Asland Walks Renewables Project

Noise Assessment based on 1x 131m Hub height Wind Turbine and 1x Solar Farm

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Issued to
GA Petfood Partners

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Rev 0	Draft pending updates-Issued for comment	09/09/24

1. INTRODUCTION

GA Petfood Partners Ltd propose to develop a renewables project at Asland Walks, Bretherton, and have instructed Spectrum Acoustic Consultants Ltd to prepare this noise impact assessment in order to inform the planning application.

2. DESCRIPTION OF PROJECT

The project name is The Asland Walks Renewables Project, and it comprises the following:

- 1x 131m hub height wind turbine and
- 1x solar farm and associated inverters, converter and batteries.

The figures below show the location of the proposed wind turbine and solar farm, along with the nearest noise sensitive receptors (NSR), which are residential locations 1-4.

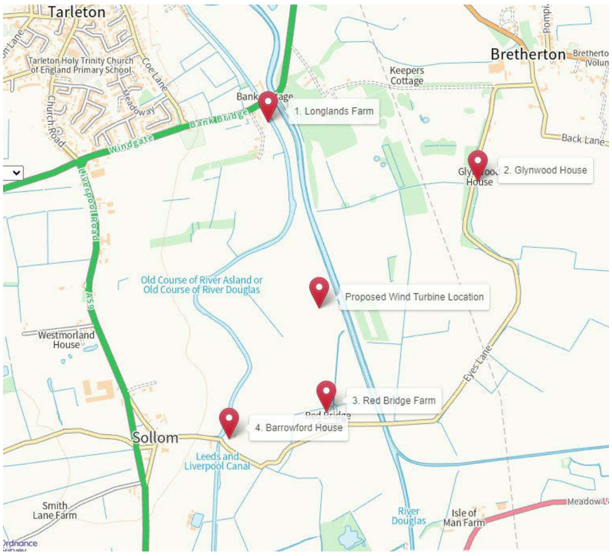

Figure 2.1: Site Location and noise sensitive receptors

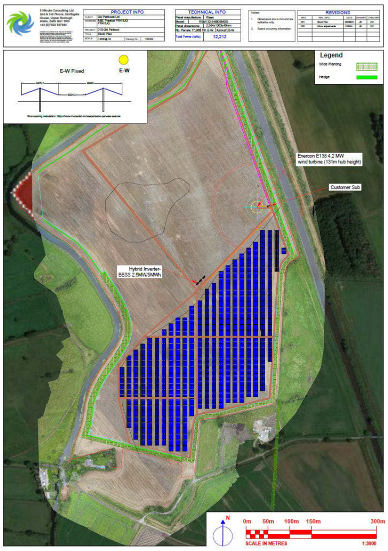

Figure 2.2: Wind Turbine and Solar Farm Locations

3. SCOPE OF ASSESSMENT

The scope of this assessment includes the following:

- construction and decommissioning noise for the wind turbine
- operational noise from the wind turbine
- construction and decommissioning noise for the solar farm
- operational noise from the solar farm

4. STANDARDS AND OTHER GUIDANCE

This section briefly outlines the standards and guidance referenced in this assessment.

4.1 IEMA GUIDELINES FOR ENVIRONMENTAL NOISE IMPACT ASSESSMENT, 2014

The Institute of Environmental Management and Assessment (IEMA) published Guidelines for Environmental Noise Impact Assessment, November 2014 (Ref. 1). It provides examples of good practice in relation to methodologies and procedures used in environmental noise impact assessments and provides a definition of noise impact and noise effect. It recognises that, as no two situations are the same, there is no precise relationship between noise impact and noise effect that can be universally applied. However, it does provide guidance in relation to the methods and procedures commonly used to determine the significance of a potential noise impact.

In the context of this assessment, the IEMA guidelines are used to inform the preparation of this document.

4.2 THE ASSESSMENT AND RATING OF NOISE FROM WIND TURBINES (ETSU-R-97)

This document (Ref. 2) describes a methodology for developing noise limits for wind farm developments, appropriate for use as the basis for noise related planning conditions.

The methodology involves assessing predicted noise levels from the wind farm against criteria curves derived from measured background noise levels at noise sensitive receptors over the range of wind turbine operating wind speeds.

UK government guidance states 'The report, ETSU-R-97: The assessment and rating of noise from wind farms should be used by local planning authorities when assessing and rating noise from wind energy developments.'

In the context of this assessment, ETSU-R-97 is used as the basis for the assessment of noise from the proposed wind turbine.

4.3 A GOOD PRACTICE GUIDE TO THE APPLICATION OF ETSU-R-97 FOR THE ASSESSMENT AND RATING OF WIND TURBINE NOISE (AND ASSOCIATED SUPPLEMENTARY GUIDES 1-5)

Good practice guidance (GPG) on noise assessments of wind farms has been prepared by the Institute of Acoustics (Ref. 3). The Department for Energy Security and Net Zero accept that it represents current industry good practice and endorses it as a supplement to ETSU-R-97. It is available on the Department of Energy and Climate Change website.

In the context of this assessment, the Good Practice Guide is used to support the assessment of noise from the proposed wind turbine.

4.4 BS 4142:2014+A1:2019 METHODS FOR RATING AND ASSESSING INDUSTRIAL AND COMMERCIAL SOUND

The principle of BS 4142 (Ref. 4) is to determine an initial estimate of impact of industrial/commercial sound on nearby residents by comparing the Rating Level (sound level from the industrial/commercial source, with a correction applied for any acoustic features that characterise the sound) with the Background Sound Level (L_{A90} as measured in absence of the industrial/commercial source).

Generally, the greater the difference by which the Rating Level exceeds the Background Sound Level, the greater the magnitude of impact. BS 4142 states that *'a difference of around +10 dB or more is likely to be an indication of a significant adverse impact […]. A difference of around +5 dB is likely to be an indication of an adverse impact […]. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.'*

However, BS 4142 also advises that '*when making assessments and arriving at decisions […] it is essential to place the sound in context'* so in each case, the context in which the sound is placed must be considered and the initial estimate of impact should be modified accordingly. For example, it advises '*Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night*.' It also indicates that impacts estimated during '*the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night-time period for sleep purposes.*'

In the context of this assessment, BS4142 is used for assessing noise from the proposed solar farm and associated equipment.

4.5 BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise and Part 2 Vibration

BS 5228-1 provides useful general advice together with a method for predicting noise from construction sites based on information provided on construction noise levels applicable to various plant and construction operations.

Annex E provides informative guidance on assessing the significance of noise effects due to construction activity for projects of significant size. The guidance applies to residential dwellings only.

Annex E3 shows examples of an assessment of the change in noise level due to construction activity to indicate a *potential significant effect*. It includes the ABC Method, which takes into account the existing noise level in setting a threshold. Where a potential significant effect is indicated, further consideration of other factors (number of affected receptors, duration, acoustic character, etc.) should be taken into account to establish whether or not there is a significant effect.

BS 5228-2 provides guidance on the measurement and assessment of vibration effects. Annex B sets out a range of vibration levels, in terms of the measured peak particle velocity, which provide an indication of potential effects. It advises that where these values are likely to be routinely exceeded then a further assessment in accordance with BS 6472 or other guidance might be appropriate.

In the context of this assessment, BS5228-1 is used to assess the noise from construction and decommissioning activities associated with the wind turbine and solar farm. Vibration is not expected to be a significant aspect of construction, operation or commissioning of the development.

4.6 ISO 9613-1:1993 ACOUSTICS – ATTENUATION OF SOUND DURING PROPAGATION OUTDOORS – PART 1: CALCULATION OF THE ABSORPTION OF SOUND BY THE ATMOSPHERE AND PART 2 GENERAL METHOD OF CALCULATION

ISO 9613 (parts 1 and 2) specify an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources.

The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission.

ISO 9613 is endorsed by Ref. 3 (for use in predicting noise from wind turbines) and Ref. 4 (for use in predicting noise from fixed installations (in this case a solar farm).

In the context of this assessment, the DGMR Software 'iNoise' noise modelling software is utilised for the prediction of environmental noise from the wind turbine and solar farm as it conforms with ISO 9613.

5. BASELINE NOISE SURVEY

5.1 SURVEY PERIOD

With regard to the assessment of wind turbine noise, ETSU-R-97 (Ref. 2) states the following on Page 85:

> It is expected that to avoid the results being weighted by unrepresentative conditions at least 1 week's worth of measurements will be required. The actual duration will depend upon the weather conditions, in particular the strength and direction of the wind that has blown during the survey period and the amount of rain.

With regard to the assessment of solar farm noise, BS 4142:2014+A1:2019 (Ref. 4) states the following in section 8.1.4:

> The monitoring duration should reflect the range of background sound levels for the period being assessed. In practice, there is no "single" background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment should be representative of the period being assessed.

In view of the above, the baseline noise survey was undertaken from 05/03/24 to 03/04/24 (approximately four weeks), in order to capture data over a wide variety of weather conditions and to satisfy the requirements of both of the above relevant standards and guidelines.

5.2 MEASUREMENT LOCATIONS

Measurements were taken at 4 residential locations representative of the nearest noise sensitive receptors around the proposed development site.

The co-ordinates of the measurement locations are shown below along with those of the proposed wind turbine and noise sources associated with the proposed solar farm (Note: the solar panels themselves do not generate noise).

Noise Sensitive Receptor	Baseline noise survey measurement positions		Comment
	X (Easting)	Y (Northing)	
1. Longlands Farm	346012	420159	See Figure 5.2.2
2. Glynwood House	346935	419899	See Figure 5.2.3
3. Red Bridge Farm	346267	418888	See Figure 5.2.4
4. Barrowford House	345843	418767	See Figure 5.2.5
5. LIDAR and Weather Station	346073	419539	See Figure 5.2.6

Table 5.2.1: Measurement Locations

Noise sources associated with proposed development (abbreviation in Figure 5.2.1)	Noise Source Location		Comment
	X (Easting)	Y (Northing)	
Proposed Wind Turbine (WT)	346236	419341	
Proposed Solar Farm Inverters (I)	346142	419158	Adjacent to Solar Farm Batteries (B) in Figure 5.2.1 below
Proposed Solar Farm Converters (C)	346135	419322	
Proposed Solar Farm Batteries (B)	346133	419164	

Table 5.2.2: Proposed development noise source locations

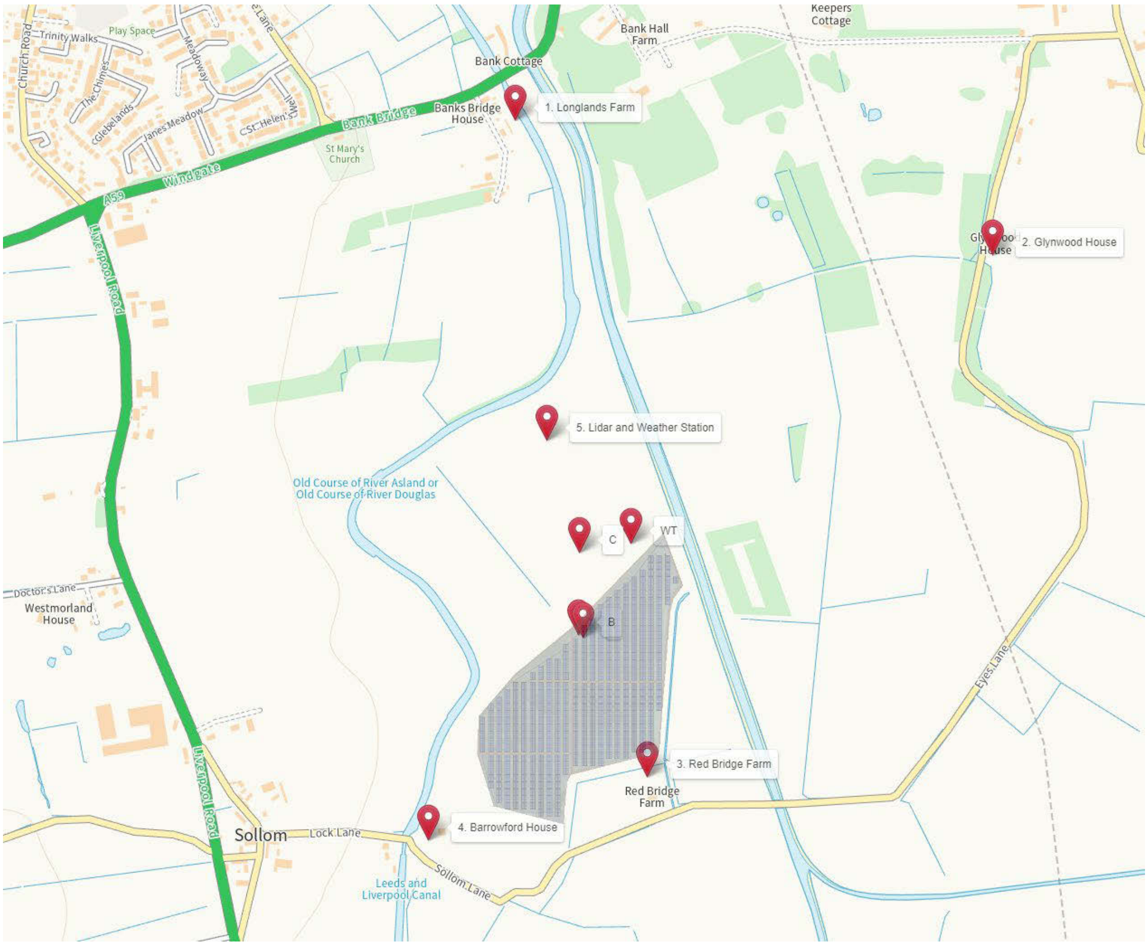

Figure 5.2.1: Noise measurement locations relative to proposed wind turbine location

