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ACOUSTIC AUDIT - IMMISSION REPORT BOREALIS ICE PROTECTION SYSTEM

Amherst Island Wind Project

Amherst Island, Ontario

Version 1

Project Number: 02000707

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VERSION CONTROL

Amherst Island Wind Project
Acoustic Audit - Immission Report, Borealis Ice Protection System

Version	Date	Version Description
1	June 24, 2021	Original Report

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EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Windlectric Inc. to complete an Immission Audit at two locations near Wind Turbine Generator S37 ("WTG S37"), part of the Amherst Island Wind Project ("Wind Project") in Loyalist Township, Ontario. The Immission Audit is required as a condition of a Provincial Officer's Order 0222-BYJKLW, served to the Wind Project by the Ontario Ministry of the Environment, Conservation and Parks ("MECP") on February 25, 2021, and amended on March 10 and April 28, 2021. The purpose of the Immission Audit is to assess the potential acoustic impact of an ice protection system installed in WTG S37 on neighbouring receptors. HGC Engineering has assessed the acoustic impact against the acoustic criteria of the MECP and in accordance with the requirements of the MECP's *Compliance Protocol for Wind Turbine Noise*. The results of the immission audit and a time history analysis of the operation of WTG S37 with and without the ice protection system operating, indicate that the addition of the ice protection system to turbine WTG S37 has a negligible acoustic impact at a selected monitoring location. This report presents the results from the measurement campaign, completed between March 12 and May 28, 2021. Details of the measurements and analysis are provided herein.

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1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Windlectric Inc. to complete an Acoustic Audit – Immission at two locations near Wind Turbine Generator S37 ("WTG S37"), part of the Amherst Island Wind Project ("Wind Project"). The Wind Project is located in Loyalist Township, Ontario and consists of 26 Siemens SWT-xx-113 wind turbine generators, each rated at either 2772 kW or 2942 kW. All wind turbine generators have a hub height of 99.5 m.

WTG S37 is outfitted with a retrofit blade ice protection system manufactured by Borealis Wind Inc. The system consists of a blade heater installed in each blade and a control cabinet installed in the nacelle. The ice protection system has two modes of operation: ON and OFF. De-icing refers to the operation of the ice protection system while the wind turbine is parked, and anti-icing refers to the operation of the ice protection system during normal turbine operation to prevent ice accumulation on the blades. For the duration of the testing period described in this report, the ice protection system was operating while WTG 37 was operational and was deactivated (off) while WTG S37 was parked, unless otherwise noted.

The Audit is required as a condition of a Provincial Officer's Order 0222-BYJKLW ("Order"), served to the Wind Project by the Ontario Ministry of the Environment, Conservation and Parks ("MECP") on February 25, 2021, and amended on March 10 and April 28, 2021. The measurements and analysis described herein were conducted in accordance with the requirements of Part D of the MECP's *Compliance Protocol for Wind Turbine Noise* ("Compliance Protocol") [1]. This report summarizes the results of the Immission Audit.

2 MONITORING LOCATION

As required by the Order, two monitoring locations were selected to represent noise sensitive receptors to the north and south of WTG S37 with a predicted Wind Project only sound level of 39.2 dBA. The final monitoring locations were selected based on sound levels predicted by an acoustic model prepared by HGC Engineering, landowner permission, and absence of local interfering sound (i.e. trees, crops, etc.). Note that both selected locations are not receptor

locations with respect to either the Renewable Energy Approval for the project or the *Noise Assessment Report* ("NAR") [2] prepared by Hatch but rather represent a non-participating receptor with the highest predicted sound level from the Wind Project.

Monitoring location M1 is a vacant lot 740 m northwest of WTG S37. The sound level meter was installed approximately 60 m east of the intersection of Concession Road 3 and Stella 40 Foot Road. The microphone was placed at a height of 4.5 m.

Monitoring location M2 is a vacant lot 755 m southeast of WTG S37. The sound level meter was installed approximately 25 m north of the South Shore Road, and 90 m to the shore of Lake Ontario. The microphone was placed at a height of 4.5 m.

The Wind Project area is generally rural in nature with infrequently travelled gravel roads. An overview of the receptor and monitoring locations is shown in Figure 1, and photos of the installation are provided in Appendix A.

The predicted sound levels at the receptor and monitoring locations, along with their respective UTM coordinates and distances to the nearest wind turbines can be found in Table 1.

Table 1: Predicted Sound Levels and UTM Coordinates of Selected Locations

Location	UTM Coordinates		Nearest Wind Turbine		Predicted Sound Level [dBA]
	Easting	Northing	ID	Distance [m]	
M1	365061	4890441	S37	740	39.2 *
M2	365949	4889249		755	39.2*

* Sound level predicted by acoustic model prepared by HGC Engineering.

3 INSTRUMENTATION

The Compliance Protocol provides instrumentation requirements for Acoustical Audits of wind energy projects. The instrumentation used for this acoustic audit satisfies the requirements of the Compliance Protocol.

Audio frequency sound levels were measured using Svantek 977 sound level meters each connected to a ½" microphone. The microphones were set at a height of approximately 4.5 m

and equipped with a 175 mm diameter windscreen to minimize wind-induced microphone self-noise.

The energy-equivalent average sound level, denoted L_{EQ}, was recorded by the instrumentation. The audio-frequency measurements are presented as A-weighted sound levels as they are intended to represent the loudness of sounds as perceived by the human ear. The overall audio-frequency sound level monitoring results are summarized in this report.

In addition to the acoustic instrumentation, meteorological instruments were used. An anemometer and wind vane were installed on a 10 m tall tower at each monitoring location, approximately 5 m from the sound monitoring equipment, to collect local wind speed and direction. Weather conditions including temperature, humidity, and precipitation were measured at location M1.

The various instruments deployed by HGC Engineering are summarized in Table 2.

Table 2: Measurement Instrumentation

Location	Instrumentation Make and Model	Serial Number	Calibration Date	Calibration Due Date
M1	Svantek 977	36816	December 27, 2021	December 27, 2022
	NRG #40C anemometer	179500266979	January 13, 2020	January 13, 2022
M2	Svantek 977	36827	December 27, 2021	December 27, 2022
	Vaisala WXT 520	R3150067	August 2, 2019	August 2, 2021

Each sound level meter was configured to measure and record spectral (frequency-dependent) one-minute L_{EQ} sound level measurements. For identification of dominant sources, the sound level meters also recorded audio files.

Correct calibration of the acoustic instrumentation was verified using an acoustic calibrator manufactured by Brüel & Kjær. Calibration verification was carried out on several occasions throughout the measurement period.

A windscreen was used on the microphone, consistent with the requirements of MECP technical publication *NPC-103*, *Procedures* [3]. A large wind screen, 175 mm in diameter, was used on the sound level meters to minimize wind-induced microphone self-noise at higher wind speeds. Sound level data included herein has not been adjusted for the sound insertion loss of the large wind screen.

All the equipment was within its annual or bi-annual calibration, confirmed by the calibration certificates found in Appendix B.

4 ASSESSMENT CRITERIA

The MECP publication *Noise Guidelines for Wind Farms – Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities* [4] indicates the applicable sound level limit for wind energy projects in a Class 3 environment. Additionally, the Compliance Protocol includes the same sound level limits which are shown in Table 3.

Table 3: Wind Turbine Noise Criteria [dBA]

10 m Height Wind Speed [m/s]	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 3 Area [dBA]	40.0	40.0	40.0	43.0	45.0	49.0	51.0

If the ambient sound levels (OFF condition) are greater than the applicable limits identified in Table 3, then the applicable limits are the determined ambient sound (OFF condition) in each of the integer wind speed bins.

It should be noted that the sound level limits of the MECP apply only to the sound level contribution of the sound source under assessment, in this case the sound from the wind turbine generators. Thus, where a sound level measured at a receptor location includes significant sound due to the relevant sound source and unrelated background sound sources (i.e. road vehicles, trains, air traffic, farming machinery, wind, etc.), some form of evaluation must be made to determine the sound level contribution of the source under assessment in the absence of the background sounds.

5 METHODOLOGY

The Immission Audit was completed in accordance with Part D of the Compliance Protocol. Part D includes requirements for instrumentation, measurement, and data reduction procedures to assist with determining compliance.

A series of one-minute energy-equivalent sound level measurements are collected with ("ON") and without ("OFF") the wind turbines operating. The ON condition is defined as any period where all wind turbine generators within 3 km of the measurement location are operational. The OFF condition is defined as any period where sufficient nearby wind turbine generators are parked (i.e. 0 rpm) to reduce the total sound level contribution of the facility at the measurement location to less than 30 dBA.

Simultaneously, wind speed and direction at 10 m height are measured and collected in one-minute intervals. The measured sound level data is separated into integer wind speed "bins" where the sound levels corresponding to each integer wind speed are logarithmically averaged to determine the L_{EQ} sound level when the wind turbines are operational and when they are parked. The ambient L_{EQ} (turbines parked) is logarithmically subtracted from the overall L_{EQ} (turbines operational) to determine the sound level contribution of the wind turbines alone. Supplementary data including wind speed at turbine hub height, wind speed at noise measurement height, turbine electrical power output, turbine yaw position, temperature, humidity, and statistical noise indices (Ln) can also be measured during the monitoring campaign to aid in the analysis.

Part D of the Compliance Protocol requires at least 120 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbines are operating and at least 60 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbines are parked. Prior to determining the number of data points measured in each wind speed bin, the data is filtered to only include night-time hours (between 22:00 and 05:00) and data outside of rainfall (no rain within one hour of the measurement interval). In accordance with the environmental specifications of the instrumentation, data measured during periods with temperatures below -10°C or relative humidity greater than 90% were omitted from the analysis. Data is also filtered to only include periods where the closest turbine is operating at greater or

equal to 85% of its rated electrical power output and at least 90% of its maximum sound power, and the turbine yaw position is +/-45 degrees from the line of sight between the closest turbine and the measurement location (measurement location is downwind).

A modified electrical power filter of 75% of the rated electrical output of turbine WTG S37 was used to increase the number of valid data points. It has been established on previous Audits conducted at the Wind Project that the turbine operational (ON) sound levels remained relatively unchanged between the modified power filter rating (75% of the rated electrical output) and the 85% rated electrical output prescribed by the Compliance Protocol. Furthermore, a recent Acoustic Test Report for WTG S37, completed by HGC Engineering, dated June 9, 2021 [5], supports the use of a modified power filter. The Acoustic Test Report indicates the maximum sound power of the wind turbine is reached at approximately 72% of the rated electrical power output in the downwind condition.

The specific yaw position and power filter used at location M1 are summarized in Table 4. Additionally, all wind turbines within 3 km of the measurement location were operational.

Table 4: Yaw Position and Power Filters

Location	Condition	Rated Electrical Power [kW]	Acceptable Yaw Position	S37 Power [kW]
M1	Downwind	2942	98° to 188°	2206.5 (75%)
	Upwind		278° to 8°	
	Crosswind		8° to 98° and 188° to 278°	
M2	Downwind	2942	278° to 8°	2206.5 (75%)
	Upwind		98° to 188°	
	Crosswind		8° to 98° and 188° to 278°	

If the measurement campaign does not yield enough data to satisfy the minimum requirements of Part D of the Compliance Protocol, a Revised Assessment Methodology Immission Audit can be completed. As described in Part E5.5 of the Compliance Protocol, three wind speed bins between 1 and 7 m/s or two wind speed bins between 1 and 4 m/s are required. With appropriate justification, the number of one-minute intervals required in each bin may be reduced to 60 for turbine operational measurements (ON) and 30 for ambient measurements (OFF). Appropriate

justification for a reduced amount of data is determined on a case-by-case basis and may include the length of the monitoring campaign (greater than 6 weeks) and lower standard deviation of the sound levels.

