* Predicted level from Sound Level Prediction Results, [Modified Model for As-built] 77 WTGs – Stantec [3]

** Predicted level from Aercoustics' acoustic model

2.2 Sample size requirements

As per Section D3.8 of the MECP protocol, at least 120 data points in each wind bin are required for Turbine ON measurements, and 60 data points for the ambient measurements between 4-7 m/s integer wind speeds inclusively (10m height).

The sample size requirements of 120 data points for Turbine ON and 60 data points for the ambient measurements between 4-7 m/s integer wind speeds has been satisfied for receptors O0085.

The Revised Assessment Methodology for I-Audits (RAM-I) may allow for a lower amount of data points to be used in the analysis, provided that the quality of data remains high. RAM-I analysis was conducted as per Section 5.5 of the Protocol. This methodology is employed in cases where insufficient data is collected despite sound monitoring lasting longer than 6 weeks.

2.2.1 RAM-I Sample Size Requirements

The RAM-I assessment methodology reduces the sample size requirements, the Protocol states:

“The Ministry may accept a reduced number of data points for each wind speed bin with appropriate justification. [...] The acceptable number of data points will be influenced by the quality of the data (standard deviation)” {Section E 5.5 (5)}

The threshold of 60 data points for Turbine ON measurements and 30 data points for Turbine OFF measurements is used in this assessment.

The range of wind bins which may be used to assess compliance is expanded to include a minimum of one of the following conditions as outlined in Section E 5.5(1):

- a. *“Three (3) of the wind speed bins between 1 and 7 m/s (inclusive), or*
- b. *Two (2) of the wind speed bins between 1 and 4 m/s (inclusive)”*

The RAM-I sample size requirement of 60 data points for Turbine ON and 30 data points for ambient measurements for 3 wind speed bins has been satisfied for receptor O0085 in wind speed bins between 1 and 7m/s (inclusive) for Mode 1500kW and Mode II (3.0MW).

3 Sound Level Limits

The purpose of the sound measurements was to confirm whether the sound emitted by the wind facility is in compliance with the MECP allowable sound level limits. The MECP sound level limits for wind turbines vary with wind speed defined at a 10 m height. The details of the sound level limits are presented in Table 3 below.

Table 3: MECP Sound Level Limits for Wind Turbines

Wind speed at 10m height [m/s]	MECP Sound level limit [dBA]
≤ 4	40
5	40
6	40
7	43

4 Audit Results

The following tables detail the sound levels measured at receptor O0085 when all the nearby turbines were on (Turbine ON) and when all the nearby turbines were off (Turbine OFF). Wind bins which satisfy the sample size requirements for both Turbine ON and Turbine OFF are highlighted in grey in Tables 4, 5, and 6.

4.1 Mode 1500kW

The Turbine ON sound level presented was filtered for hub-height wind speeds corresponding to Mode 1500 kW, for times when the closest turbine was generating between 1275kW and 1677.5 kW power and the receptor was in a downwind condition from the closest turbine.

Table 4: M0085 Sound levels measured for Turbine ON and OFF – Mode 1500kW

Wind Speed at 10m Height (m/s)	Turbine ON			Turbine OFF			Turbine ONLY**
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]	
0	20	39.0	1.0	0	-	-	*
1	56	38.4	2.1	6	24.4	1.0	*
2	139	38.9	1.4	168	30.3	4.4	38
3	546	39.2	1.3	182	30.7	3.3	38
4	652	39.6	1.4	113	32.0	2.3	39
5	485	40.9	1.5	116	35.6	2.7	39
6	211	43.2	1.2	62	40.2	1.8	40
7	114	47.7	2.0	17	44.2	1.8	*

*Insufficient amount of data points as per Part D protocol

4.2 Mode II (3.0MW)

The Turbine ON sound level presented was filtered for the hub-height wind speeds corresponding to Mode II (3.0MW), for times when the closest turbine was generating 85% electrical power or greater and the receptor was in a downwind condition from the closest turbine.