Figure 5.2.2: Location 1 Longlands Farm

Figure 5.2.3: Location 2 Glynwood House

Figure 5.2.4: Location 3 Red Bridge Farm

Figure 5.2.5: Location 4 Barrowford House

Figure 5.2.6: Lidar and Weather Station

5.3 INSTRUMENTATION

Instrumentation used during the survey was as follows:

- Bruel & Kjaer Type 2238 Sound Level Meter s/n 2562704
- Bruel & Kjaer Type 4188 Microphone s/n 2658552
- Bruel & Kjaer Type 4231 Acoustic Calibrator s/n 2586661
- High performance windshield

- Bruel & Kjaer Type 2250 Sound Level Meter s/n 3010857
- Bruel & Kjaer Type 4189 Microphone s/n 3060877
- Bruel & Kjaer Type 4231 Acoustic Calibrator s/n 2291483
- High performance windshield

- Bruel & Kjaer Type 2250 Sound Level Meter s/n 3023840
- Bruel & Kjaer Type 4189 Microphone s/n 3130623
- Bruel & Kjaer Type 4231 Acoustic Calibrator s/n 3030524
- High performance windshield

- Bruel & Kjaer Type 2250 Sound Level Meter s/n 3024396
- Bruel & Kjaer Type 4189 Microphone s/n 3349664
- Bruel & Kjaer Type 4231 Acoustic Calibrator s/n 3021281
- High performance windshield

- Davis Vantage Pro 2 Weather Station for ground level wind speed and rainfall data

- ZX LIDARS type ZX300 for wind speed and direction measurement equipment for Wind Turbine Hub Height measurements (provided by GA Petfood Partners)

5.4 MEASUREMENT PROCEDURE

At each measurement position, noise levels of 10-minute duration were recorded continuously over the survey period.

Noise levels were recorded in terms of $L_{A90,10min}$, which represents the noise level exceeded for 90% of the sample time over each 10 minute period, in line with the requirements of ETSU-R-97 (Ref. 2). $L_{A90,T}$ is defined in BS4142 (Ref. 3), as the measure of background noise when it is applied to the residual noise level (the noise in the absence of the specific noise being assessed).

Before, during and after the survey, the sound level meters were field-calibrated in accordance with the manufacturer's guidelines, and no significant drift was observed. The field calibrators are laboratory calibrated annually and the meters and microphones are laboratory calibrated at 2 yearly intervals, all in accordance with UKAS procedures by a UKAS-accredited laboratory.

Throughout the survey, wind speed was measured at hub height using a LIDAR installation, whilst rainfall and wind speed at 1.5m above ground level were measured by the weather station (see Figures 5.2.1 and 5.2.6 above).

The background noise data is used in the noise impact assessments for both the wind turbine and the solar farm, although it is processed differently for each assessment. Due to the large amount of raw data, only the processed data is included in this report, however the raw data is available separately upon request as a stand-alone document.

6. WIND TURBINE CONSTRUCTION AND DECOMMISSIONING NOISE

6.1 ASSESSMENT

Construction noise has been calculated in Table 6.1 below at the nearest residence for each significant construction activity using BS 5228-1:2009 (Ref. 5). These predictions are for ***estimated*** equipment and duration, based on typical construction activities for a similar site, so details may change. Decommissioning noise is expected to use similar equipment, although detailed information is not available at this stage.

Construction Activity and Working Hours	BS5228 eqpt. Ref.	BS5228 Activity LAeq (10m)	Nearest residence and distance	Distance attenuation (from BS5228 Fig. F2)	LAeq at nearest residence (dB)
Track reinforcing and building (07.00-17.00 for 2 weeks (est.) Mon-Fri) 24t Bulldozer 23t Articulated Dump Truck 35t Tracked Excavator 39t Road Lorry 22t Road Roller **Total**	C5 ref 15 C5 ref 17 C5 ref 18 C5 ref 21 C5 ref 19	83 81 80 80 80	Red Bridge Farm (approx. 450m from centre of site)	-39	44 42 41 41 41 **49**
Construction of Turbine Foundations (07.00-17.00 for 5 days for 3 weeks (est.) Mon-Fri 35t Tracked Excavator 23t Articulated Dump Truck 35t Large Concrete Lorry Concrete Pump and Cement- Mixer Truck (discharging) **Total**	C5 ref 18 C5 ref 17 C4 ref 21 C4 ref 24	80 81 77 67	Red Bridge Farm (approx. 450m from centre of site)	-39	41 42 38 28 **46**
Digging of Cable Trench (07.00-17.00 for 3 days (est.) Mon-Fri 21t Tracked Excavator **Total**	C4 ref 65	71	Red Bridge Farm (approx. 450m from centre of site)	-39	32 **32**
Turbine Delivery and Erection (07.00-19.00 for 2 weeks (est.) Mon-Fri Diesel Generator 39t road lorry 100t Mobile Crane **Total**	C4 ref 86 C6 ref 21 C4 ref 41	65 80 71	Red Bridge Farm (approx. 450m from centre of site)	-39	26 41 32 **42**
Decommissioning (07.00-19.00 for 6 days over 2 weeks (est.) Mon-Fri 39t Road Lorry 100t Mobile Crane 35t Tracked Excavator **Total**	C6 ref 21 C4 ref 41 C5 ref 18	80 71 80	Red Bridge Farm (approx. 450m from centre of site)	-38	42 33 42 **45**
BS5228 Minimum Threshold of Significance (from BS5228-1 Table E.1 Daytime 07.00-19.00)					**65**

Table 6.1: Calculation and Assessment of Construction and Decommissioning Noise

6.2 CONCLUSIONS

Table 6.1 above demonstrates that calculated noise levels generated at the nearest residences during the construction and decommissioning of the proposed development are below the threshold of significance when assessed using guidance from BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* (Ref. 5).

In practice, some of the construction activities will be temporarily closer to noise sensitive receptors (e.g. for access road construction), however the work will be limited in duration and within normal working hours. At this stage, however, the route of the access road has not been finalised.

7. WIND TURBINE OPERATING NOISE

7.1 ASSESSMENT METHODOLOGY-ETSU-R-97

The main actions to be undertaken in order to complete a wind farm noise assessment in accordance with ETSU-R-97 (Ref. 2) may be summarised as follows:-

I. Predict environmental noise levels generated by the proposed wind turbine development at the nearest noise sensitive locations over the range of operational wind speeds.

II. If predicted levels are below 35 dB(A) $L_{A90,10min}$ then this condition alone would be expected to offer sufficient amenity, and background noise surveys would generally be unnecessary.

III. If predicted levels exceed 35 dB(A) $L_{A90,10min}$ then environmental noise surveys should be undertaken to determine existing background noise levels at the nearest noise sensitive locations over the range of operational wind speeds.

IV. Night-time $L_{A90,10min}$ noise limits for the wind turbine development should be derived from the night-time background $L_{A90,10min}$ +5dB, with a lower limit of 43 dB, over the range of operational wind speeds.

V. In low noise environments, daytime $L_{A90,10min}$ noise limits for the wind turbine development should be derived from the quiet daytime period background $L_{A90,10min}$ + 5 dB, with a lower limit of 35-40 dB (depending upon the number of dwellings, effect on power generation and duration of exposure), over the range of operational wind speeds. The lower limit of 35 dB(A) has been assumed for this assessment.

VI. Both day- and night-time lower limits can be increased to 45 dB(A), and consideration can be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.

VII. The Quiet Daytime Period is defined in ETSU-R-97 (Ref. 2) as 1600-2300 hrs Mon-Fri, 1300-2300 hrs Sat and 0700-2300 hrs Sun. The Night-time Period is defined as 2300-0700 hrs.

7.2 PROPOSED WIND TURBINE MANUFACTURER NOISE DATA

The turbine manufacturer has provided technical Data Sheets for the proposed unit which include overall dB(A) sound power levels (Ref. 7 - see also Appendix A) as well as 1/3 octave band frequency spectra (Ref. 8 - see also Appendix B). Spectrum have been advised that the data for operating Mode 0 should be used.

7.3 ENVIRONMENTAL NOISE MODEL

Spectrum Acoustic Consultants Ltd use the DGMR Software 'iNoise' noise model, which complies with the methodology detailed in ISO 9613 (Ref. 6) and is therefore endorsed by The Department for Energy and Climate Control, via Institute of Acoustics guidance (Ref. 3).

The sound power level data used in the model was based on the overall dB(A) sound power levels provided by the manufacturer (Ref. 7 and Appendix A of this document), and represents the wind turbine sound power levels for integer wind speeds at a height of 10m.

Ref. 3 states the following regarding uncertainties, and the manufacturer has confirmed that the expected sound power levels given in the data sheet (see Appendices A and B of this document) ***include*** uncertainties, as follows:

> Due to uncertainties in sound measurements (σ_R) and series product variations (σ_P), the sound power level values indicated in this document allow for an uncertainty of σ_R = 0.5 dB(A) and σ_P = 1.2 dB(A). The 90 % confidence interval applies:

$$L_{e,\max} = L_W + 1{,}28 \cdot \sqrt{\sigma_R^2 + \sigma_P^2}$$

In order to normalise the wind speeds from hub height to 10m height, a logarithmic shear profile with a roughness length of 0.05m was assumed, in line with Ref. 3 (section 2.6.2).

Octave band sound power levels used in the noise model are derived from the 1/3 octave band data provided by the manufacturer (Ref. 8 and Appendix B of this document), converted to octave bands using standard logarithmic addition.

The resulting overall dB(A) and 'A' weighted octave band frequency sound power level spectra used in the noise model are given below.

Wind Speed normalised to 10m Height (m/s)	dB(A)	Octave Band Centre Frequency (Hz) and Octave Band Sound Power Levels ('A' weighted)								
		31	63	125	250	500	1k	2k	4k	8k
3	96	62	73	81	88	89	92	89	78	58
4	99	68	77	85	90	93	95	92	82	63
5	103	74	83	90	94	97	99	96	87	69
6	106	77	86	92	96	100	102	98	90	73
7	106	78	87	93	96	100	102	98	90	73
8	106	79	88	93	96	99	102	99	90	73
9	106	79	88	93	96	99	102	99	91	73
10	106	80	89	94	96	99	102	99	91	72

Table 7.3: Assumed wind turbine 'A' weighted octave band sound power level frequency spectra for integer wind speeds at 10m height, as used in noise model

The parameter settings assumed for the purposes of the noise prediction were as recommended by the 2013 Institute of Acoustics Document 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (Ref 3.), which has now been endorsed by the Department of Energy and Climate Change (DECC), as follows:-

- manufacturer sound power level data normalised to 10m height used
- Temperature= 10 Deg. C
- Humidity = 70%
- Ground factor = 0.5
- Source Height (hub height) = 131m
- Receiver height = 4.0m

7.4 PREDICTED ENVIRONMENTAL NOISE LEVELS GENERATED BY THE WIND TURBINE

Predicted environmental noise levels generated by the turbines are given graphically as noise contours and numerically in tabular form for specific identified sensitive receptors in Appendix C. The predicted levels are given in terms of $L_{A90,T}$ in line with para 14 of the ETSU-R-97 (Ref. 2) Executive Summary, which reads:-

> 14. The Noise Working Group is agreed that the $L_{A90,10min}$ descriptor should be used for both the background noise and the wind farm noise, and that when setting limits it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5-2.5dB(A) less than the L_{Aeq} measured over the same period. The use of the $L_{A90,10min}$ descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

Numerical values of the predicted $L_{A90,T}$ generated by the wind turbine are summarised below for the nearest noise sensitive receptors.