The Compliance Protocol allows for the removal of individual events to improve the signal to noise ratio. An additional filter to remove gusty wind events that cause low frequency buffeting on the microphone was used to omit data where the maximum recorded 10 m height wind speed was more than 3 m/s greater than the average wind speed recorded over the same minute. A review of the audio recordings allows for the identification of the dominant noise source within a given one-minute interval, and the subsequent removal of data points that contain interference (birds, car passbys, voices, dogs, wind gusts, waves, etc.).

Adjustments to the measured sound levels may be required based on wind turbine tonality, if any. If during the measurement campaign the project wind turbines exhibit tonal characteristics (a whine, screech, buzz or hum) then an assessment of the tonal audibility is required according to the CAN/CSA publication *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques* [6] or at the MECP Director's discretion another equivalent standard/procedure. The average tonal audibility correction must be determined for each integer wind speed and the correction added to the final noise contribution of the Wind Project at those wind speeds, in accordance with International Standards Organization *1996-2* [7].

6 MEASUREMENTS AND RESULTS

Instrumentation was deployed between March 12 and May 28, 2021, at location M1, and between March 18 and May 28, 2021, at location M2. The weather during the monitoring period varied, including several days with rain and snow. Temperatures ranged from -10°C to 25°C. Ground conditions immediately surrounding the measurement locations were fallow grassland for the duration of the monitoring period.

Wind speeds at 10 m height ranged from 0 m/s up to 16 m/s. The prevailing wind direction during the monitoring period was from the northwest. Figures 2 and 3 show the wind direction for each monitoring location during nighttime periods over the duration of the measurement campaign.

After a review of the data collected at monitoring location M2, it was clear that the sound levels were dominated by noise from waves crashing on the shore of Lake Ontario, and not by the Wind Project. Following the requirements of the Compliance Protocol, the sound level contribution of the Wind Project could not be determined at location M2, and thus the sound level summary for this monitoring location has been omitted from Sections 6.1 through 6.3.

Appendix C includes a statement from the Wind Project indicating the wind turbine generators were operating normally from March 12 to May 28, 2021, during operational ON data and the required turbines were shut down for ambient OFF data.

6.1 M1 Sound Level Summary, Downwind Conditions

The summary of valid data points collected in the downwind condition at location M1 is shown in Table 5.

Table 5: Location M1 - Summary of Valid Data Points, Downwind Condition

Wind Project Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Operating (ON)	3^	8^	65	26^	50^	16^	1^
Ambient (OFF)	7^	11^	4^	1^	0^	0^	0^

^ Insufficient data. Fewer than 60 Operational (ON) or 30 Ambient (OFF) data points collected.

Insufficient data was collected in all wind speed bins, primarily due to a lack of wind from the southeast, as shown in Figure 2. Following the requirements of the Compliance Protocol, the sound level contribution of the wind facility could not be determined at monitoring location M1 for the downwind condition.

6.2 M1 Sound Level Summary, Crosswind Conditions

The sound level summary for data collected in the crosswind condition at location M1 is shown in Tables 6a and 6b.

Table 6a: Location M1 - Summary of Valid Data Points, Crosswind Condition

Wind Project Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Operating (ON)	9^	48^	160	129	121	40^	32^
Ambient (OFF)	90	78	183	32	10^	7^	2^

^ Insufficient data. Fewer than 60 Operational (ON) or 30 Ambient (OFF) data points collected.

Table 6b: Location M1 - Sound Level Summary, Crosswind Condition, L_{EQ} [dBA]

L_{EQ} Sound Level [dBA]	10 m Height Wind Speed [m/s]			
	3		4	
Average Operating (ON) / Std Dev.	39	1.1	39	1.4
Average Ambient (OFF) / Std Dev.	32	1.5	34	2.2
Wind Project Only	**38**		**38**	
Exclusionary Minimum Criteria	40		40	
Applicable Criteria	40		40	
Excess	**0**		**0**	

The operating ON and ambient OFF measurements show 5 dB and 7 dB of separation in the 3 m/s and 4 m/s wind speed bins, respectively, indicating the dominant source of the sound is the wind facility under audit.

Based on the data presented above, and in Figure 4, the Wind Project is compliant with the MECP's sound level criteria at monitoring location M1 for data collected in the crosswind condition.

6.3 M1 Sound Level Summary, Upwind Conditions

The sound level summary for data collected in the upwind condition at location M1 is shown in Tables 7a and 7b.

Table 7a: Location M1 - Summary of Valid Data Points, Upwind Condition

Wind Project Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Operating (ON)	0^	25^	102	161	178	120	66
Ambient (OFF)	78	22^	24^	54	15^	30	37

^ Insufficient data. Fewer than 60 Operational (ON) or 30 Ambient (OFF) data points collected.

Table 7b: Location M1 - Sound Level Summary, Upwind Condition, L_{EQ} [dBA]

L_{EQ} Sound Level [dBA]	10 m Height Wind Speed [m/s]					
	4		6		7	
Average Operating (ON) / Std Dev.	40	0.9	41	1.1	41	1.2
Average Ambient (OFF) / Std Dev.	32	1.7	39	1.7	40	2.0
Wind Project Only	**39**		**35**		**37**	
Exclusionary Minimum Criteria	40		40		43	
Applicable Criteria	40		40		43	
Excess	**0**		**0**		**0**	

The operating ON and ambient OFF measurements show a 8 dB separation in the 4 m/s wind speed bin, indicating the dominant source of the sound is the wind facility under audit. As expected, the separation between operating ON and ambient OFF measurements decreases as wind speed increases, due to the increase in ambient sound level caused by the wind.

Based on the data presented above, and in Figure 5, the Wind Project is compliant with the MECP's sound level criteria at monitoring location M1 for data collected in the upwind condition.

6.4 Time History Analysis

At the request of the MECP, the Borealis ice protection system was cycled on and off over seven nighttime periods for the purpose of isolating the acoustic impact of the system. The Borealis system was cycled on and off approximately every hour between 22:00 and 5:00 on March 29 through April 2, and on April 5 and 6, 2021.

Tables 8, 9, and 10 show the sound level summary for the data collected at monitoring location M1 during the seven nighttime periods described above, binned by wind speed and Borealis

operation. Other filters include wind gust criteria, rain and included/excluded data based on a review of audio data. Electrical power filters were not included on the data presented below.

Table 8: Sound Level Results Aggregated by Borealis Operation, Location M1, Downwind Condition

Operating Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Borealis ON, WTG S37 ON							
Valid Data Points			9	29	55	22	1
Std. Dev. [dB]			0.8	1.5	1.2	0.8	-
L_{EQ} Sound Level [dBA]			38.2	39.5	42.9	44.4	45.3
Borealis OFF, WTG S37 ON							
Valid Data Points		2	6	9	41	13	
Std. Dev. [dB]		6.1	1.1	2.2	0.6	1.0	
L_{EQ} Sound Level [dBA]		34.6	38.7	41.1	42.6	43.2	

Table 9: Sound Level Results Aggregated by Borealis Operation, Location M1, Crosswind Condition

Operating Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Borealis ON, WTG S37 ON							
Valid Data Points	24	6	16	15	1	5	
Std. Dev. [dB]	3.1	3.2	3.6	1.8	-	0.8	
L_{EQ} Sound Level [dBA]	36.2	32.4	35.5	38.4	38.6	47.3	
Borealis OFF, WTG S37 ON							
Valid Data Points	114	72	24	13	2		
Std. Dev. [dB]	3.4	4.4	2.9	4.3	0.6		
L_{EQ} Sound Level [dBA]	37.2	37.1	32.6	35.7	39.3		

Table 10: Sound Level Results Aggregated by Borealis Operation, Location M1, Upwind Condition

Operating Condition	10 m Height Wind Speed [m/s]						
	1	2	3	4	5	6	7
Borealis ON, WTG S37 ON							
Valid Data Points	87	88	88	108	19	3	
Std. Dev. [dB]	2.0	4.2	2.3	1.6	1.8	0.7	
L_{EQ} Sound Level [dBA]	27.8	32.8	36.6	38.3	40.6	44.4	
Borealis OFF, WTG S37 ON							
Valid Data Points	180	162	106	25	3		
Std. Dev. [dB]	4.7	3.7	4.1	1.5	0.3		
L_{EQ} Sound Level [dBA]	35.9	32.7	36.2	39.9	39.7		

The data presented in Tables 8, 9, and 10 does not show any correlation between the operation of the Borealis ice protection system and sound level at the receptor location. There are several instances where the measured sound level is higher without the operation of the Borealis system, when aggregated by wind speed and direction. In instances where the measured sound level is higher with the Borealis system operating in a given wind condition, the difference in sound level is within the calculated standard deviation of the measurements.

A time history plot for each of the nighttime periods is shown in Appendix D. As shown in Figures D1 through D7, there is no appreciable change in overall sound pressure level with the Borealis system operating or off. Instead, the data indicates that sound level measured at monitoring location M1 is correlated with wind speed and wind turbine power output.

6.5 Tonality Assessment

As requested by the MECP, a detailed tonality analysis was completed following methods from ISO/PAS 20065 [8]. The audio recordings collected at location M1 during the monitoring campaign were utilized to generate 3-second narrow-band spectra between 20 Hz and 6000 Hz. Due to the prevalence of higher frequency natural sounds in the area (i.e., birds, crickets, frogs, etc.), the upper frequency limit of the tonality analysis was limited to 1000 Hz. This upper frequency limit is consistent with any potential tones identified during the Emission Test for S37. The tonal audibility results for each 3-second spectra were binned into integer wind speeds and

logarithmically averaged in accordance with the standard to determine the tonal audibility value for each wind speed bin. Where tonal audibility greater than 4 dB is determined, adjustments are made to the wind project only sound levels based on the procedure described in ISO 1996-2.

The tonality analysis found no tonal audibility (i.e., tonal audibility greater than 0 dB) and no penalties are applicable for this measurement campaign. Summary results of the tonality analysis are found in Appendix E. Detailed tonality analysis results are available electronically, upon request.

7 CONCLUSIONS

The measurements and analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment, Conservation and Parks' 2017 publication *Compliance Protocol for Wind Turbine Noise* indicate that the Amherst Island Wind Project is operating in compliance with the MECP's sound level criteria at monitoring location M1, under the conditions detailed in this report. Furthermore, the results of this immission audit, including a time history analysis of the operation of WTG S37 with and without the Borealis system operating, indicate that the addition of Borealis ice protection system to turbine WTG S37 has a negligible acoustic impact at monitoring location M1.

For the duration of the measurement campaign, the sound levels at location M2 were dominated by noise from waves crashing on the shore of Lake Ontario, and not by the Wind Project. Thus, the acoustic contribution of the Wind Project and the Borealis system could not be determined at monitoring location M2.

REFERENCES

1. Ontario Ministry of the Environment, Conservation and Parks, *Compliance Protocol for Wind Turbine Noise Guideline for Acoustic Assessment and Measurement,* April 2017.
2. Hatch, *Amherst Island Wind Project Noise Assessment Report*, May 3, 2013.
3. Ontario Ministry of the Environment, Conservation and Parks Publication, NPC-103, *Procedures.*
4. Ontario Ministry of the Environment, Conservation and Parks Publication, *Noise Guidelines for Wind Farms*, May 2016.
5. HGC Engineering, *Acoustic Test Report – WTG S37, Version 3,* June 9, 2021.
6. CAN/CSA-C61400-11:13, *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques,* 2018.
7. International Standards Organization 1996-2, *Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels*, 2007.
8. ISO/PAS 20065:2016, *Acoustics — Objective method for assessing the audibility of tones in noise — Engineering method*, July 2016.