Table 5: MO0085 Sound levels measured for Turbine ON and OFF – Mode II (3.0MW)

Wind Speed at 10m Height (m/s)	Turbine ON			Turbine OFF			Turbine ONLY
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]	
0	0	-	-	0	-	-	-
1	0	-	-	6	24.4	1.0	-
2	12	41.4	0.6	168	30.3	4.4	*
3	22	41.2	0.9	182	30.7	3.3	*
4	110	41.7	0.9	113	32.0	2.3	41
5	359	42.3	0.8	116	35.6	2.7	41
6	205	43.7	1.1	62	40.2	1.8	41
7	75	47.2	1.6	17	44.2	1.8	*

*Insufficient amount of data points as per RAM-I protocol

4.3 Mode 1000kW

The Turbine ON sound level presented was filtered for the hub-height wind speeds corresponding to Mode 1000 kW, for times when the closest turbine was generating 1159kW electrical power or less and the receptor was in a downwind condition from the closest turbine.

Table 6: M0085 Sound levels measured for Turbine ON and OFF – Mode 1000kW

Wind Speed at 10m Height (m/s)	Turbine ON			Turbine OFF			Turbine ONLY**
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]	
0	0	-	-	0	-	-	-
1	0	-	-	6	24.4	1.0	-
2	0	-	-	168	30.3	4.4	-
3	0	-	-	182	30.7	3.3	-
4	0	-	-	113	32.0	2.3	-
5	0	-	-	116	35.6	2.7	-
6	0	-	-	62	40.2	1.8	-
7	0	-	-	17	44.2	1.8	-

*Insufficient amount of data points as per RAM-I protocol

The following figures present the scatter plots showing each valid 1-minute interval measured sound level at M0085 when all the nearby turbines were ON (Turbine ON + Background) and when all the nearby turbines were OFF (Turbine OFF) for each operation mode (Mode 1500kW, Mode II (3.0MW) and Mode 1000kW). It should be noted that the turbine ON sound level includes all sounds measured during the interval.

Figure 1: M0085 – Mode 1500kW - Measured Sound Levels for Turbine ON and Background vs Wind Speed

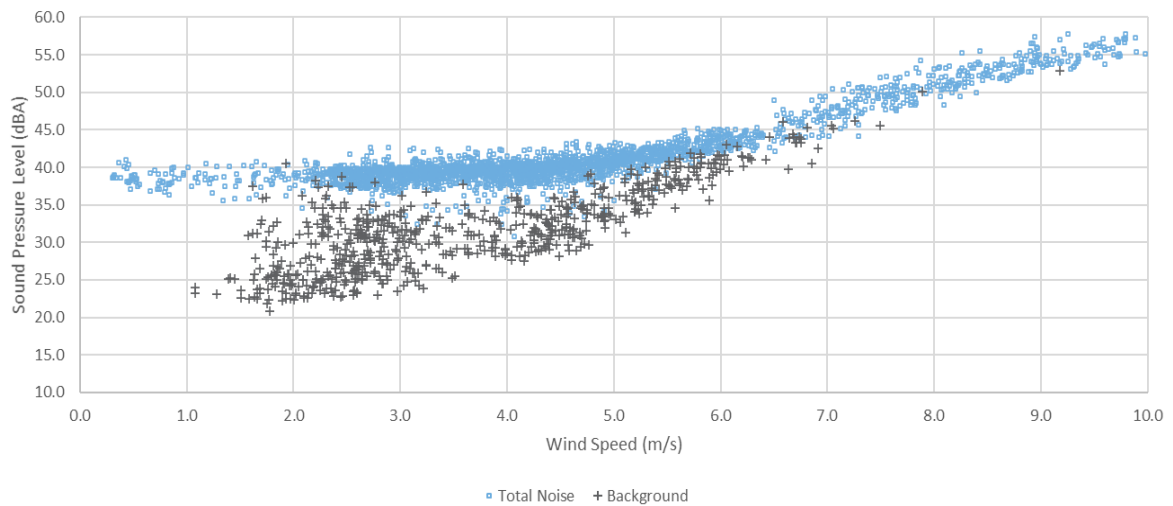


Figure 2: M0085 – Mode II (3.0MW) - Measured Sound Levels for Turbine ON and Background vs Wind Speed