Location	Wind Speed at 10m Height (m/s)							
	3	4	5	6	7	8	9	10
1. Longlands Farm	25	28	32	35	35	35	35	35
2. Glynwood House	22	25	29	32	32	32	32	32
3. Red Bridge Farm	29	32	36	39	39	39	39	39
4. Barrowford House	25	29	33	36	36	35	35	36

Table 7.4: Predicted wind turbine environmental noise levels at nearest sensitive receptors (dB $L_{A90,T}$)

Since some of the predicted noise levels in Table 7.4 above exceed 35 dB(A), a full assessment has been undertaken in line with Ref. 2 (Executive Summary).

7.5 DERIVED WIND TURBINE NOISE CRITERIA

Appendix D includes regression analyses of wind speed against background noise level with best fit polynomial curves shown in black. For each location, there is one graph for the 'quiet daytime period' and one graph for the 'night-time period'.

Wind speeds are normalised to 10m height.

Derived wind turbine noise limits are superimposed on each graph. These are the noise criteria proposed by ETSU-R-97 (Ref. 2) for use in planning conditions as noise limits for the wind turbine, and are reproduced numerically in tables 7.6.1-7.6.4 below.

7.6 ASSESSMENT OF PREDICTED OPERATIONAL NOISE LEVELS

The derived noise limits for each assessment location are given numerically below, and compared with the predicted noise levels at each location (from Table 7.4).

Time Period	Derived noise criteria based on noise levels at measurement Location 1: Longlands Farm (dB $LA_{90,10\ min}$)									
	Wind Speed at 10m height (m/s)									
	3	4	5	6	7	8	9	10	11	12
Derived Quiet Daytime Noise Criteria	44	44	44	45	46	42	49	51	53	56
Derived Night-time Noise Criteria	43	43	43	43	43	43	45	48	49	50
Predicted wind turbine noise level	25	28	32	35	35	35	35	35	n/a	n/a
Minimum safety margin	18	15	11	8	8	8	10	13	n/a	n/a

Table 7.6.1: Derived wind turbine noise limits at Location 1: Longlands Farm

Time Period	Derived noise criteria based on noise levels at measurement Location 2: Glynwood House (dB $LA_{90,10\ min}$)									
	Wind Speed at 10m height (m/s)									
	3	4	5	6	7	8	9	10	11	12
Derived Quiet Daytime Noise Criteria	38	39	41	42	44	46	47	48	48	48
Derived Night-time Noise Criteria	43	43	43	43	43	43	44	46	46	46
Predicted wind turbine noise level	22	25	29	32	32	32	32	32	n/a	n/a
Minimum safety margin	16	14	12	10	11	11	12	14	n/a	n/a

Table 7.6.2: Derived wind turbine noise limits at Location 2: Glynwood House

Time Period	Derived noise criteria based on noise levels at measurement Location 3: Red Bridge Farm (dB $LA_{90,10\ min}$)									
	Wind Speed at 10m height (m/s)									
	3	4	5	6	7	8	9	10	11	12
Derived Quiet Daytime Noise Criteria	40	40	41	42	43	44	46	49	51	55
Derived Night-time Noise Criteria	43	43	43	43	43	43	44	47	49	50
Predicted wind turbine noise level	29	32	36	39	39	39	39	39	n/a	n/a
Minimum safety margin	11	8	5	3	4	4	5	8	n/a	n/a

Table 7.6.3: Derived wind turbine noise limits at Location 3: Red Bridge Farm

Time Period	Derived noise criteria based on noise levels at measurement Location 4: Barrowford (dB $LA_{90,10\ min}$)									
	Wind Speed at 10m height (m/s)									
	3	4	5	6	7	8	9	10	11	12
Derived Quiet Daytime Noise Criteria	41	42	43	44	46	47	50	52	54	55
Derived Night-time Noise Criteria	43	43	43	43	43	44	48	50	51	51
Predicted wind turbine noise level	25	29	33	36	36	35	35	36	n/a	n/a
Minimum safety margin	16	13	10	7	7	9	13	14	n/a	n/a

Table 7.6.4: Derived wind turbine noise limits at Location 4: Barrowford

7.7 CONCLUSIONS

The tables above show that the predicted wind turbine noise levels are significantly below the derived noise criteria at each location for all wind speeds, resulting in significant safety margins at all locations.

It should also be noted that alternative operating modes for the wind turbine have lower noise levels than those of Mode 0.

8. SOLAR FARM CONSTRUCTION AND DECOMMISSIONING NOISE

Construction and decommissioning noise have been calculated in Table 8.1 below at the nearest residence for each significant construction activity using BS 5228-1: (Ref. 5). These predictions are for estimated equipment and duration based on typical construction activities for a similar site, so details may change. Decommissioning noise is expected to use similar equipment, although detailed information is not available at this stage.

Construction Activity and Working Hours	BS5228 eqpt. Ref.	BS5228 Activity LAeq (10m)	Nearest residence and distance	Distance attenuation (from BS5228 Fig. F2)	LAeq at nearest residence (dB)
Track reinforcing and building (07.00-17.00 for 2 weeks Mon-Fri)			Red Bridge Farm (approx. 450m from centre of site)	-39	
24t Bulldozer	C5 ref 15	83			44
23t Articulated Dump Truck	C5 ref 17	81			42
35t Tracked Excavator	C5 ref 18	80			41
39t Road Lorry	C5 ref 21	80			41
22t Road Roller	C5 ref 19	80			41
Total					**49**
Construction of foundations for Transformer, inverter, converter and battery (07.00-17.00 for 5 days over 3 week period Mon-Fri)	C5 ref 18	80	Red Bridge Farm (approx. 450m from centre of site)	-39	41
35t Tracked Excavator	C5 ref 17	81			42
23t Articulated Dump Truck	C4 ref 21	77			38
35t Large Concrete Lorry	C4 ref 24	67			28
Concrete Pump and Cement-Mixer Truck (discharging)					**46**
Total					
Digging of Cable Trench (07.00-17.00 for 3 days Mon-Fri)			Red Bridge Farm (approx. 450m from centre of site)	-39	
21t Tracked Excavator	C4 ref 65	71			32
Total					**32**
Installing solar panels (07.00-17.00 for 5 days over 3 week period Mon-Fri)			Red Bridge Farm (approx. 450m from centre of site)	-39	
Mini-piling rig to install screwed piles for solar ground mounts	C3 ref 18	75			36
Total					**36**
BS5228 Minimum Threshold of Significance (from BS5228-1 Table E.1 Daytime 07.00-19.00)					**65**

Table 8.1: Predicted solar farm construction noise levels

Table 8.1 above demonstrates that calculated noise levels generated at the nearest residences during the construction and decommissioning of the proposed development are below the threshold of significance when assessed using guidance from BS 5228-1 (Ref. 5).

In practice, some of the construction activities will be temporarily closer to noise sensitive receptors (e.g. for access road construction), however the work will be limited in duration and within normal working hours. At this stage, however, the route of the access road has not been finalised.

9. SOLAR FARM OPERATING NOISE

9.1 ASSESSMENT METHODOLOGY-BS4142

The main actions to be undertaken in order to complete a solar farm noise assessment in accordance with BS4142 (Ref. 4) may be summarised as follows:

I. Establish background noise levels at nearest noise sensitive locations for wind speeds below 5m/s at microphone height

II. Predict the Specific Sound Level generated by the solar farm at the assessment locations, defined as follows in Ref. 4:

> **specific sound level, $L_s = L_{\mathrm{Aeq},Tr}$**
>
> equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r

III. Calculate the Rating Level of the solar farm noise at the assessment locations, defined as follows in Ref. 4:

> **rating level, $L_{\mathrm{Ar},Tr}$**
>
> specific sound level plus any adjustment for the characteristic features of the sound

IV. Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, with regard to the following guidelines:

> a) Typically, the greater this difference, the greater the magnitude of the impact.
>
> b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
>
> c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
>
> d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

V. Where the initial estimate of the impact needs to be modified due to context, take all pertinent factors into consideration.

9.2 PROPOSED SOLAR FARM EQUIPMENT NOISE DATA

The proposed solar farm comprises several components and these are identified in the figure below.

Note: This arrangement is not final.

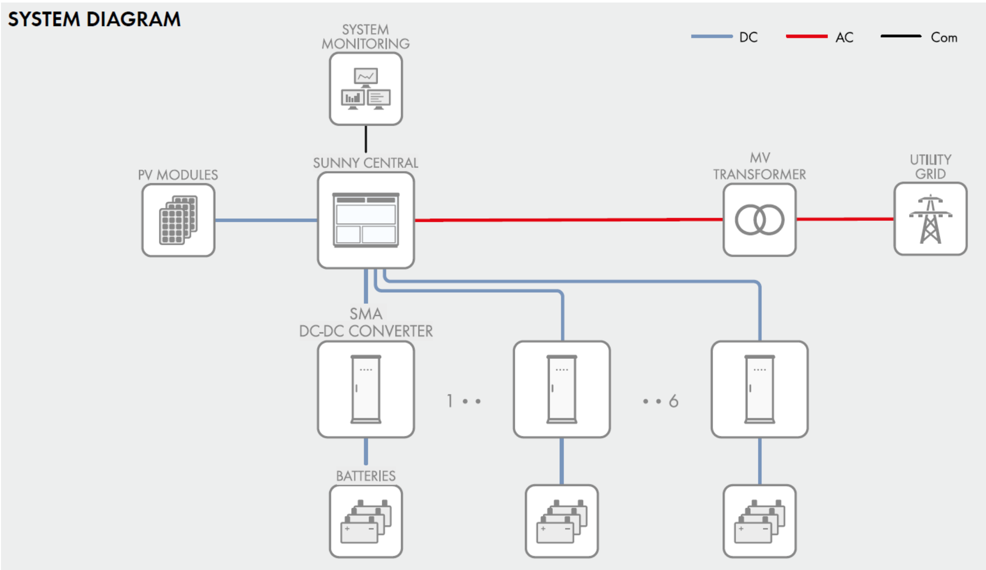

Figure 9.2: System diagram of solar farm components

Noise data attributed to each item for the purposes of this assessment is included in Appendix E and described below.

Component	Manufacturer noise data	Spectrum Comment	Number of units
PV Modules (solar panels)	n/a	No noise generated	17,960
Sunny Central (incorporating inverters and transformer)	93 dB L_{WA}	3-stack inverters without noise reduction kit	1
DC-DC converters	<65 dB(A) at 10m	Estimate 93 dB LwA (each) 99 dB LwA (total for 4)	4
Batteries	<70 dB at 1m (each)	Assumed to be dB(A) Estimate 82 dB LwA (each) 95 dB LwA (total)	18 (est.)

Table 9.2: Summary of noise sources associated with the solar farm

9.3 ENVIRONMENTAL NOISE MODEL

Spectrum Acoustic Consultants Ltd use the DGMR Software ‘iNoise’ noise model, which complies with the methodology detailed in ISO 9613 (Ref. 6) and is therefore endorsed by BS4142.

The sound power level data used in the model was based on the dB(A) sound power levels given in Table 9.3.

Corrections have been made for the number of units *n* (+10log*n*) where applicable, and a frequency spectrum has been estimated for each source.

The resulting sound power levels for each noise source used in the solar farm model are as follows.

Noise Source		Octave Band Centre Frequency (Hz) dB Lin								
	dB(A)	31	63	125	250	500	1k	2k	4k	8k
Sunny Central (inverters and transformer)	93	101	101	101	96	91	86	83	79	76
DC-DC Converters (total for 4)	101	92	92	97	97	94	94	92	89	87
Batteries (total for 18)	95	103	103	103	98	93	88	85	81	78

Table 9.3: Octave band sound power levels used in solar farm noise model

The parameter settings assumed for the purposes of the noise prediction were as follows:-

- Temperature= 10 Deg. C
- Humidity = 70%
- Ground factor = 0.8
- Receiver height = 1.5m

9.4 PREDICTED ENVIRONMENTAL NOISE LEVELS GENERATED BY THE SOLAR FARM

Predicted environmental noise levels generated by the solar farm are given graphically as noise contours and numerically in tabular form for specific identified sensitive receptors in Appendix F, with the numerical results summarised below.

Location	Predicted Noise Level
1. Longlands Farm	27
2. Glynwood House	23
3. Red Bridge Farm	35
4. Barrowford House	32

Table 9.4: Predicted solar farm environmental noise levels at nearest sensitive receptors

9.5 BACKGROUND NOISE LEVELS

Background noise levels were measured continuously at 4 noise sensitive receptors as described in Section 5, over approximately 4 weeks.

The noise data was then filtered to only include data during periods with 10min mean measured wind speeds of 5 m/s at 131m height. This is approximately equivalent to 3m/s at 1.5m height (assuming logarithmic shear and a ground factor of 0.05), and therefore well within guidelines from BS4142 (Ref. 4) for the avoidance of wind generated noise on microphones (5m/s).

Measured background noise levels are summarised below.