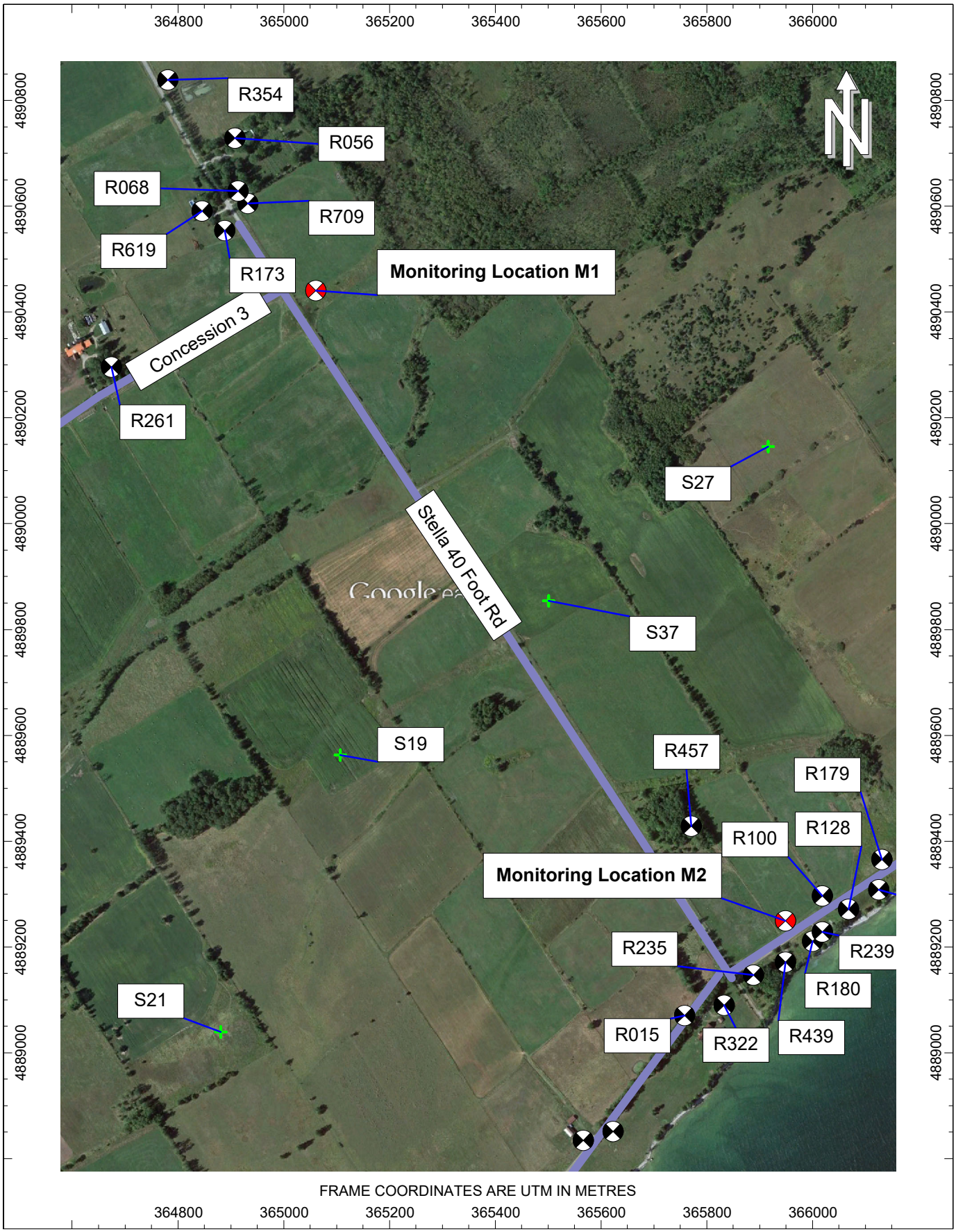


Figure 1 - Overview of Monitoring Locations M1 and M2

Figure 2: Wind Direction, Amherst Island Wind Project
Monitoring Location M1, Nighttime Period (22:00 to 5:00), March 12 to May 28, 2021

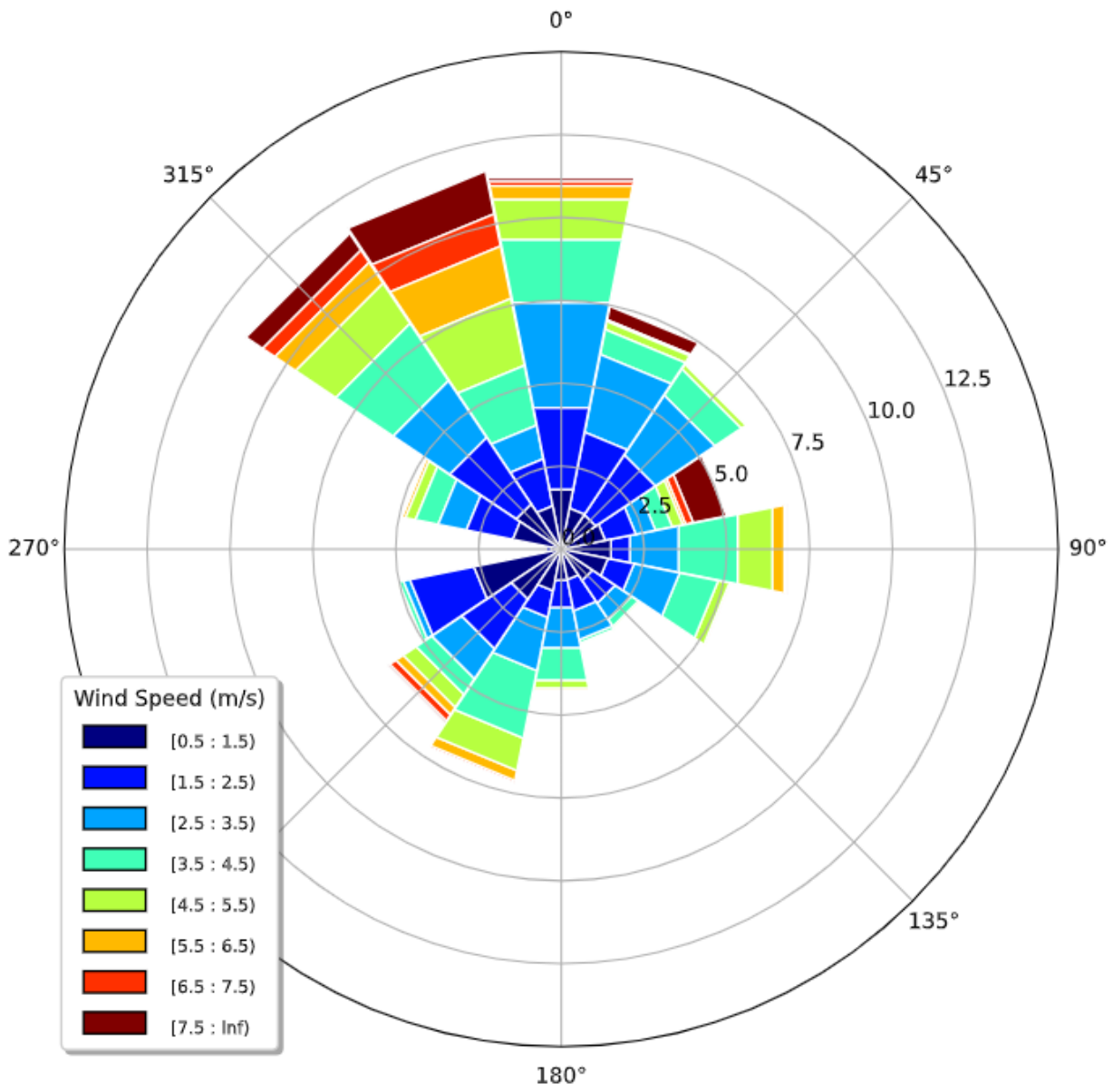


Figure 3: Wind Direction, Amherst Island Wind Project
Monitoring Location M2, Nighttime Period (22:00 to 5:00), March 18 to May 28, 2021

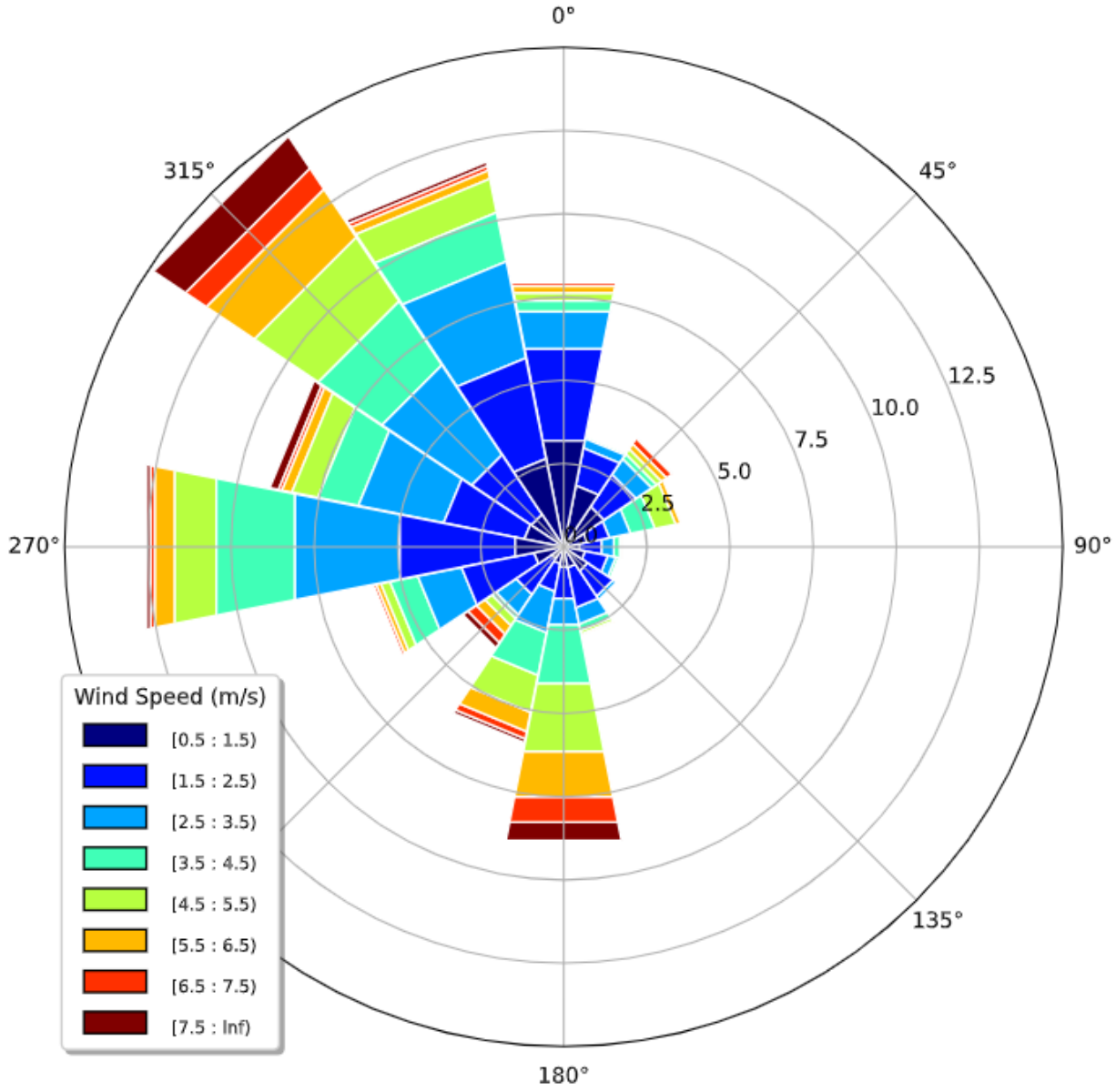


Figure 4: Immission Results, Crosswind Condition, Monitoring Location M1
Amherst Island Wind Project, March 12 to May 28, 2021