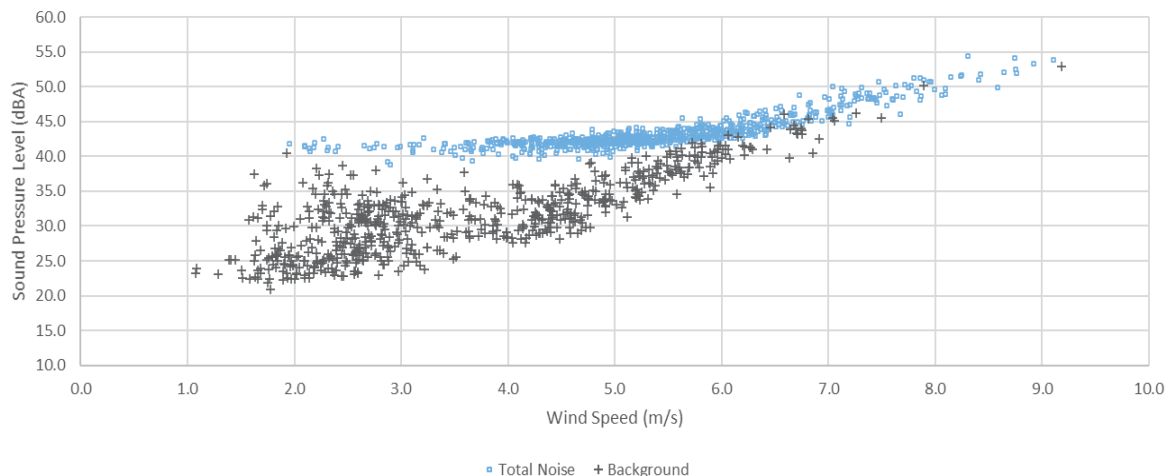
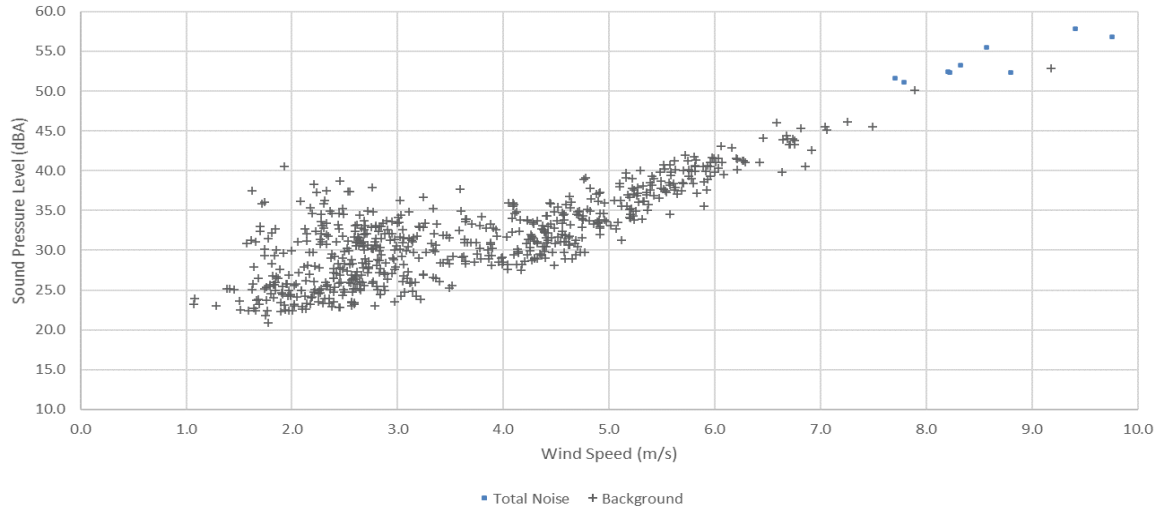


Figure 3: M0085 – Mode 1000kW - Measured Sound Levels for Turbine ON and Background vs Wind Speed



5 Assessment of Compliance

5.1 Overall Sound Level

The turbine-only component of the sound level was derived from a logarithmic subtraction of the ambient noise from that of the sound level measured with the turbines operating. The resulting sound level can be attributed to the turbines.