Location	Daytime (07:00-23:00) Mean $L_{A90,10min}$ (dB)	Night-time (23:00-07:00) Mean $L_{A90,10min}$ (dB)
1. Longlands Farm	41	33
2. Glynwood House	36	30
3. Red Bridge Farm	39	30
4. Barrowford House	40	31

Table 9.5: Measured background noise levels

Note: Since the solar farm will only be operational during the daytime (sunlight hours), only daytime background noise levels are used in the assessments below (07:00-23:00 hrs).

It is understood, however, that batteries may potentially generate some noise at night, and if this is found to be the case then an assessment will be undertaken when details are available.

9.6 ASSESSMENT OF PREDICTED OPERATIONAL NOISE LEVELS

Assessments in line with BS4142 (Ref. 4) for each location are given below, using data from Table 9.4 and Table 9.5 above.

The assessments below refer to guidance from BS4142 on tonality, which reads as follows:

> ***Tonality***
>
> *For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.*

The Specific Sound Level is the sound level generated at the receiver by the industrial noise source without any character correction, and the Rating Level is the Specific Sound Level with any character correction added.

Regarding the impact of the sound, BS4142 advises:

'Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.'

The above guidance is taken into consideration in the assessments below for solar farm noise at each noise sensitive receptor.

Location 1: Longlands Farm		
Results		**Comment**
Background sound level (Daytime)	$L_{A90,T}$ =41	
Specific sound level	$L_{Aeq,T}$ =27	
Acoustic feature correction	2	Possible tonality from inverters. 2 dB tonal penalty added in line with BS4142 (Ref. 4) since specific level is below background level and therefore only likely to be just perceptible.
Rating level	27+2=29	
Excess of rating over background sound level	29-41= -12	
Assessment indicates low impact		Calculated rating level is 12dB below background sound level indicating low impact in accordance with BS4142 (Ref. 4).

Table 9.6.1: BS4142 assessment of solar farm noise at Location 1

Location 2: Glynwood House		
Results		**Comment**
Background sound level (Daytime)	$L_{A90,T}$ =36	
Specific sound level	$L_{Aeq,T}$ =23	
Acoustic feature correction	2	Possible tonality from inverters. 2 dB tonal penalty added in line with BS4142 (Ref. 4) since specific level is below background level and therefore only likely to be just perceptible.
Rating level	23+2=25	
Excess of rating over background sound level	25-36= -11	
Assessment indicates low impact		Calculated rating level is 10 dB below background sound level indicating low impact in accordance with BS4142 (Ref. 4).

Table 9.6.2: BS4142 assessment of solar farm noise at Location 2

Location 3: Red Bridge Farm		
Results		**Comment**
Background sound level (Daytime)	$L_{A90,T}$ =39	
Specific sound level	$L_{Aeq,T}$ =35	
Acoustic feature correction	2	Possible tonality from inverters. 2 dB tonal penalty added in line with BS4142 (Ref. 4) since specific level is below background level and therefore only likely to be just perceptible.
Rating level	35+2=37	
Excess of rating over background sound level	37-39= -2	Calculated rating level is 2 dB below background sound level indicating low impact in accordance with BS4142 (Ref. 4).
Assessment indicates low impact		

Table 9.6.3: BS4142 assessment of solar farm noise at Location 3

Location 4: Barrowford House		
Results		**Comment**
Background sound level (Daytime)	$L_{A90,T}$ =40	
Specific sound level	$L_{Aeq,T}$ =32	
Acoustic feature correction	2	Possible tonality from inverters. 2 dB tonal penalty added in line with BS4142 (Ref. 4) since specific level is below background level and therefore only likely to be just perceptible.
Rating level	32+2=34	
Excess of rating over background sound level	34-40= -6	Calculated rating level is 6 dB below background sound level indicating low impact in accordance with BS4142 (Ref. 4).
Assessment indicates low impact		

Table 9.6.4: BS4142 assessment of solar farm noise at Location 4

The above assessments indicate that noise from the solar farm will be of low impact at the nearest noise sensitive receptors.

10. CONCLUSIONS

This noise impact assessment has considered noise generated by a proposed wind turbine and solar farm at Asland Walks, Bretherton.

Both operational noise and construction noise have been considered and assessed in line with current UK standards and guidelines at the nearest noise sensitive receptors.

In all cases, predicted noise levels have been found to be within the relevant criteria for low impact.

Note: Some aspects of the solar farm design are still to be finalised and it is intended that this assessment should be updated as appropriate if there is any significant change to predicted noise levels. It is not expected, however, that the changes would result in the development generating unacceptable noise levels.

11. REFERENCES

Documents referenced in this proposal are detailed below.

Ref. No.	Document title	Rev	Date
1	Guidelines for Environmental Noise Impact Assessment, IEMA, 2014	2nd Edition	2014
2	The Assessment and Rating of Noise from Wind Turbines (ETSU-R-97)	Final Report	September 1996
3	A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (and associated supplementary guides 1-5)		May 2013
4	BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound*		2019
5	BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*		2014
6	ISO 9613: *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: Attenuation of sound during propagation outdoors – Part 2: General method of calculation*		1993/1996
7	Technical Data Sheet: Operating Mode 0 s *Enercon E-138 EP3/ 4260 kW wind energy converter with TES*		03/02/23
8	Technical Data Sheet; One-third octave band level operating mode 0 s *Enercon E-138 EP3/ 4260 kW wind energy converter with TES*		03/02/23

12. GLOSSARY OF ACOUSTIC TERMS

$L_{\mathrm{Aeq},T}$	Equivalent continuous A-weighted sound pressure level over the period T
L_{pA}	A-weighted sound pressure level
L_{wA}	A-weighted sound power level
$L_{A90,T}$	A-weighted sound pressure level exceeded for 90% of the time. Used as a representative value for the background sound level in BS4142 (Ref. 4).

APPENDIX A

Wind turbine noise data for Operating Mode 0 – overall dB(A)

Technical data sheet

Operating mode 0 s

ENERCON E-138 EP3 E3 / 4260 kW wind engergy converter with TES (Trailing Edge Serrations)

Publisher

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Local court: Aurich ▪ Company registration number: HRB 411
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2023-02-03	en	DA	WRD Wobben Research and Development GmbH / Documentation Department

Applicable documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in brackets where applicable. The titles of superordinate standards and guidelines are indicated in the original language or as an English translation. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies. This list contains documents concerning optional components if necessary.

Higher-level standards and guidelines

Document ID	Document
IEC 61400-11:2012	Wind turbines – Part 11: Acoustic noise measurement techniques
IEC 61400-12-1:2017	Wind energy generation systems – Part 12-1: Power performance measurements of electricity producing wind turbines

Associated documents

Document ID	Document
various	Garantie des Leistungsverhaltens für ENERCON Windenergieanlagen (Power Performance Warranty for ENERCON Wind Energy Converters)

Table of contents

List of abbreviations

Abbreviations

HH	Hub height
HST	Hybrid steel tower
HT	Hybrid tower
ST	Steel tower

Variables, units, formulas

L_{WA}	Sound power level
v_H	Wind speed at hub height
v_s	Standardised wind speed
σ_P	Serial product variation
σ_R	Uncertainty in measurement

1 Available operating mode

The table below shows which operating mode is available for what tower versions or hub heights.

Tab. 1: Available operating mode

Operating mode	Tower version and hub height (HH)				
	E-138 EP3 E3-ST-81-FB-C-01	E-138 EP3 E3-ST-99-FB-C-01	E-138 EP3 E3-HST-111-FB-C-01	E-138 EP3 E3-HST-131-FB-C-01	E-138 EP3 E3-HT-160-ES-C-01
	HH 81 m	HH 99 m	HH 111 m	HH 131 m	HH 160 m
0 s	x	x	x	x	x

x = Available

- = Not available

2 General information

In addition to the technical properties of the wind energy converter listed in this document, it is imperative to note the supplement to this document. An overview of the supplements is available to Sales (D0950052 ‘Übersicht Beiblätter zu den Schall- und Leistungsdatenblättern’ (Overview of supplements to the sound and performance data sheets)).

2.1 Power Performance

The power values, power coefficients (c_p values) and thrust coefficients (c_t values) given in this document are predicted values. Based on the current development status of this wind energy converter type, ENERCON considers it sufficiently likely that these values will be reached. The power performance of the wind energy converter is only guaranteed under the conditions described in the document ‘Power Performance Warranty for ENERCON Wind Energy Converters’.

2.2 Information on sound power levels

Allocation of the sound power levels (L_{WA}) to the standardised wind speed (v_s) at a height of 10 m is valid only if based on a logarithmic wind shear law with a roughness length of 0.05 m. Allocation of the sound power levels to the wind speed at hub height (v_H) is valid for all hub heights (HH). During measurements, the wind speed is determined based on the power output and the power curve.

Due to uncertainties in sound measurements (σ_R) and series product variations (σ_P), the sound power level values indicated in this document allow for an uncertainty of σ_R = 0.5 dB(A) and σ_P = 1.2 dB(A). The 90 % confidence interval applies:

$$L_{e,\max} = L_W + 1{,}28 \cdot \sqrt{\sigma_R^2 + \sigma_P^2}$$

If, during measurement, the difference between total noise and extraneous noise is less than 6 dB(A), a greater uncertainty should be assumed. The guideline is IEC 61400-11:2012.

The sound power levels are calculated for the conditions stated in tab. 2, p. 8. A prevailing turbulence intensity distribution of 6 % to 12 % is assumed.

This data sheet does not constitute a warranty of compliance with project-specific or site-specific sound power levels.

2.3 Operating parameters

The settings of the wind energy converter’s reactive power generation and wind farm open-loop and closed-loop control systems influence the power performance. The calculated power curves, c_p and c_t curves listed in this document apply only to operation without limitations.

2.4 Site properties

The power, c_p and c_t curves and sound power levels listed in this document have been calculated for the conditions described in tab. 2, p. 8 with undamaged leading edges and clean rotor blades. The calculations are based on experience with wind energy converters in a wide variety of locations.

Tab. 2: Site conditions

Parameter	Value (10-minute mean)
Standard air density	1.225 kg/m³
Relative air humidity	70 %
Temperature	15 °C
Turbulence intensity	According to ch. 2.5, p. 9
Wind shear exponent	0.0 to 0.3
Maximum difference of wind direction between upper and lower blade tip	10°
Maximum flow inclination	±2°
Terrain	According to IEC 61400-12-1:2017
Snow/ice	No
Rain	No

Otherwise, the framework conditions according to IEC 61400-12-1:2017 apply.

2.5 Turbulence intensity

The table below defines the range of validity for the power curves, c_p and c_t curves with regard to the turbulence intensities that may prevail on site. See tab. 2, p. 8 for further restrictions.

Tab. 3: Turbulence intensity

Wind speed in m/s	Lower limit of turbulence intensity in %	Upper limit of turbulence intensity in %
0.00	20.00	40.00
0.50	20.00	40.00
1.00	20.00	40.00
1.50	20.00	40.00
2.00	20.00	40.00
2.50	20.00	40.00
3.00	18.32	34.02
3.50	16.45	30.55
4.00	15.05	27.95
4.50	13.96	25.93
5.00	13.09	24.31
5.50	12.38	22.99
6.00	11.78	21.88
6.50	11.28	20.95
7.00	10.85	20.15
7.50	10.48	19.46
8.00	10.15	18.85
8.50	9.86	18.31
9.00	9.61	17.84
9.50	9.38	17.41
10.00	9.17	17.03
10.50	8.98	16.68
11.00	8.81	16.37
11.50	8.66	16.08
12.00	8.52	15.82
12.50	8.39	15.57
13.00	8.27	15.35
13.50	8.15	15.14
14.00	8.05	14.95
14.50	7.95	14.77
15.00	7.86	14.60

Wind speed in m/s	Lower limit of turbulence intensity in %	Upper limit of turbulence intensity in %
15.50	7.78	14.45
16.00	7.70	14.30
16.50	7.63	14.16
17.00	7.56	14.03
17.50	7.49	13.91
18.00	7.43	13.79
18.50	7.37	13.69
19.00	7.31	13.58
19.50	7.26	13.48
20.00	7.21	13.39
20.50	7.16	13.30
21.00	7.12	13.22
21.50	7.07	13.14
22.00	7.03	13.06
22.50	6.99	12.99
23.00	6.95	12.92
23.50	6.92	12.85
24.00	6.88	12.78
24.50	6.85	12.72
25.00	6.82	12.66
25.50	6.79	12.60
26.00	6.76	12.55
26.50	6.73	12.50
27.00	6.70	12.45
27.50	6.68	12.40
28.00	6.65	12.35

3 Operating mode 0 s

3.1 Calculated power, cp and ct values – operating mode 0 s

Tab. 4: Calculated power, c_p and c_t values for E-138 EP3 E3 / 4260 kW – operating mode 0 s