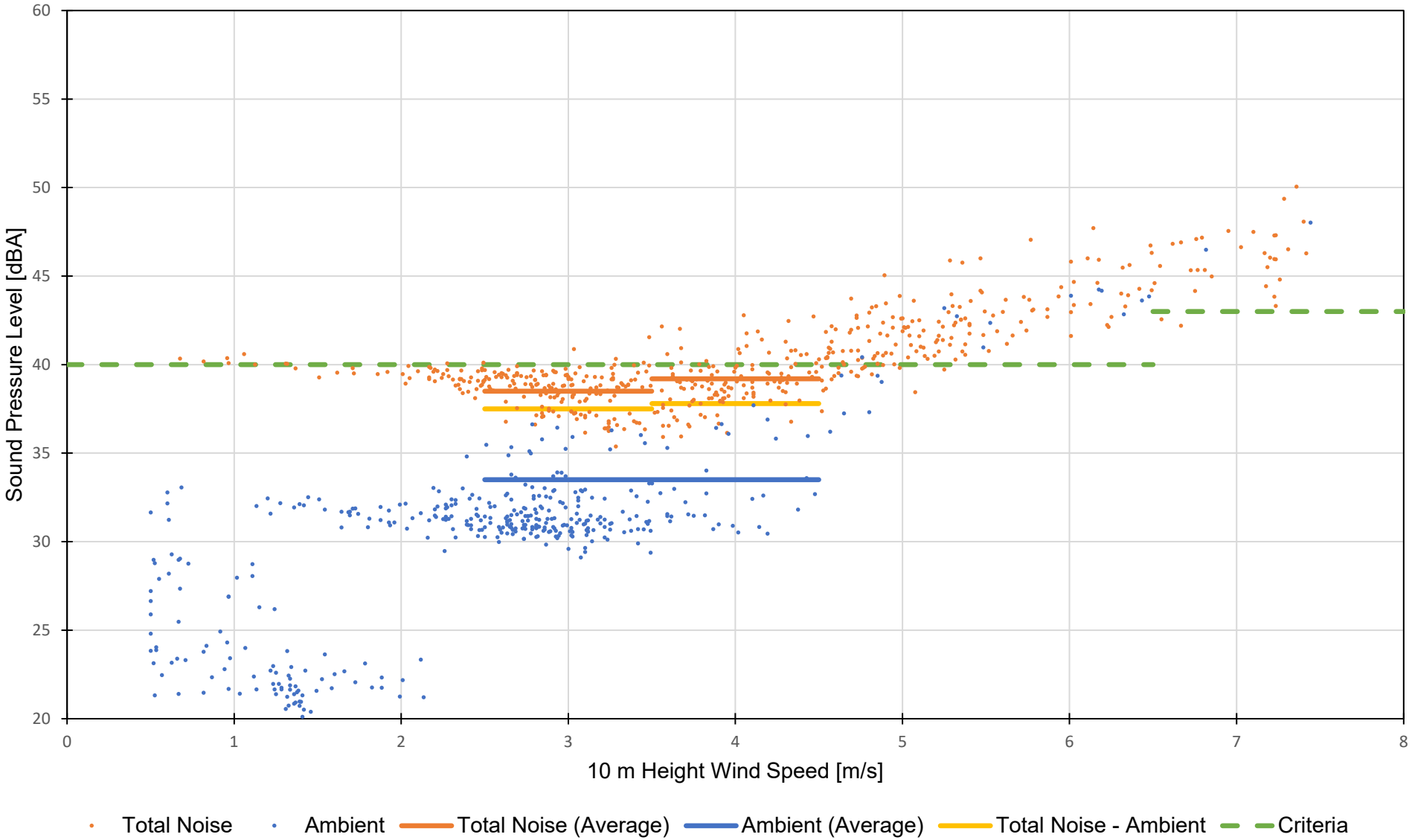
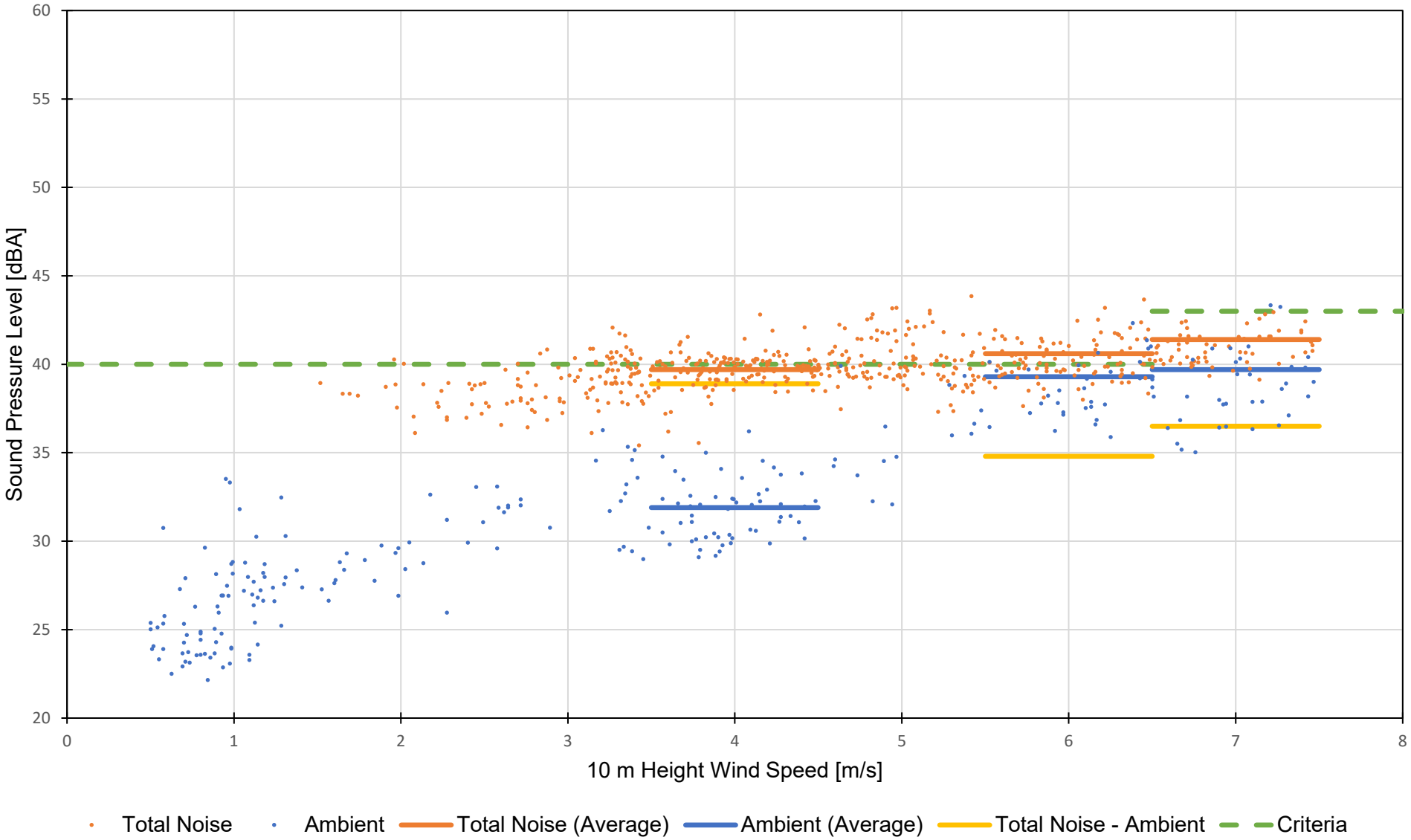


Figure 5: Immission Results, Upwind Condition, Monitoring Location M1
Amherst Island Wind Project, March 12 to May 28, 2021



APPENDIX A:
MONITORING LOCATION PHOTOS

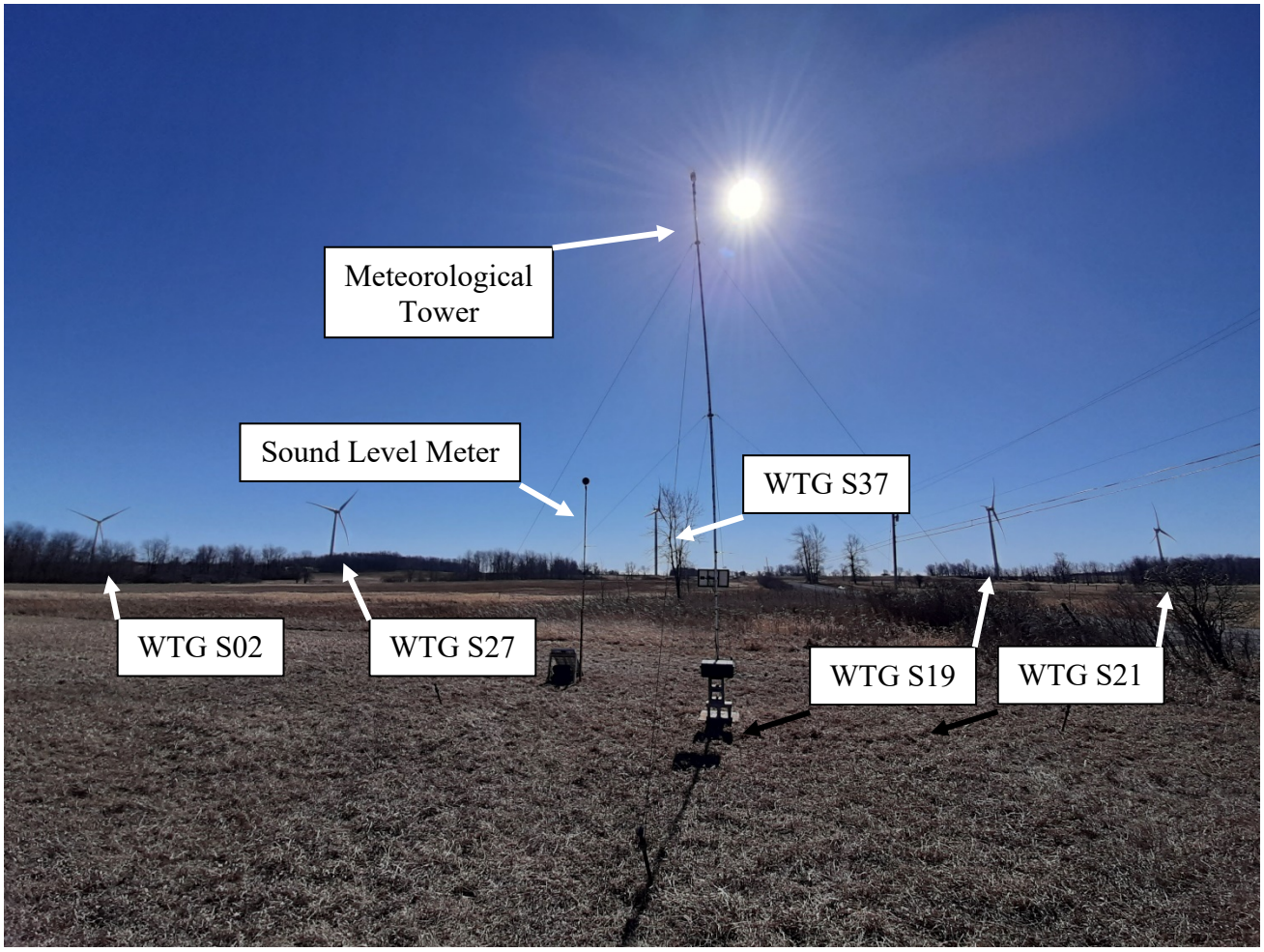


Photo of Meteorological Tower and Sound Level Meter at Monitoring Location M1 (looking south)