The audit at M0085 is considered representative of the sound levels at Receptor O0085 given the placement of the acoustic monitoring station. Table 7 presents the Turbine ON, Turbine OFF and calculated Turbine ONLY sound pressure levels between 0-7 m/s for each mitigation mode. Wind bins which satisfy sample size requirements for both Turbine ON and Turbine OFF are highlighted in grey.

Table 7 Assessment Table

Mode	Wind speed at 10m height [m/s]	0	1	2	3	4	5	6	7
Mode 1500kW	Turbine ON LAeq [dBA]	*	*	39	39	40	41	43	48
	Turbine OFF LAeq [dBA]	*	*	30	31	32	36	40	*
	Turbine ONLY LAeq [dBA]	*	*	38	38	39	39	40	*
	MECP limit	40	40	40	40	40	40	40	43
	Compliance (y/n)	-	-	y	y	y	y	y	-
Mode II (3.0MW)	Turbine ON LAeq [dBA]	-	-	*	*	42	42	44	47
	Turbine OFF LAeq [dBA]	-	-	30	31	32	36	40	*
	Turbine ONLY LAeq [dBA]	*	*	*	*	41	41	41	*
	MECP limit	40	40	40	40	40	40	40	43
	Compliance (y/n)	-	-	-	-	n	n	n	-
Mode 1000kW	Turbine ON LAeq [dBA]	-	-	-	-	-	-	-	-
	Turbine OFF LAeq [dBA]	-	-	30	31	32	36	40	*
	Turbine ONLY LAeq [dBA]	-	-	-	-	-	-	-	-
	MECP limit	40	40	40	40	40	40	40	43
	Compliance (y/n)	-	-	-	-	-	-	-	-

*Insufficient amount of data points to calculate Turbine ONLY level as per RAM-I protocol

6 Statement of Compliance

Based on the calculated turbine-only component indicated in the Niagara Region Wind Farm Project was found to be compliant with MECP limits at receptor O0085 during the audit for the Mode 1500kW.

Based on the calculated turbine-only component indicated in Table 7 the Niagara Region Wind Farm was found to be non-compliant with the MECP limits at receptor O0085 for the Mode II (3.0MW).

Insufficient data was available to make an assessment for the Mode 1000kW, this is due to the infrequent occurrence of the necessary conditions for Mode 1000kW.

7 Conclusion

Aeroustics Engineering Limited has completed the Phase 3 acoustic immission audit outlined in the Renewable Energy Approval for the Niagara Region Wind Farm Project. The audit was completed as per the methodology outlined in Parts D and E of the “*MECP Compliance Protocol for Wind Turbine Noise*.”

The measured turbine-only noise impact for each curtailment mode at the audit location was compared to the Ministry of Environment Conservation and Parks (“MECP”) sound level limits. The measured turbine-only levels were found to be in compliance with the applicable sound level limits for the Mode 1500kW. The measured turbine-only levels were found to be non-compliant with the applicable sound level limits for the Mode II (3.0MW). Insufficient data was available to make an assessment for the Mode 1000kW, this is due to the infrequent occurrence of the necessary conditions for Mode 1000kW.

It is anticipated that an updated Noise Abatement Plan would be developed by others.

8 References

- [1] V. Schroter, “Renewable Energy Approval #4353-9HMP2R”, Ontario Ministry of the Environment, Toronto, ON, November 6, 2014 and further modified on November 23, 2015, May 6, 2016 and May 12, 2016.
- [2] Ministry of the Environment and Climate Change, “*Compliance Protocol for Wind Turbine Noise*”, Ontario Ministry of the Environment, Toronto, ON, April 21, 2017.
- [3] K. Ganesh and K. Mallinen, “Niagara Region Wind Farm Noise Assessment Report – REA Amendment”, Stantec Consulting Ltd., Markham, ON, April 08, 2016.
- [4] P. Ashtiani and A. Munro, “Niagara Region Wind Farm – Turbine T46 – IEC 61400-11 Edition 3.0 Measurement Report”, Aeroustics Engineering Ltd., Mississauga, ON, 03 November 2017.

[5] P. Ashtiani and A. Munro, "Niagara Region Wind Farm – Turbine T35 – IEC 61400-11 Edition 3.0 Measurement Report", Aeroustics Engineering Ltd., Mississauga, ON, 03 November 2017.