Wind speed v in m/s	Power P in kW	c_p value	c_t value
0.00	0	0.00	0.00
0.50	0	0.00	0.00
1.00	0	0.00	0.00
1.50	0	0.00	0.00
2.00	2	0.03	0.77
2.50	19	0.13	1.05
3.00	69	0.28	1.04
3.50	146	0.37	0.97
4.00	250	0.43	0.94
4.50	383	0.46	0.92
5.00	540	0.47	0.90
5.50	729	0.48	0.89
6.00	952	0.48	0.89
6.50	1211	0.48	0.88
7.00	1506	0.48	0.86
7.50	1829	0.47	0.84
8.00	2173	0.46	0.80
8.50	2523	0.45	0.76
9.00	2865	0.43	0.71
9.50	3186	0.41	0.65
10.00	3474	0.38	0.60
10.50	3718	0.35	0.54
11.00	3913	0.32	0.49
11.50	4060	0.29	0.44
12.00	4164	0.26	0.39
12.50	4233	0.24	0.35
13.00	4260	0.21	0.31
13.50	4260	0.19	0.28
14.00	4260	0.17	0.25
14.50	4260	0.15	0.22
15.00	4260	0.14	0.20

Wind speed v in m/s	Power P in kW	c_p value	c_t value
15.50	4260	0.13	0.18
16.00	4260	0.11	0.17
16.50	4260	0.10	0.15
17.00	4260	0.10	0.14
17.50	4260	0.09	0.13
18.00	4260	0.08	0.12
18.50	4260	0.07	0.11
19.00	4260	0.07	0.10
19.50	4260	0.06	0.09
20.00	4260	0.06	0.09
20.50	4252	0.05	0.08
21.00	4184	0.05	0.07
21.50	4082	0.05	0.07
22.00	3943	0.04	0.06
22.50	3762	0.04	0.06
23.00	3543	0.03	0.05
23.50	3289	0.03	0.05
24.00	3008	0.02	0.04
24.50	2709	0.02	0.04
25.00	2187	0.02	0.03
25.50	1892	0.01	0.02
26.00	1613	0.01	0.02
26.50	1348	0.01	0.02
27.00	1106	0.01	0.01
27.50	889	0.01	0.01
28.00	753	0.00	0.01

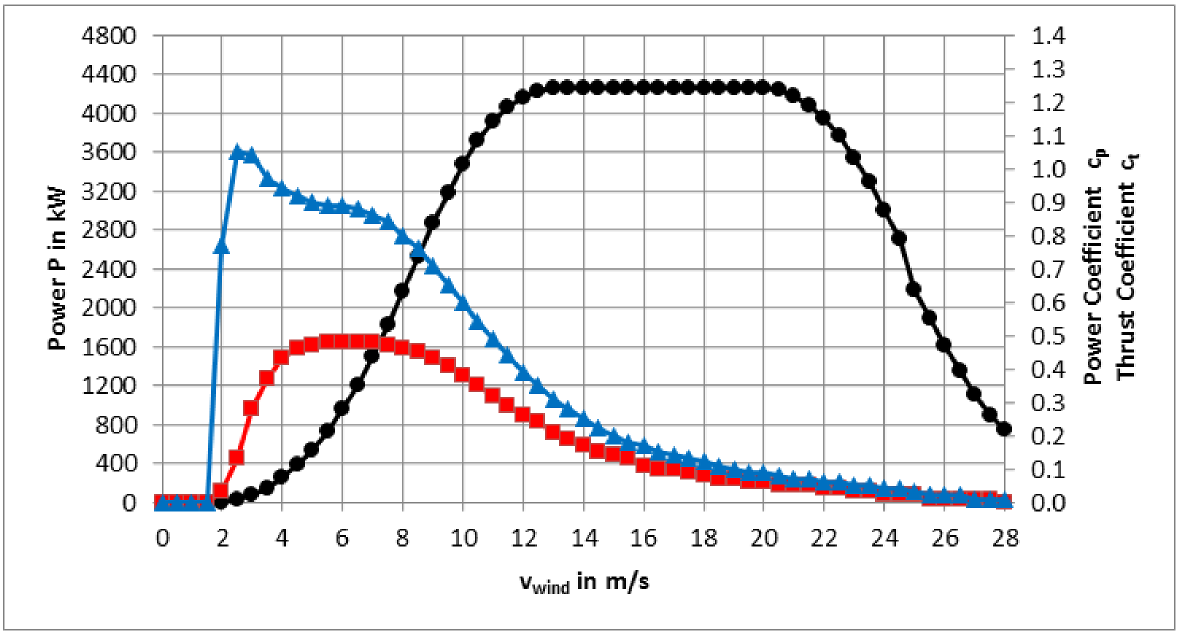

Fig. 1: Power, c_p and c_t curves for E-138 EP3 E3 / 4260 kW – operating mode 0 s

◆—◆—◆	Power P in kW
▲—▲—▲	c_t value
■—■—■	c_p value

3.2 Calculated sound power levels – operating mode 0 s

In operating mode 0 s the wind energy converter operates in a power-optimised mode to achieve optimum yield. The highest expected sound power level is 106.0 dB(A) in the nominal power range. All the sound power levels indicated apply taking into account the uncertainties described in ch. 2.2, p. 7. After reaching the nominal power, the sound power level will not increase further.

Tab. 5: Technical specifications

Parameter	Value	Unit
Nominal power (P_n)	4260	kW
Nominal wind speed	13.0	m/s
Minimum operating speed		
■ E-138 EP3 E3-ST-81-FB-C-01	4.4	rpm
■ E-138 EP3 E3-ST-99-FB-C-01	4.4	rpm
■ E-138 EP3 E3-HST-111-FB-C-01	4.4	rpm
■ E-138 EP3 E3-HST-131-FB-C-01	4.4	rpm
■ E-138 EP3 E3-HT-160-ES-C-01	4.4	rpm
Speed setpoint	11.1	rpm

Tab. 6: Calculated sound power level in dB(A), based on wind speed at hub height v_H

v_H	Sound power level in dB(A)
5 m/s	96.3
5.5 m/s	97.6
6 m/s	99.0
6.5 m/s	100.5
7 m/s	101.9
7.5 m/s	103.3
8 m/s	104.7
8.5 m/s	105.6
9 m/s	105.8
9.5 m/s	105.9
10 m/s	105.9
10.5 m/s	105.9
11 m/s	106.0
11.5 m/s	106.0
12 m/s	106.0
12.5 m/s	106.0
13 m/s	106.0
13.5 m/s	106.0
14 m/s	106.0

v_H	Sound power level in dB(A)
14.5 m/s	106.0
15 m/s	106.0

APPENDIX B

Wind turbine noise data for Operating Mode 0 – 1/3 Octave Band

Technical data sheet

One-third octave band level operating mode 0 s

ENERCON E-138 EP3 E3 / 4260 kW wind energy converter with TES (Trailing Edge Serrations)

Publisher

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2023-02-03	en	DA	WRD Wobben Research and Development GmbH / Documentation Department

Applicable documents

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Document ID	Document
various	Datenblatt Betriebsmodi (Data sheet operating modes)

Table of contents

List of abbreviations

Abbreviations

HH	Hub height
HST	Hybrid steel tower
HT	Hybrid tower
IS	Immissions site
SIS	Substitute immissions site
ST	Steel tower

Variables, units, formulas

$\mathbf{v_H}$	Wind speed at hub height
$\mathbf{v_s}$	Standardised wind speed

1 Available operating mode

The table below shows which operating mode is available for what tower versions or hub heights.

Tab. 1: Available operating mode

Operating mode	Tower version and hub height (HH)				
	E-138 EP3 E3-ST-81-FB-C-01	E-138 EP3 E3-ST-99-FB-C-01	E-138 EP3 E3-HST-111-FB-C-01	E-138 EP3 E3-HST-131-FB-C-01	E-138 EP3 E3-HT-160-ES-C-01
	HH 81 m	HH 99 m	HH 111 m	HH 131 m	HH 160 m
0 s	x	x	x	x	x

x = Available

- = Not available

2 General information

This document contains additional information for the 'Datenblatt Betriebsmodi' (Data sheet operating modes). Otherwise, the regulations listed in the 'Datenblatt Betriebsmodi' (Data sheet operating modes) apply with regard to the technical properties of the wind energy converter.

3 Information on one-third octave band levels

For one-third octave band levels up to the one-third octave band centre frequency of 2000 Hz, the uncertainty specifications according to the 'Datenblatt Betriebsmodi' (Data sheet operating modes) apply. For frequencies above 2000 Hz, the uncertainties increase due to physical effects. These frequencies have no influence on the immissions site (IS) or on the substitute immissions site (SIS) and are basically negligible. Various measurements on existing ENERCON wind energy converters of different types according to the applicable directives resulted in uncertainties for the one-third octave band levels of ± 2.5 dB(A) in the 4000 Hz frequency range and ± 8.0 dB(A) in the 8000 Hz frequency range. In view of the limited investigations, the reproducibility of these measurements cannot be guaranteed for all ENERCON wind energy converters with the same uncertainties.

Allocation of the one-third octave band levels to the standardised wind speed v_s at a height of 10 m is valid only if based on a logarithmic wind profile with a roughness length of 0.05 m. Allocation of the one-third octave band levels to the wind speed at hub height (v_H) is valid for all hub heights (HH). During measurements, the wind speed is determined from the power output and the power curve. The one-third octave band levels specified below were determined based on aero-acoustic simulations. The individual one-third octave band level values cannot be guaranteed. The sum level of all one-third octave band levels per wind speed corresponds to the sound power level at this wind speed, which is specified in the underlying data sheet for the respective operating modes. For this reason, the sum level must be adhered to within the area of application defined in the data sheet and on the basis of the applicable standards and directives.

4 Operating mode 0 s

4.1 One-third octave band level at HH

In the following tables, the values at which the maximum sound power level is reached for the first time are displayed in italics.

Tab. 2: One-third octave band level in dB(A), based on wind speed at hub height v_H

One-third octave band level centre frequency in Hz	v_H in m/s										
	5	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**
20	48.0	50.7	53.1	55.3	57.3	59.1	60.9	62.0	62.4	62.6	62.9
25	52.7	55.4	57.8	60.0	62.0	63.8	65.6	66.8	67.1	67.4	67.7
31.5	56.8	59.5	61.9	64.2	66.2	68.0	69.8	70.9	71.3	71.5	71.8
40	60.4	63.1	65.5	67.8	69.8	71.6	73.4	74.6	75.0	75.2	75.5
50	65.7	67.6	69.6	71.5	73.3	75.1	76.8	77.9	78.3	78.5	78.7
63	67.7	69.9	72.0	74.1	76.0	77.7	79.5	80.6	81.0	81.2	81.4
80	70.3	72.6	74.8	76.9	78.8	80.6	82.3	83.4	83.8	84.0	84.2
100	75.6	77.1	78.7	80.4	82.0	83.5	85.1	86.1	86.4	86.6	86.8
125	76.5	78.3	80.0	81.9	83.5	85.1	86.7	87.7	87.9	88.1	88.2
160	76.6	78.6	80.5	82.4	84.0	85.6	87.1	88.1	88.3	88.4	88.5
200	82.7	83.7	84.7	85.8	86.9	88.1	89.2	90.0	90.1	90.1	90.2
250	82.9	84.1	85.4	86.7	88.0	89.3	90.5	91.3	91.3	91.4	91.3
315	83.5	84.9	86.4	87.9	89.3	90.6	92.0	92.8	92.8	92.8	92.7
400	84.3	85.8	87.4	89.0	90.5	91.9	93.3	94.1	94.1	94.1	94.0
500	84.5	86.2	87.9	89.7	91.2	92.7	94.2	95.1	95.0	95.0	94.9
630	84.9	86.6	88.3	90.1	91.6	93.2	94.7	95.6	95.6	95.6	95.6
800	86.3	87.7	89.2	90.7	92.2	93.6	95.1	96.0	96.3	96.4	96.3
1000	88.1	89.2	90.5	91.9	93.2	94.5	95.8	96.8	97.2	97.5	97.4
1250	88.3	89.4	90.6	91.9	93.2	94.4	95.7	96.7	97.2	97.4	97.4
1600	85.7	86.9	88.2	89.7	91.0	92.4	93.9	94.8	95.0	95.0	95.0
2000	84.4	85.5	86.7	88.1	89.5	90.8	92.2	93.1	93.3	93.3	93.3
2500	83.0	83.9	85.0	86.3	87.5	88.8	90.1	91.0	91.1	91.1	91.1
3150	75.6	77.6	79.5	81.5	83.3	84.9	86.6	87.6	87.7	87.8	87.8
4000	72.3	74.1	76.0	77.9	79.6	81.2	82.9	83.9	84.1	84.1	84.2
5000	68.1	69.7	71.4	73.2	74.9	76.5	78.1	79.2	79.4	79.4	79.5
6300	57.4	60.2	62.7	65.1	67.1	69.0	70.8	72.0	72.2	72.2	72.3
8000	46.8	49.5	52.0	54.5	56.6	58.5	60.3	61.5	61.7	61.8	61.9