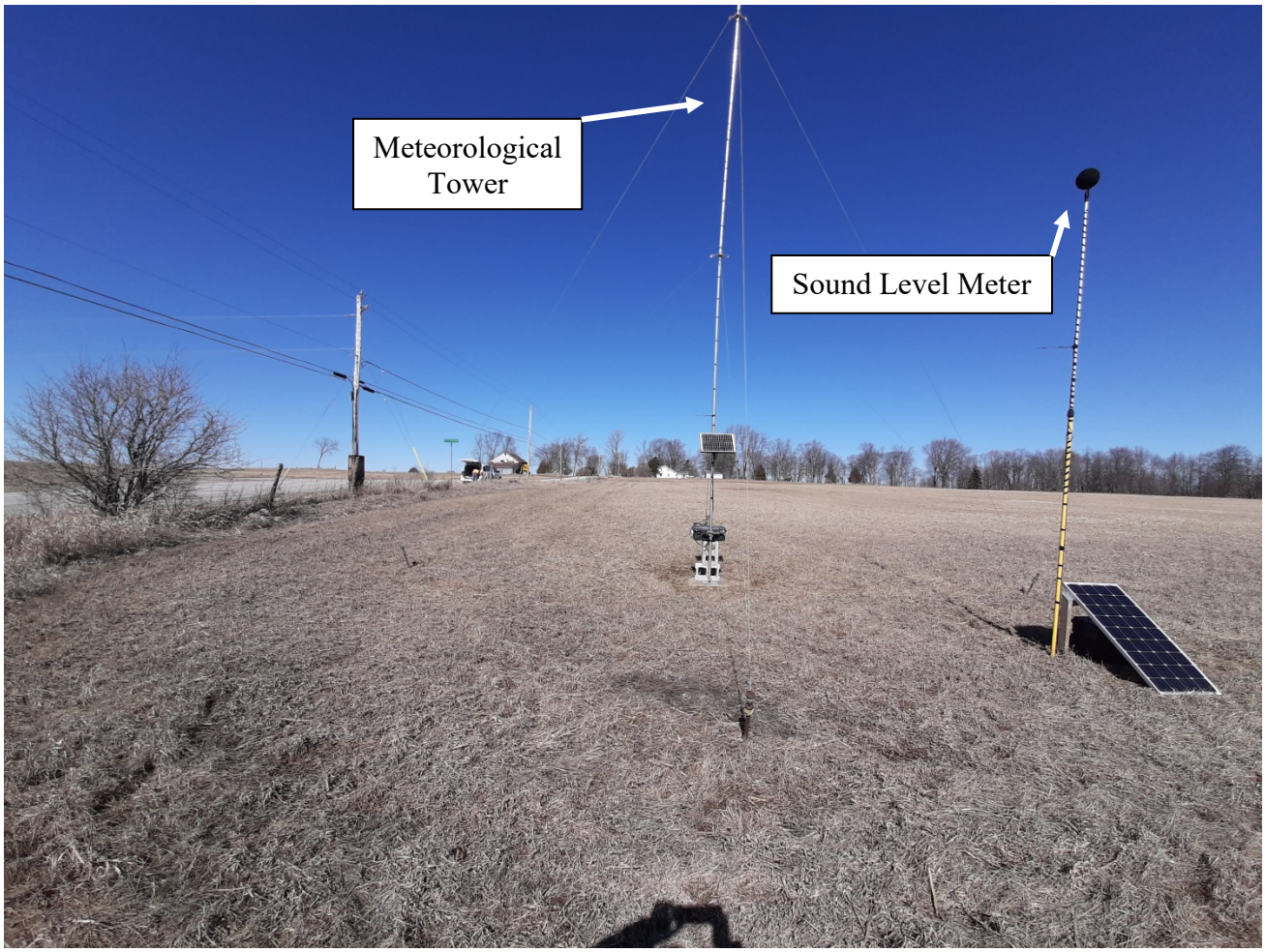


Photo of Meteorological Tower and Sound Level Meter at Monitoring Location M1 (looking north)

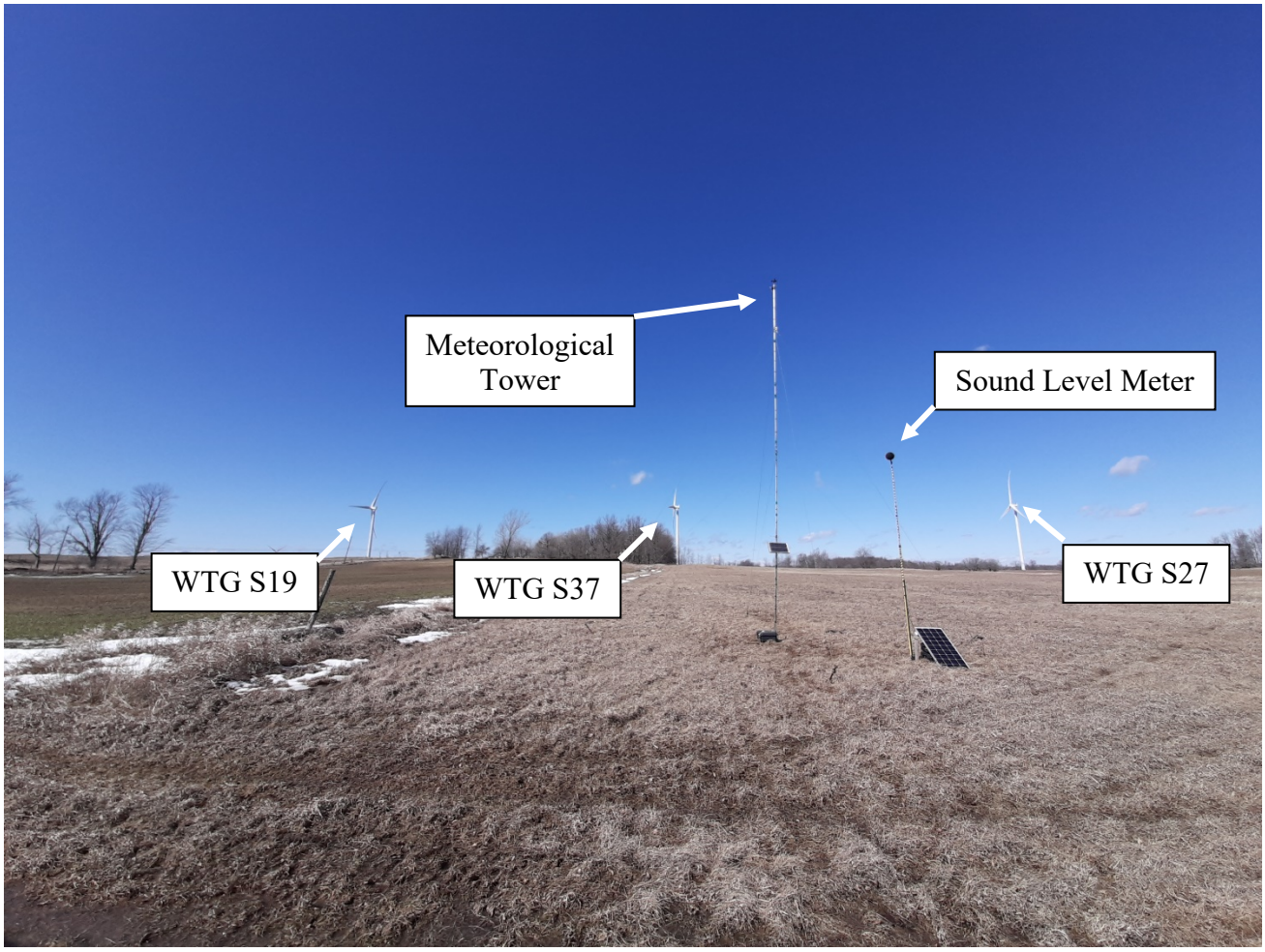


Photo of Meteorological Tower and Sound Level Meter at Monitoring Location M2 (looking north)

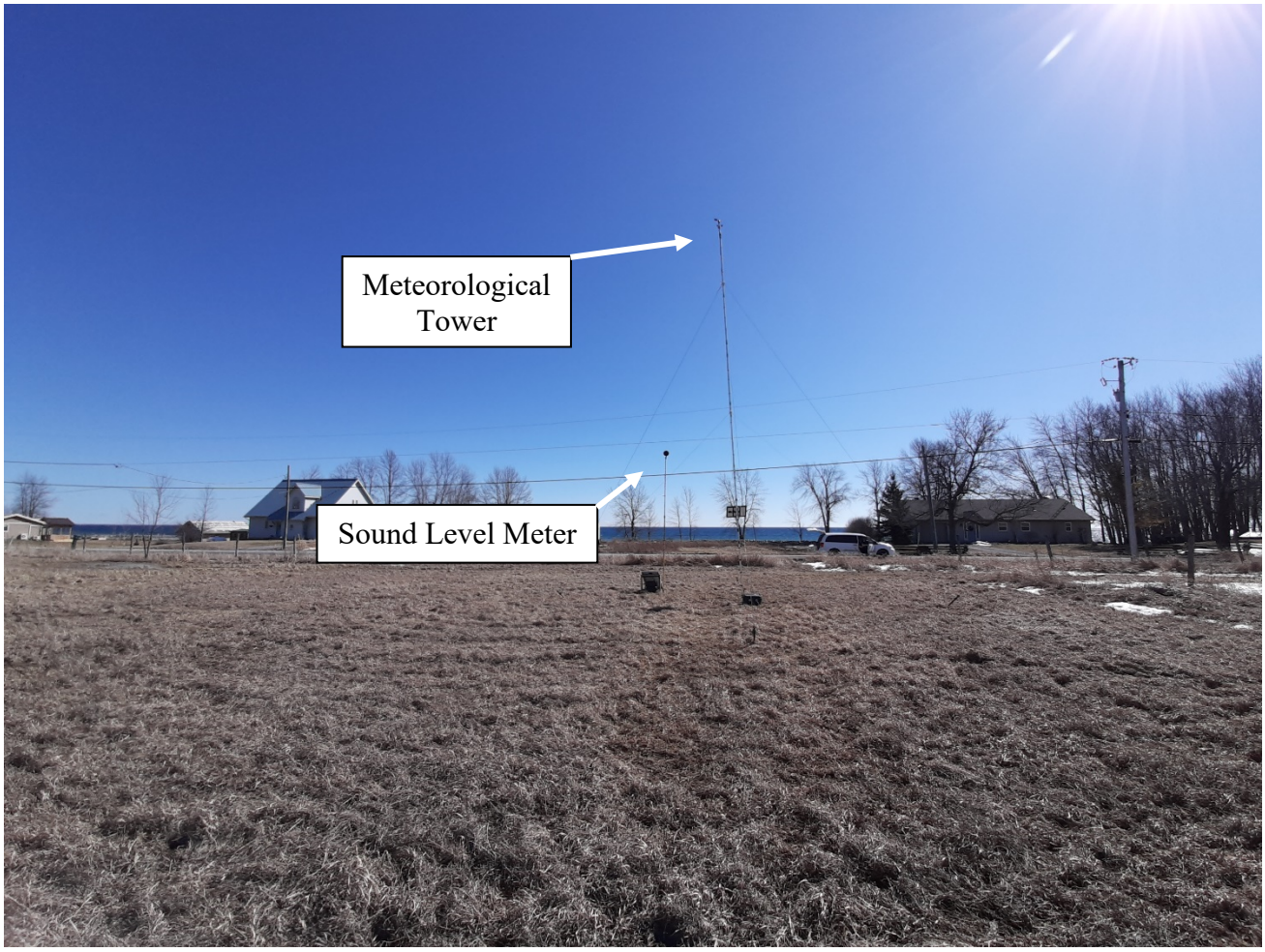


Photo of Meteorological Tower and Sound Level Meter at Monitoring Location M2 (looking south)