One-third octave band level centre frequency in Hz	v_H in m/s										
	5	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**
10000	32.4	35.0	37.4	39.8	41.9	43.9	45.8	47.0	47.1	47.2	47.3

Tab. 3: One-third octave band level in dB(A), based on wind speed at hub height v_H

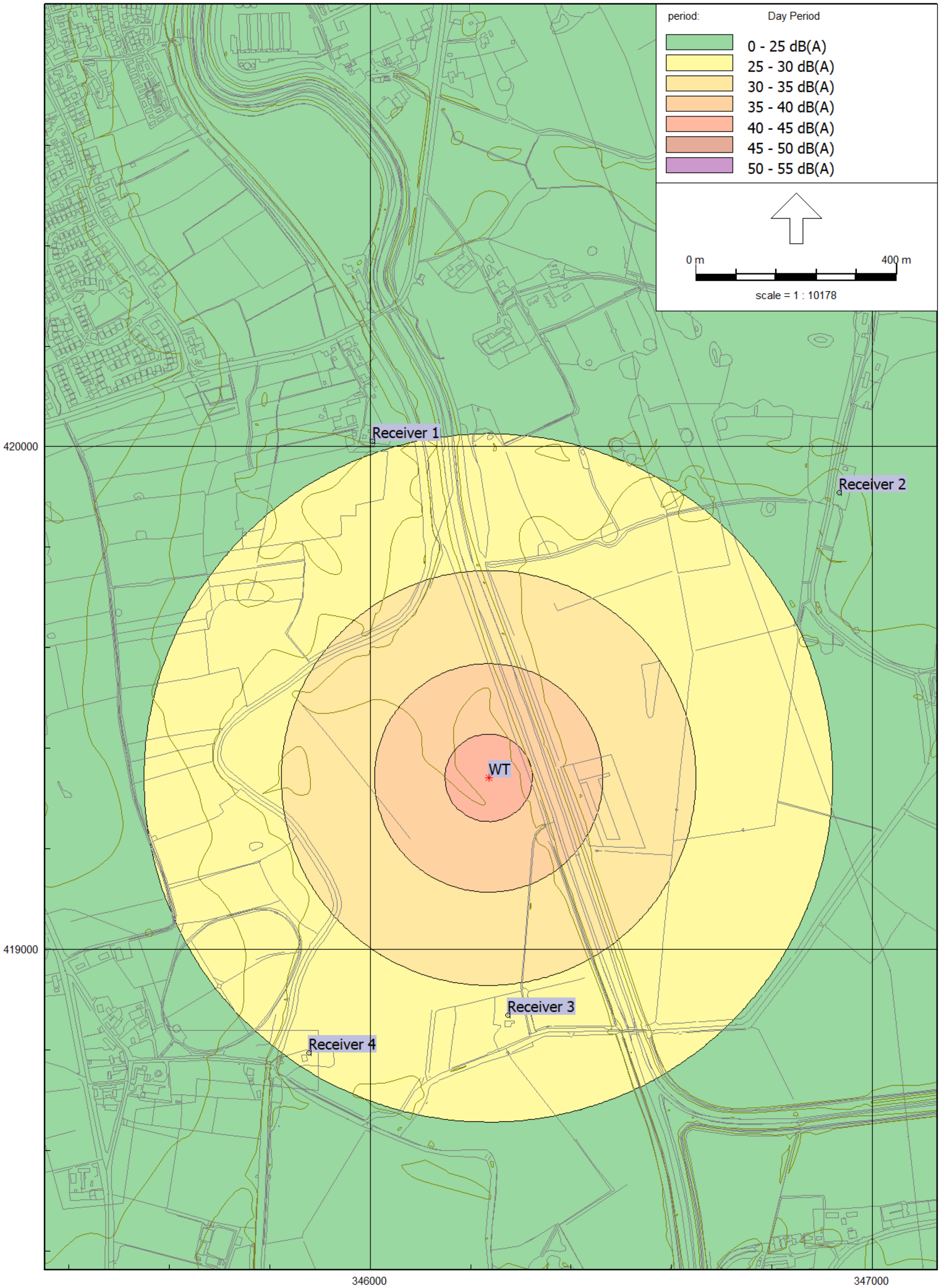
One-third octave band level centre frequency in Hz	v_H in m/s									
	10.5	**11**	**11.5**	**12**	**12.5**	**13**	**13.5**	**14**	**14.5**	**15**
20	63.2	*63.5*	63.7	64.0	64.2	64.5	64.6	64.8	65.0	65.1
25	67.9	*68.3*	68.5	68.7	69.0	69.2	69.4	69.5	69.7	69.9
31.5	72.1	*72.4*	72.6	72.9	73.1	73.4	73.5	73.7	73.9	74.0
40	75.7	*76.1*	76.3	76.5	76.8	77.0	77.1	77.3	77.5	77.7
50	79.0	*79.3*	79.5	79.8	80.0	80.2	80.4	80.5	80.7	80.9
63	81.7	*82.0*	82.2	82.4	82.7	82.9	83.0	83.2	83.3	83.5
80	84.5	*84.8*	85.0	85.2	85.4	85.6	85.7	85.9	86.0	86.2
100	87.0	*87.3*	87.5	87.6	87.8	87.9	88.0	88.1	88.2	88.4
125	88.4	*88.7*	88.8	88.9	88.9	89.1	89.1	89.2	89.2	89.4
160	88.6	*88.8*	88.9	88.9	88.9	88.9	88.9	88.9	88.9	89.0
200	90.2	*90.4*	90.4	90.3	90.2	90.2	90.2	90.1	90.0	90.0
250	91.4	*91.5*	91.5	91.3	91.2	91.1	91.0	90.8	90.7	90.7
315	92.7	*92.8*	92.8	92.5	92.3	92.2	92.0	91.8	91.7	91.6
400	94.0	*94.1*	94.0	93.7	93.5	93.4	93.2	93.0	92.8	92.7
500	94.9	*95.0*	94.9	94.7	94.5	94.4	94.2	94.0	93.8	93.7
630	95.5	*95.6*	95.6	95.4	95.3	95.3	95.2	95.0	94.9	94.8
800	96.3	*96.4*	96.4	96.4	96.3	96.3	96.3	96.2	96.1	96.1
1000	97.4	*97.5*	97.5	97.6	97.6	97.6	97.6	97.6	97.6	97.6
1250	97.4	*97.5*	97.5	97.6	97.7	97.7	97.7	97.8	97.8	97.8
1600	95.0	*95.1*	95.1	95.3	95.4	95.5	95.5	95.7	95.8	95.9
2000	93.3	*93.4*	93.4	93.6	93.7	93.8	94.0	94.3	94.5	94.6
2500	91.1	*91.3*	91.3	91.5	91.7	91.8	92.1	92.5	92.6	92.7
3150	87.8	*88.0*	88.0	88.3	88.6	88.8	89.2	89.5	89.5	89.4
4000	84.2	*84.4*	84.5	84.9	85.2	85.4	85.7	85.7	85.5	85.3
5000	79.6	*79.7*	79.9	80.3	80.5	80.7	80.7	80.4	80.1	80.0
6300	72.4	*72.6*	72.7	73.1	73.2	73.2	72.9	72.5	72.2	72.0
8000	61.9	*62.1*	62.2	62.4	62.4	62.2	61.9	61.4	61.1	60.9
10000	47.3	*47.4*	47.5	47.6	47.5	47.3	47.0	46.4	46.1	45.8

APPENDIX C

Predicted wind turbine noise levels in tabular and contour formats

ENERCON E-138 at 3 m/s wind speed (10m height) 131m hub height   Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 15:27



ISO 9613, [Asland Farm - ENERCON E-138 at 3 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

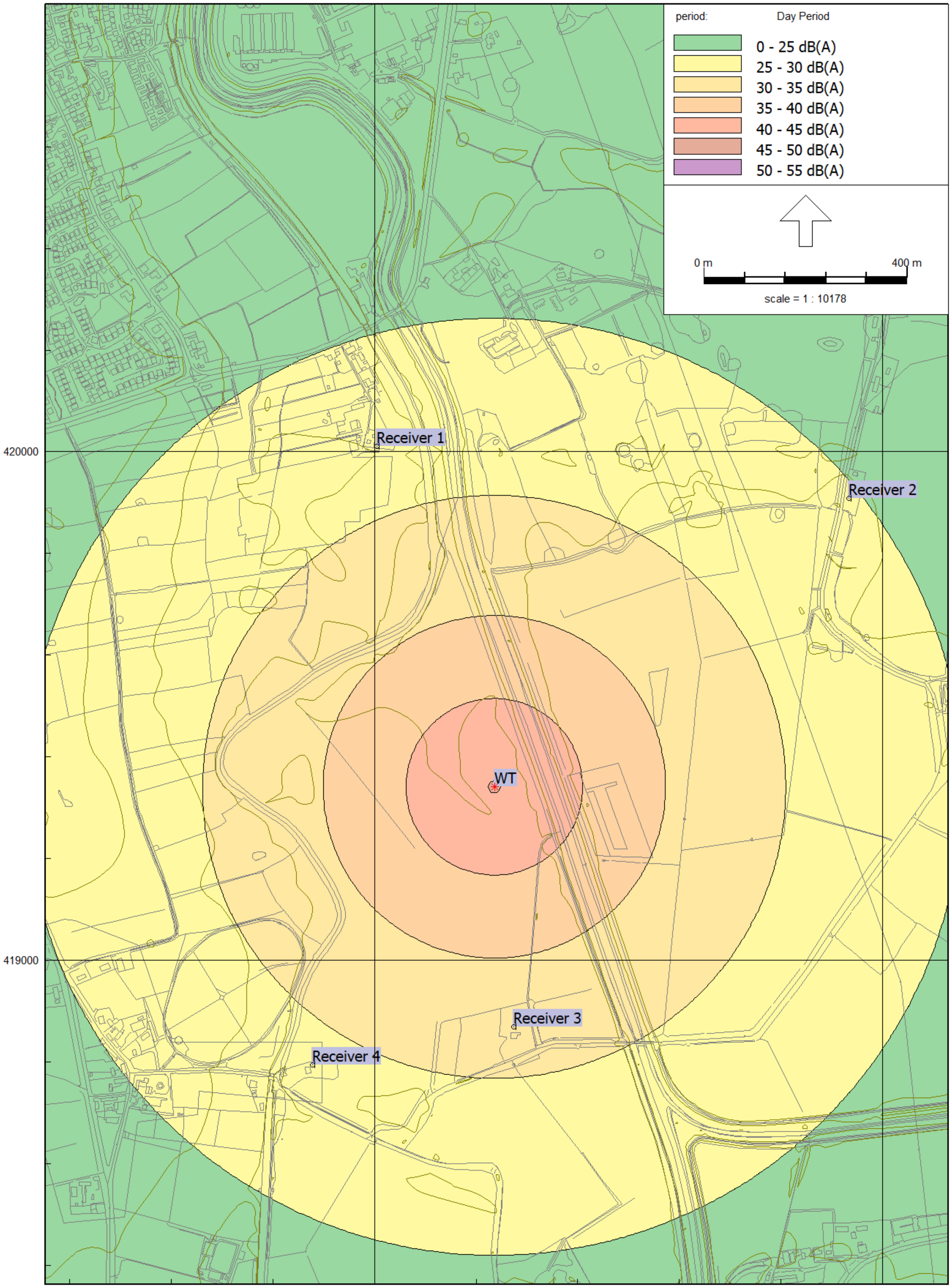
Report: Table of Results
Model: ENERCON E-138 at 3 m/s wind speed (10m height) 131m hub height
LAeq: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	25
2 A	Receiver 2	4.00	22
3 A	Receiver 3	4.00	29
4_A	Receiver 4	4.00	25

All shown dB values are A-weighted

ENERCON E-138 at 3 m/s wind speed (10m height) 131m hub height Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 15:27



ISO 9613, [Asland Farm - ENERCON E-138 at 4 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