APPENDIX B:
CALIBRATION CERTIFICATES

NRG 15

SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

NC

Certificate number: 20.US1.00229 **Date of issue:** January 13, 2020

Type: NRG 40C Anemometer **Serial number:** 179500266979

Manufacturer: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada

Anemometer received: January 09, 2020 **Anemometer calibrated:** January 13, 2020

Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F

Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Eric Jeffcoat

Calibration equation obtained: v [m/s] = 0.75991 · f [Hz] + 0.37060

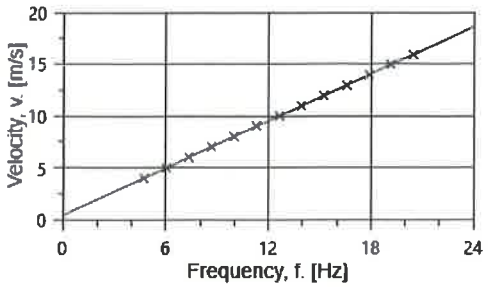
Standard uncertainty, slope: 0.00072 **Standard uncertainty, offset:** 0.01993

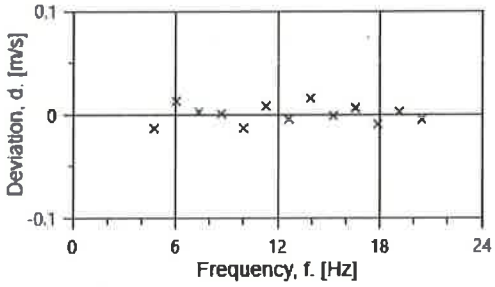
Covariance: -0.0000038 (m/s)²/Hz **Coefficient of correlation:** $\rho = 0.999997$

Absolute maximum deviation: 0.016 m/s at 10.987 m/s

Barometric pressure: 1016.3 hPa **Relative humidity:** 20.6%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.58	18.3	24.5	3.973	4.7584	-0.013	0.023
4	14.99	18.4	24.5	4.971	6.0379	0.013	0.026
6	21.63	18.4	24.6	5.972	7.3680	0.002	0.030
8	29.56	18.4	24.6	6.982	8.7002	0.000	0.034
10	38.42	18.4	24.6	7.961	10.0059	-0.013	0.038
12	48.85	18.5	24.6	8.978	11.3157	0.008	0.042
13-last	60.25	18.5	24.6	9.971	12.6403	-0.005	0.046
11	73.17	18.4	24.6	10.987	13.9501	0.016	0.051
9	86.76	18.4	24.6	11.964	15.2588	-0.001	0.055
7	102.09	18.4	24.6	12.978	16.5820	0.006	0.059
5	118.09	18.4	24.6	13.957	17.8925	-0.010	0.063
3	135.07	18.3	24.5	14.927	19.1514	0.003	0.068
1-first	153.76	18.2	24.5	15.924	20.4739	-0.005	0.072





AC-1746

CERTIFICATE of CALIBRATION

Make :	Svantek	Reference # :	159813
Model :	SVAN977	Customer :	HGC Engineering Mississauga, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	36816	P. Order :	Sean Richardson
Asset # :	SV977-5		

Cal. status : Received in spec's, minor adjustment made. Cal.level was 0.4dB

nb
2 Jan 2020

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Dec 27, 2019 By : T. Beilin

Cal. Due : Dec 27, 2020

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 800-668-7440 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

CERTIFICATE of CALIBRATION

Make :	Svantek	Reference # :	159820
Model :	SVAN977	Customer :	HGC Engineering Mississauga, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	36827	P. Order :	Sean Richardson
Asset # :	SV977-6		

Cal. status : Received in spec's, minor adjustment made.
Cal.level was 0.4dB

NC
2 Jan 2020

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

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6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 800-668-7440 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

VAISALA

Calibration sheet no. H31-19310120

CALIBRATION SHEET

Instrument	WXTPTU
Serial number	R2910116
Manufacturer	Vaisala Oyj, Finland
Test date	11 July 2019

This test report certifies that the instrument was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

Calibration results

Test phase of calibration process	Reference value	Observed value	Difference*	Uncertainty**
Pressure	1085.3	1085.3	0	± 0.4 hPa
Pressure	905.7	905.8	0.1	± 0.4 hPa
Pressure	799.8	799.9	0.1	± 0.4 hPa
Pressure	600	599.9	-0.1	± 0.4 hPa
Temperature	59.7	59.7	0	± 0.2 °C
Temperature	-5.6	-5.7	-0.1	± 0.2 °C
Temperature	-32.3	-32.3	0	± 0.2 °C
Temperature	24.8	24.8	0	± 0.2 °C
Temperature	-52.4	-52.4	0	± 0.2 °C
Relative humidity	29.5	29.5	0	± 2 %RH
Relative humidity	57.7	57.7	0	± 2 %RH
Relative humidity	91.4	91.4	0	± 3 %RH

*The test points for error values are polynomial fitting curve fitting points.
**The calibration uncertainty given at 95 % confidence level, k = 2

Traceability
The working standards for pressure and temperature are calibrated at Vaisala Measurement Standards Laboratory (MSL) by using MSL working standards traceable to National Institute of Standards and Technology (NIST, USA). The relative humidity values are calculated from measured temperature and dew-point temperature values. The dew-point working standards are traceable to the Finnish National Humidity Laboratory (MIKES).

Signature

Technician

Doc218938-A

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

APPENDIX C:
STATEMENT OF OPERATION

Liberty | Renewables
354 Davis Rd, Suite 100
Oakville, Ontario, Canada L6J 2X1

T 905-465-4500
F 905-465-4514

libertyenergyandwater.com

Date June 24, 2021

RE **Statement of Operation**
Amherst Island Wind Project
Amherst Island, Ontario

To whom it may concern,

This letter is to confirm that the wind turbine generators at the Amherst Island Wind Project were operating normally during the post-construction acoustic audit of noise-sensitive receptors near WTG S37, conducted between March 12 and May 28, 2021. Additionally, this letter confirms that the relevant turbines were parked for ambient (OFF) condition measurements.

Sincerely,

Anthony Jones

Manager, Environment

APPENDIX D:
TIME HISTORY PLOTS

Figure D1: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #1, March 29, 2021

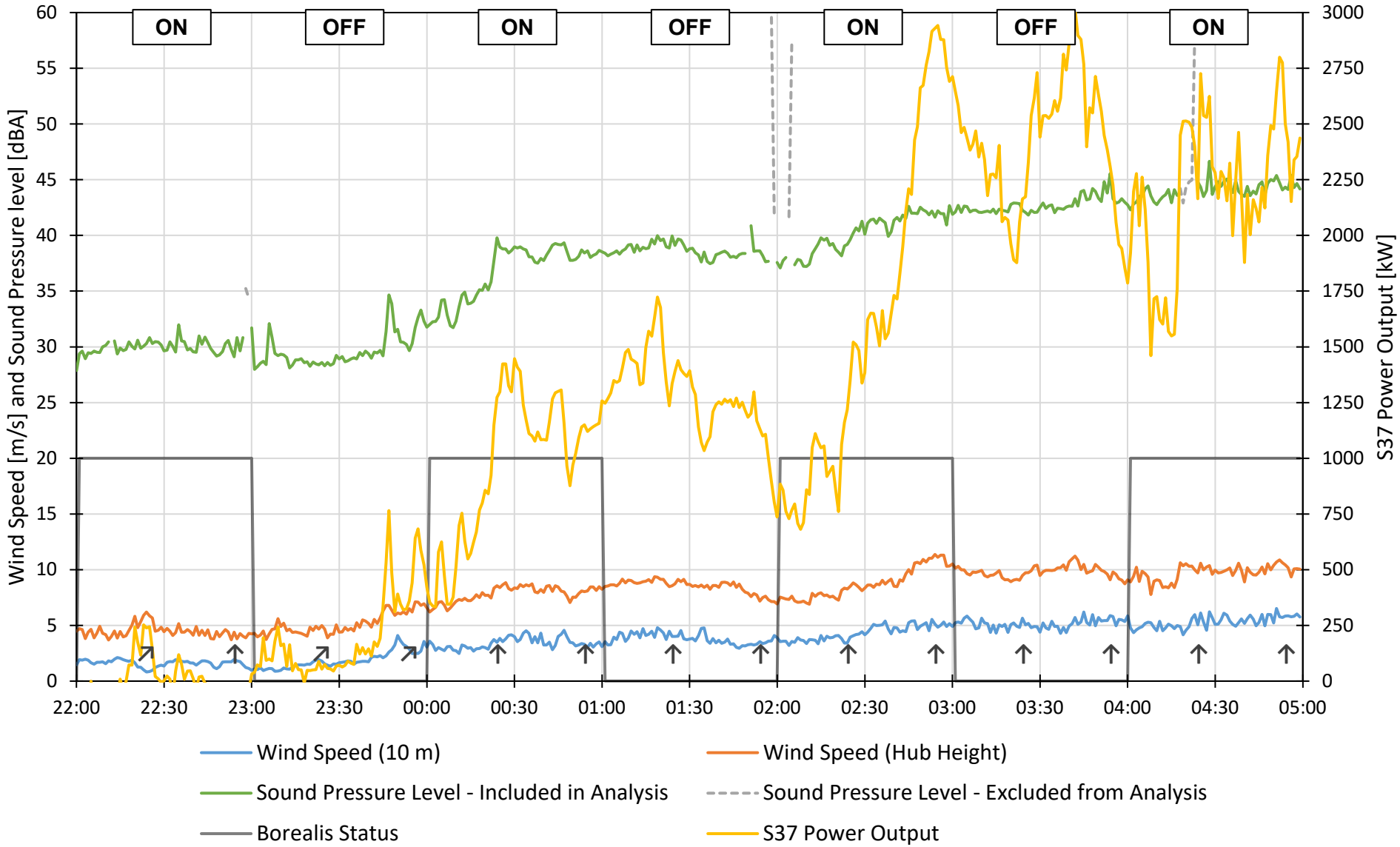


Figure D2: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #2, March 30, 2021