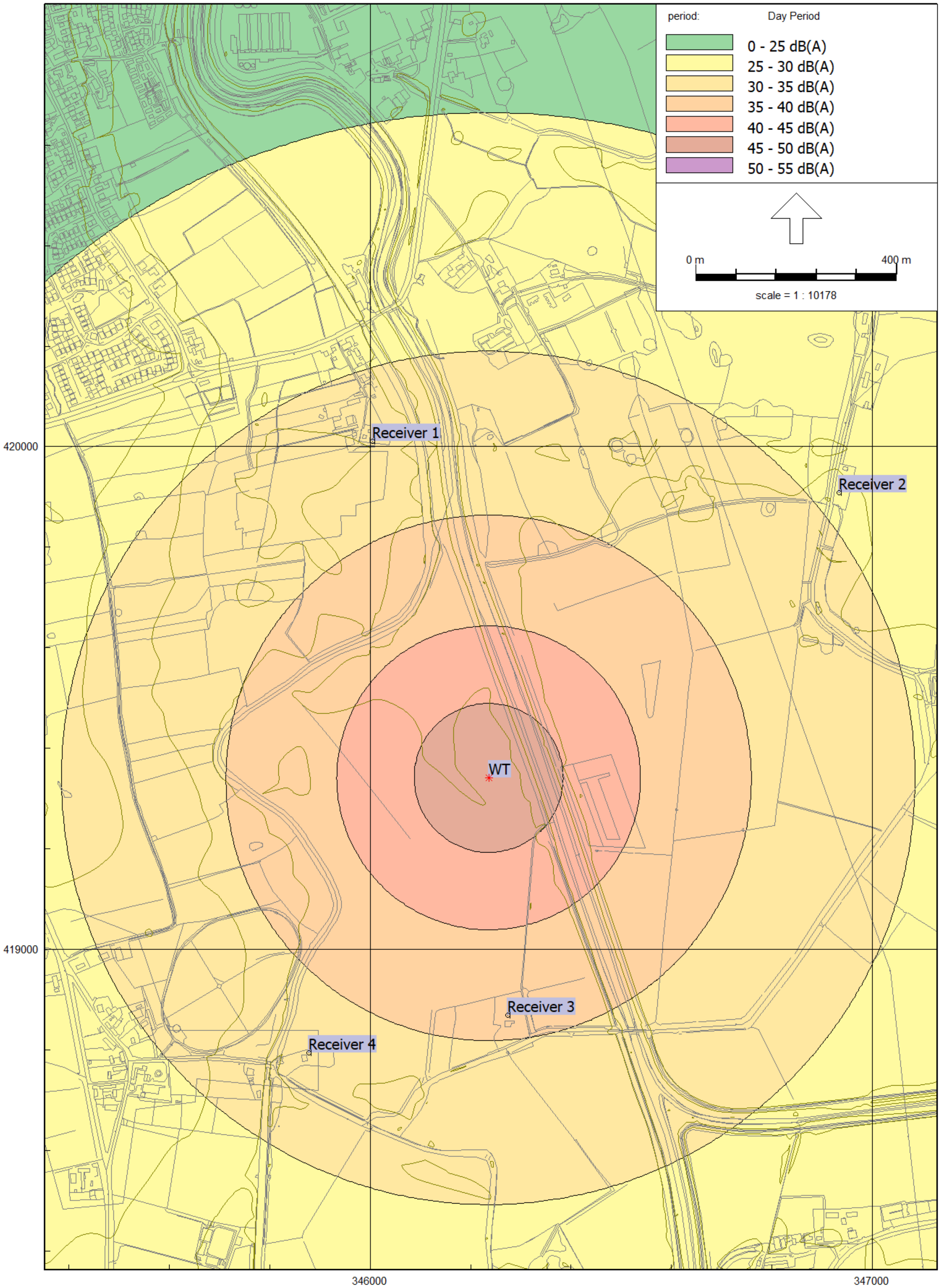
Report:	Table of Results
Model:	ENERCON E-138 at 4 m/s wind speed (10m height) 131m hub height
LAeq:	total results for receivers
Group:	(main group)
Group Reduction:	No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	28
2 A	Receiver 2	4.00	25
3 A	Receiver 3	4.00	32
4_A	Receiver 4	4.00	29

All shown dB values are A-weighted

ENERCON E-138 at 5 m/s wind speed (10m height) 131m hub height   Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 15:44



ISO 9613, [Asland Farm - ENERCON E-138 at 5 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

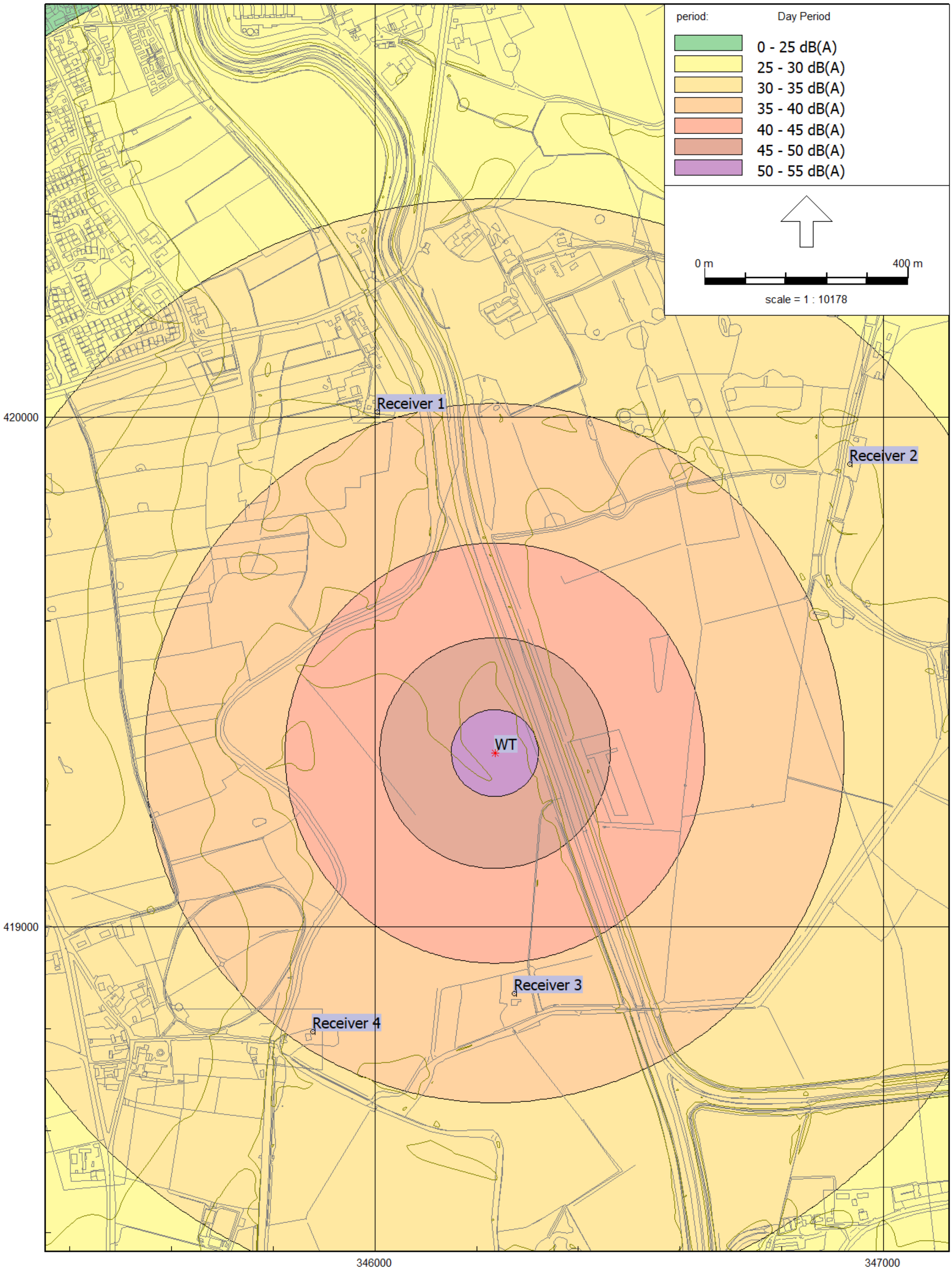
Report:	Table of Results
Model:	ENERCON E-138 at 5 m/s wind speed (10m height) 131m hub height
LAeq:	total results for receivers
Group:	(main group)
Group Reduction:	No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	32
2 A	Receiver 2	4.00	29
3 A	Receiver 3	4.00	36
4_A	Receiver 4	4.00	33

All shown dB values are A-weighted

ENERCON E-138 at 6 m/s wind speed (10m height) 131m hub height   Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 15:48



ISO 9613, [Asland Farm - ENERCON E-138 at 6 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

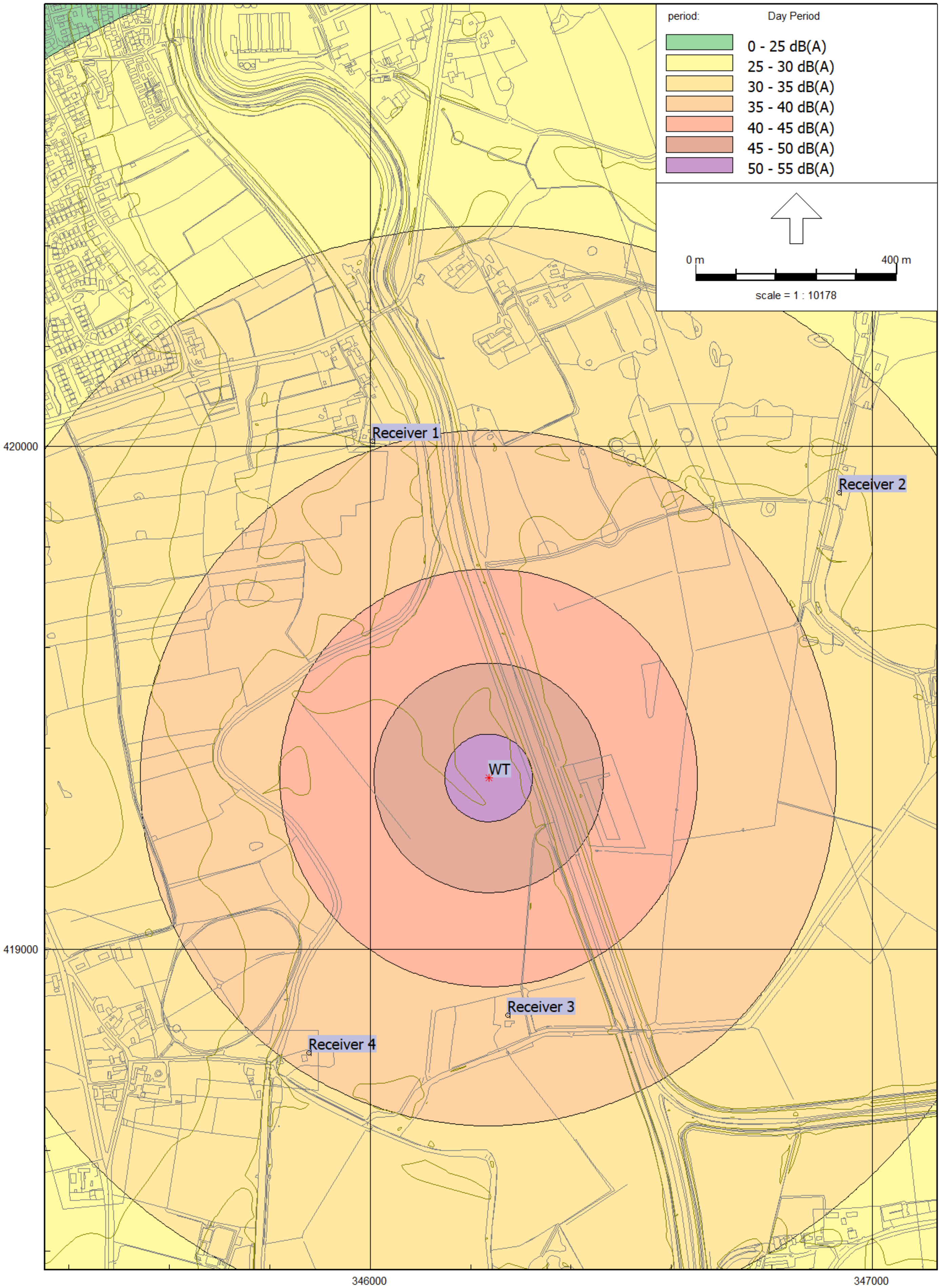
Report: Table of Results
Model: ENERCON E-138 at 6 m/s wind speed (10m height) 131m hub height
LAeq: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	35
2 A	Receiver 2	4.00	32
3 A	Receiver 3	4.00	39
4_A	Receiver 4	4.00	36

All shown dB values are A-weighted

ENERCON E-138 at 7 m/s wind speed (10m height) 131m hub height   Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 16:00



ISO 9613, [Asland Farm - ENERCON E-138 at 7 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