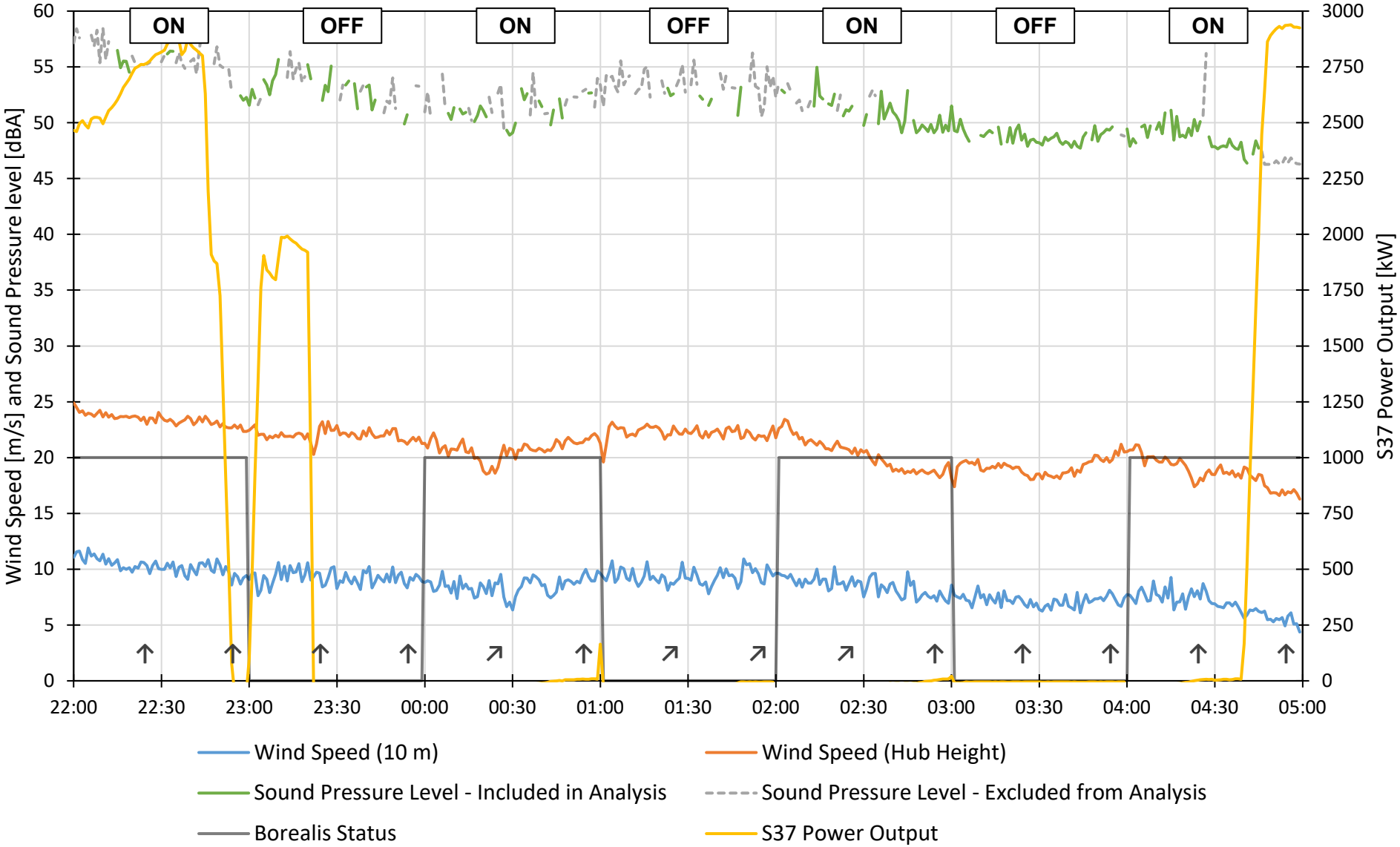


Figure D3: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #3, March 31, 2021

Figure D4: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #4, April 1, 2021

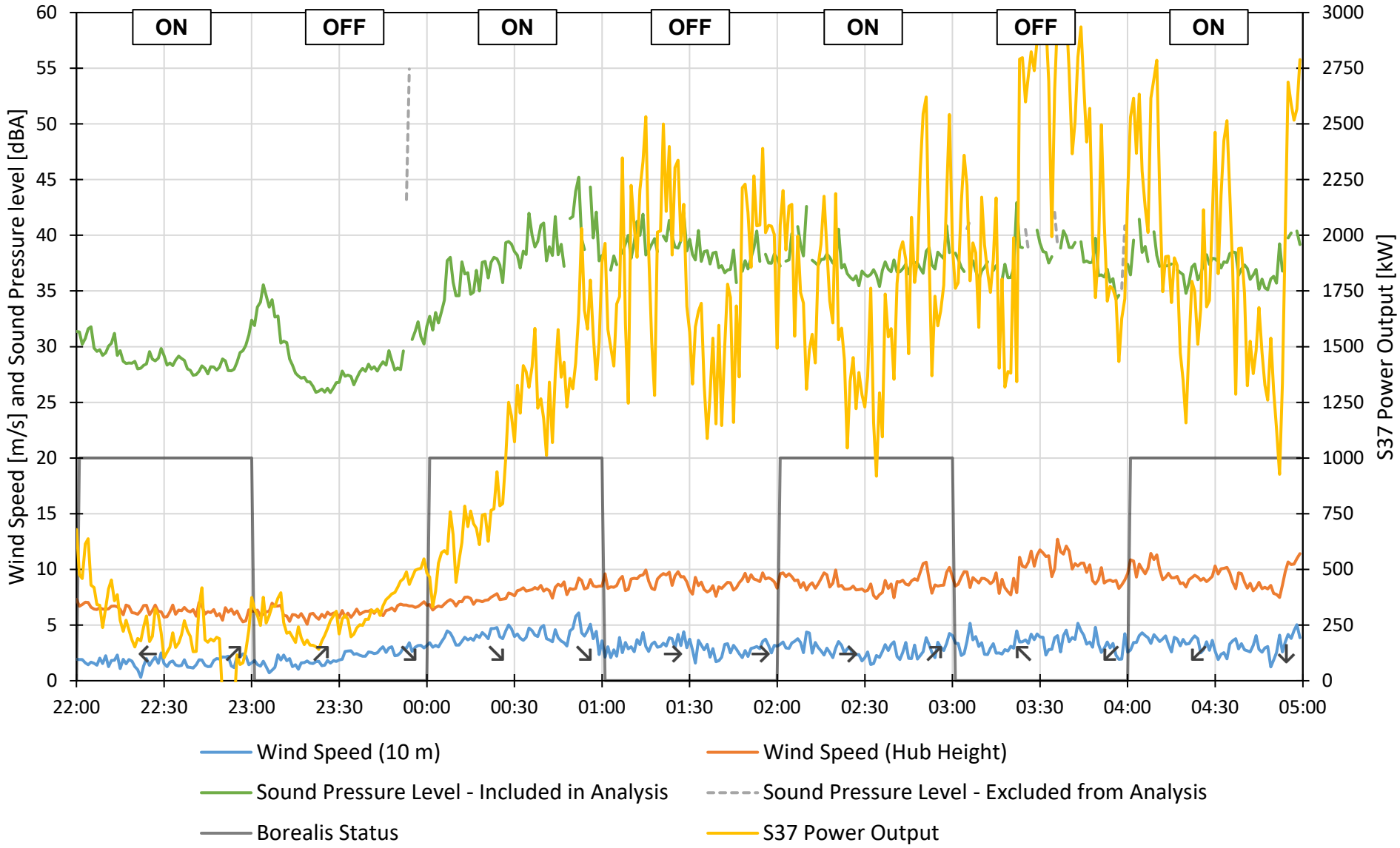


Figure D5: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #5, April 2, 2021

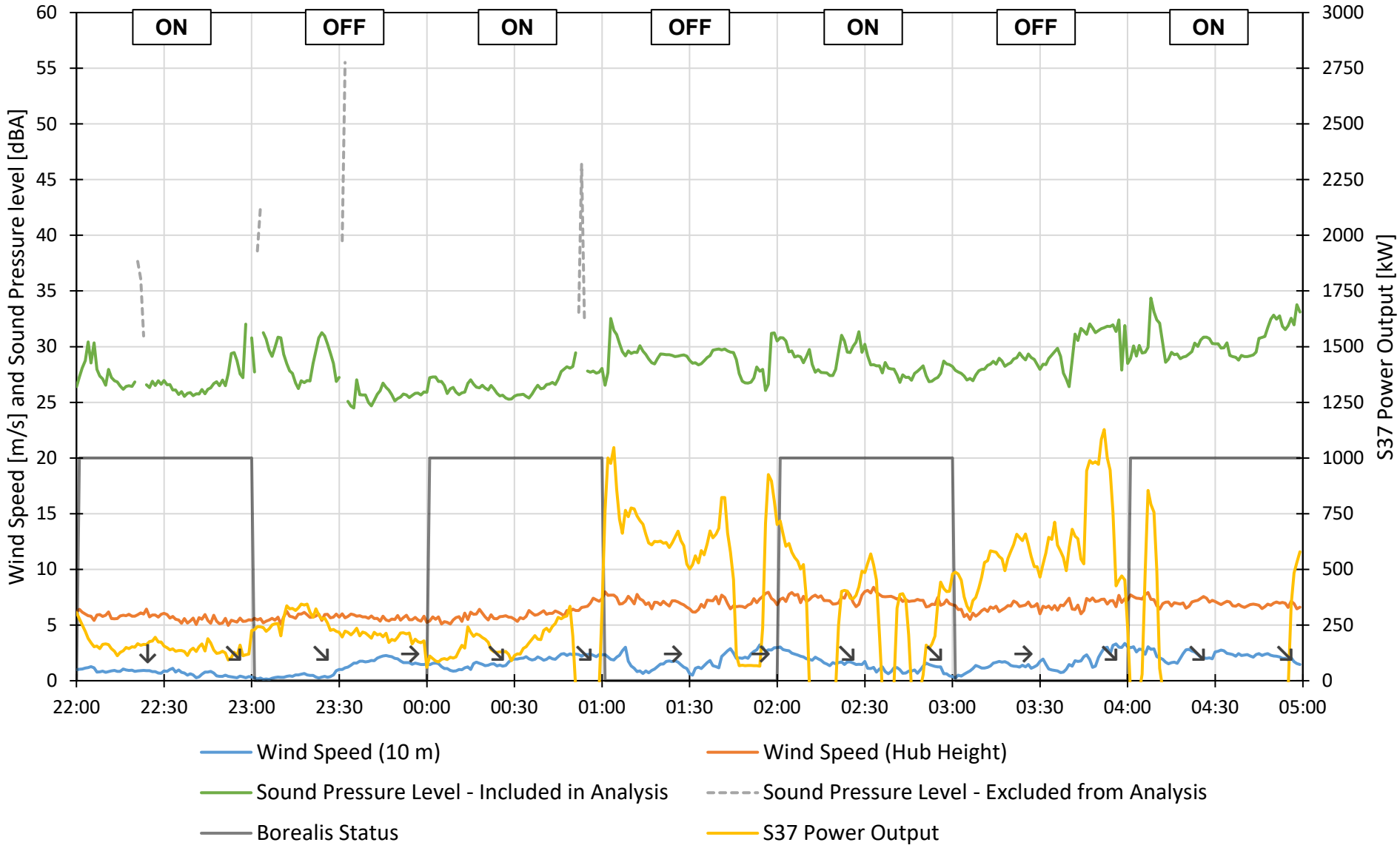


Figure D6: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #6, April 5, 2021

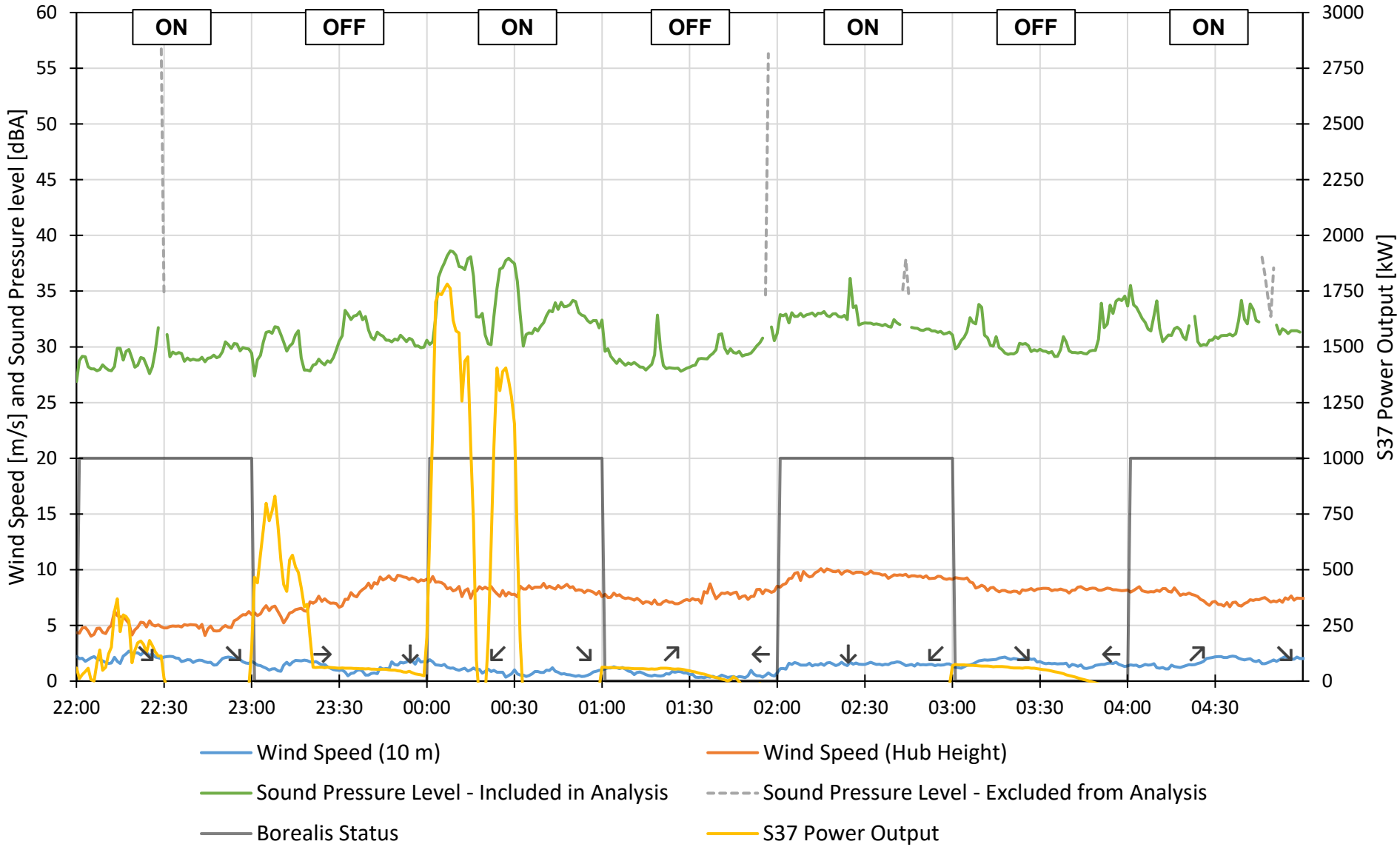
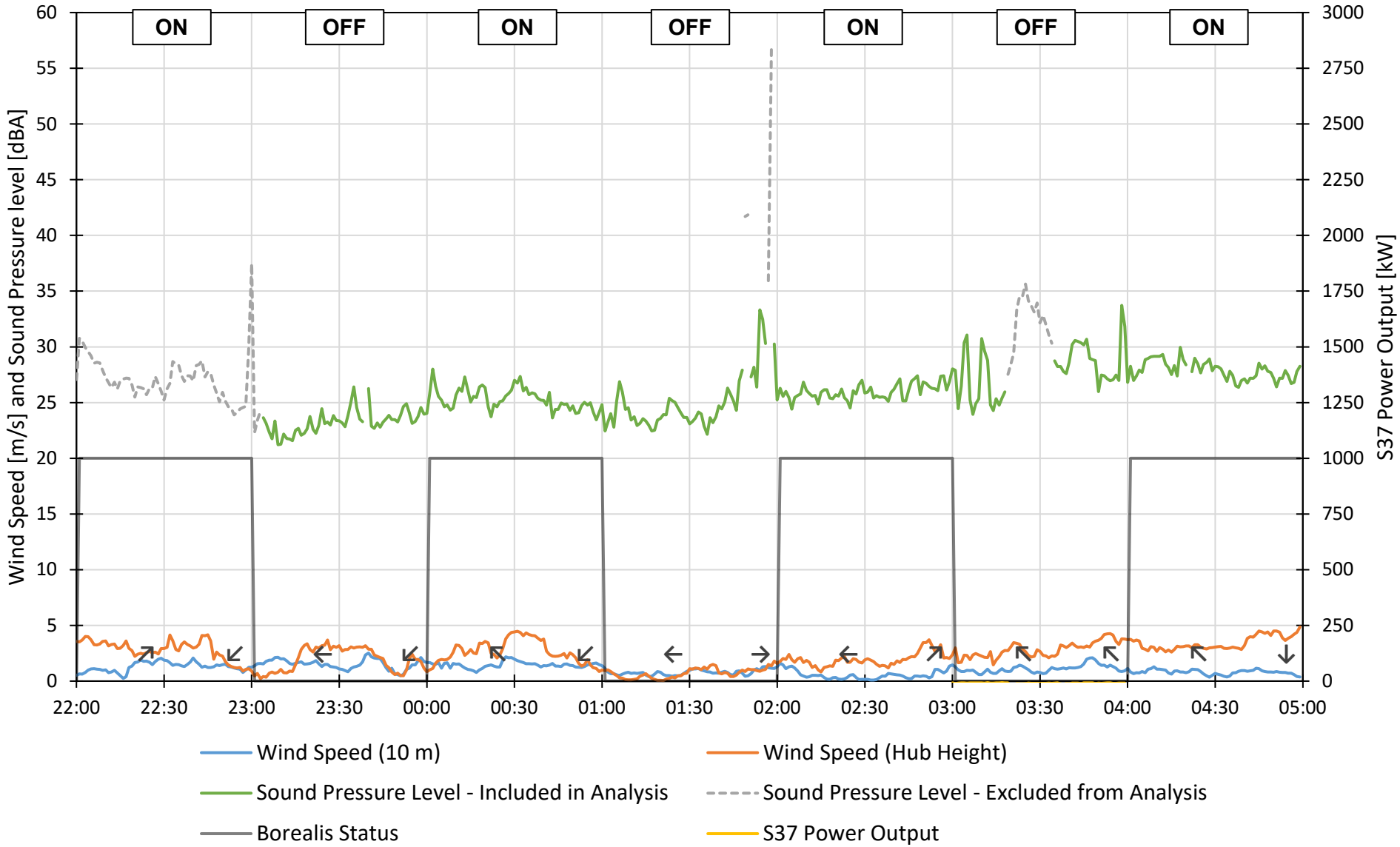


Figure D7: Sound Level, Wind Speed, Wind Direction, and Wind Turbine Power
Monitoring Location M1, WTG S37, Amerst Island Wind Project, Night #7, April 6, 2021



APPENDIX E:
TONALITY ANALYSIS

Table E1 – Summary of Tonality Analysis, Location M1, Downwind Condition

10 m Height Wind Speed Bin	Tone Count (below 1000 Hz)	Number of Spectra Analyzed	Tone Presence	Average Tonal Audibility [dB]	Tonal Penalty [dB]
1	0	60	0%	< -3	**0**
2	2	160	1%	< -3	**0**
3	25	1300	2%	< -3	**0**
4	16	520	3%	< -3	**0**
5	9	1000	1%	< -3	**0**
6	3	320	1%	< -3	**0**
7	0	20	0%	< -3	**0**

Table E2 – Summary of Tonality Analysis, Location M1, Crosswind Condition

10 m Height Wind Speed Bin	Tone Count (below 1000 Hz)	Number of Spectra Analyzed	Tone Presence	Average Tonal Audibility [dB]	Tonal Penalty [dB]
1	0	180	0%	< -3	**0**
2	36	960	4%	< -3	**0**
3	212	3200	7%	< -3	**0**
4	281	2580	11%	< -3	**0**
5	203	2420	8%	< -3	**0**
6	40	800	5%	< -3	**0**
7	7	640	1%	< -3	**0**

Table E3 – Summary of Tonality Analysis, Location M1, Upwind Condition

10 m Height Wind Speed Bin	Tone Count (below 1000 Hz)	Number of Spectra Analyzed	Tone Presence	Average Tonal Audibility [dB]	Tonal Penalty [dB]
1	0	0	-	-	**0**
2	154	500	31%	-2.3	**0**
3	355	2040	17%	< -3	**0**
4	490	3220	15%	< -3	**0**
5	543	3560	15%	< -3	**0**
6	303	2400	13%	< -3	**0**
7	150	1320	11%	< -3	**0**

APPENDIX F:
IMMISSION AUDIT CHECKLIST

Information Required in the Acoustic Audit Report – Immission

Amherst Island Wind Project, Immission Audit – Borealis Ice Protection System, Version 1

Requirement	Complete?	Notes
Did the Sound level Meter meet the Type 1 Sound level meter requirements according to the IEC standard 61672-1 Sound level Meters, Part 1: Specifications?	Y ☒ N ☐ N/A ☐	
Was the complete sound measurement system, including any recording, data logging or computing systems calibrated immediately before and after the measurement session at one or more frequencies using an acoustic calibrator on the microphone (must not exceed ±0.5dB)?	Y ☒ N ☐ N/A ☐	
Are valid calibration certificate(s) of the noise monitoring equipment and calibration traceable to a qualified laboratory? Is the validity duration of the calibration stated for each item of equipment?	Y ☒ N ☐ N/A ☐	
Was the predictable worst case parameters such as high wind shear and wind direction toward the Receptor considered? Section D3.2	Y ☒ N ☐ N/A ☐	
Is there a Wind Rose showing the wind directions at the site?	Y ☒ N ☐ N/A ☐	
Did the results cover a wind speed range of at least 4-7 m/s as outlined in section D 3.8.?	Y ☐ N ☐ N/A ☒	RAM-I audit used (Section E5.2)
Was the weather report during the measurement campaign included in the report?	Y ☒ N ☐ N/A ☐	
Did the audit state there was compliance with the limits at each wind speed category?	Y ☐ N ☒ N/A ☐	Compliance with MECP limits only determined for certain conditions.
Are pictures of the noise measurement setup near Point of reception provided?	Y ☒ N ☐ N/A ☐	
Was there justification of the Receptor location choice(s) prior to commencement of the I-Audit?	Y ☐ N ☐ N/A ☒	Receptor locations were not selected by HGC Engineering.
Was there sufficient valid data for different wind speeds?	Y ☐ N ☒ N/A ☐	Insufficient data was collected in the downwind condition.
Was the turbine (operational) specific information during the measurement campaign in tabular form (i.e. wind speed at hub height, anemometer wind speed at 10 m height, air temperature and pressure and relative humidity)?	Y ☒ N ☐ N/A ☐	

Requirement	Complete?	Notes
Were all the calculated standard deviations at all relevant integer wind speeds provided?	Y [X] N [ ] N/A [ ]	
Compliance statement	Y [X] N [ ] N/A [ ]	Compliance was only determined for complete daatsets
All data included in an Excel spreadsheet	Y [X] N [ ] N/A [ ]	To be provided separately
If deviations from standard; was justification of the deviations provided	Y [ ] N [ ] N/A [X]	