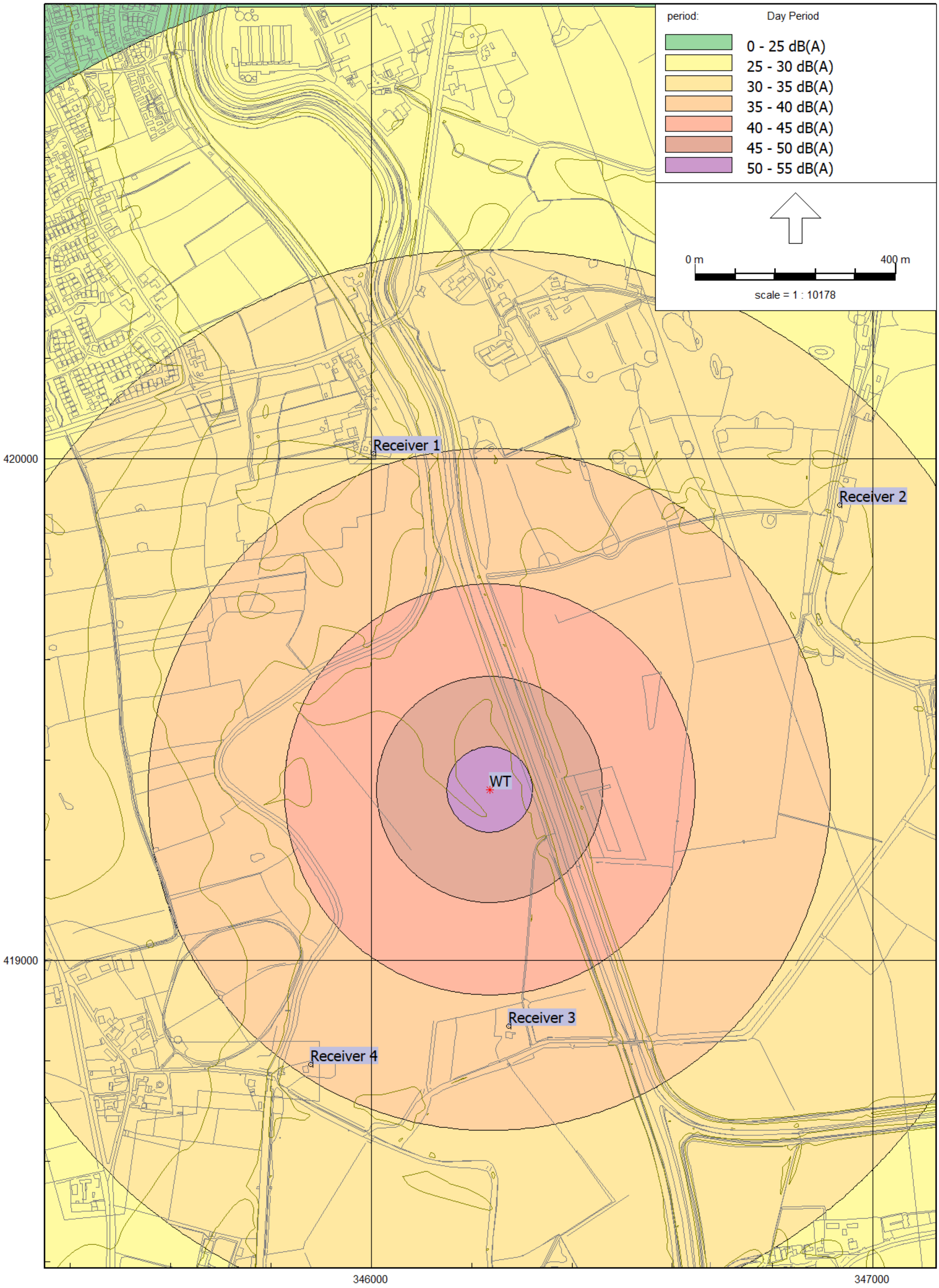
Report:	Table of Results
Model:	ENERCON E-138 at 8 m/s wind speed (10m height) 131m hub height
LAeq:	total results for receivers
Group:	(main group)
Group Reduction:	No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	35
2 A	Receiver 2	4.00	32
3 A	Receiver 3	4.00	39
4_A	Receiver 4	4.00	35

All shown dB values are A-weighted

ENERCON E-138 at 8 m/s wind speed (10m height) 131m hub height   Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 16:06



ISO 9613, [Asland Farm - ENERCON E-138 at 8 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

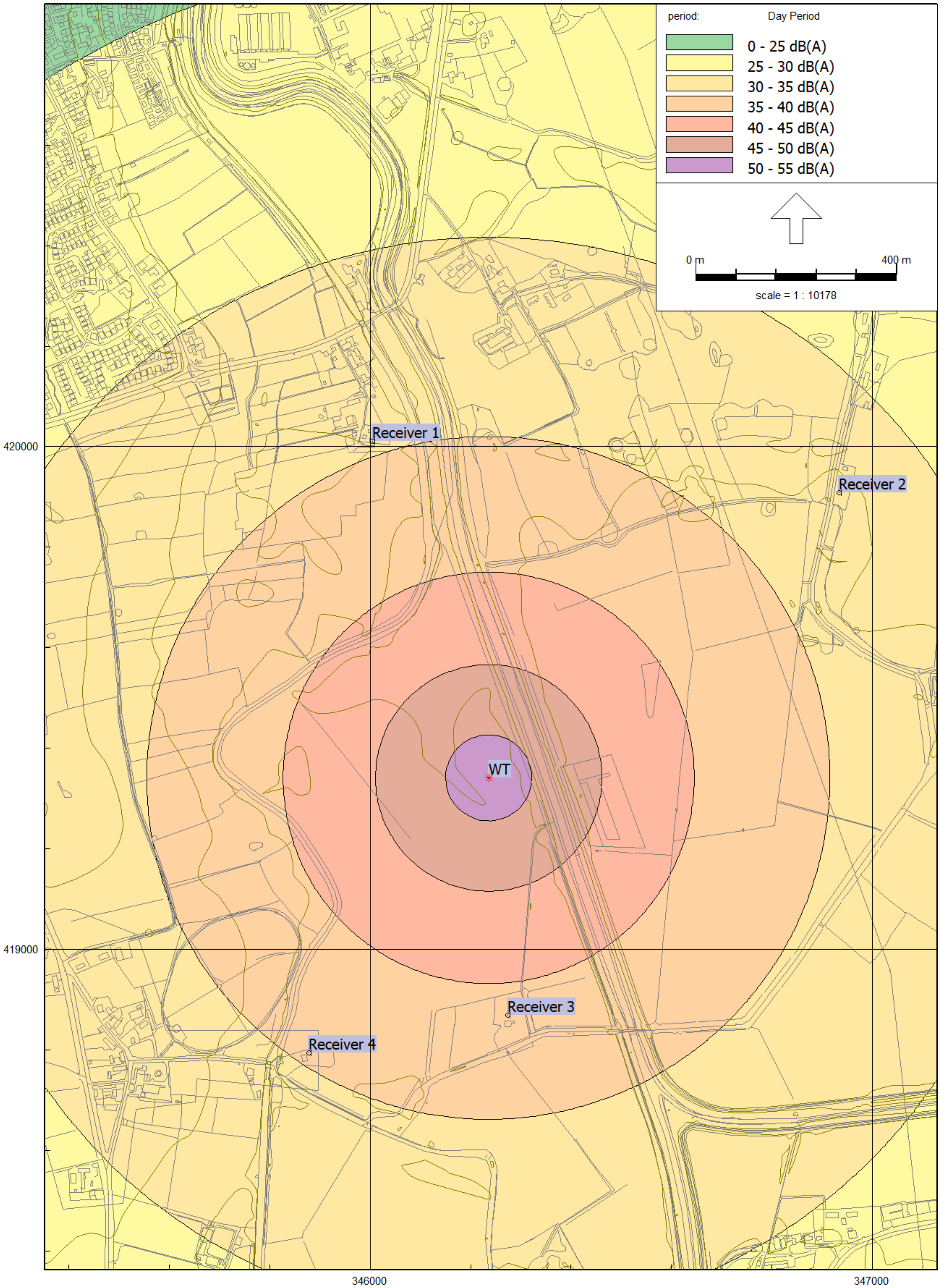
Report:	Table of Results
Model:	ENERCON E-138 at 9 m/s wind speed (10m height) 131m hub height
LAeq:	total results for receivers
Group:	(main group)
Group Reduction:	No

Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	35
2 A	Receiver 2	4.00	32
3 A	Receiver 3	4.00	39
4_A	Receiver 4	4.00	35

All shown dB values are A-weighted

ENERCON E-138 at 9 m/s wind speed (10m height) 131m hub height Spectrum Acoustic Consultants Ltd - United Kingdom

10 Sep 2024, 16:15

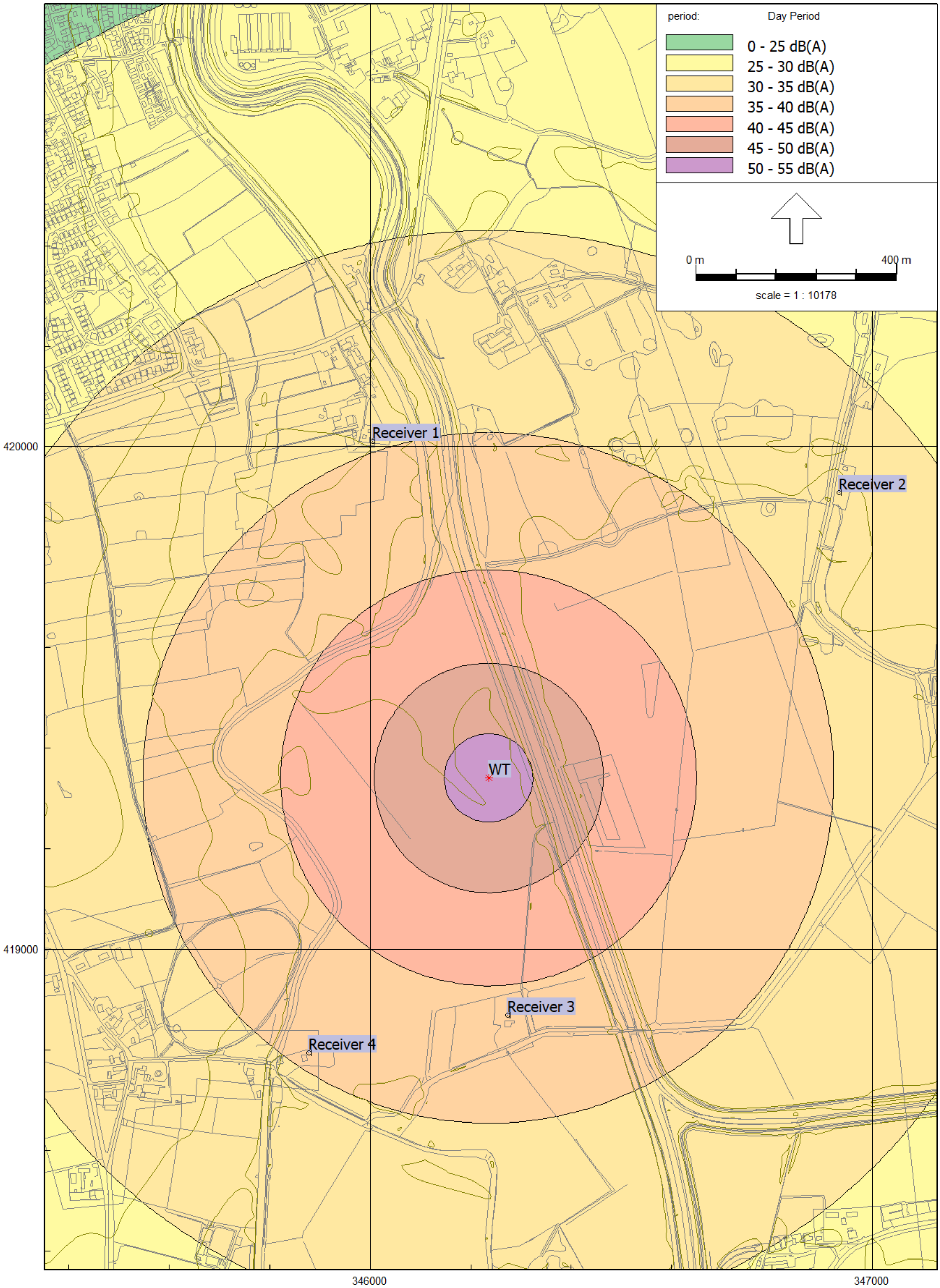


ISO 9613, [Asland Farm - ENERCON E-138 at 9 m/s wind speed (10m height) 131m hub height] , iNoise V2024.1 Enterprise Licensed to Spectrum Acoustic Consultants Ltd - United Kingdom

Report: Table of Results
Model: ENERCON E-138 at 9 m/s wind speed (10m height) 131m hub height
LAeq: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day
1_A	Receiver 1	4.00	35
2_A	Receiver 2	4.00	32
3_A	Receiver 3	4.00	39
4_A	Receiver 4	4.00	35

All shown dB values are A-weighted


period: Day Period
0 - 25 dB(A)
25 - 30 dB(A)
30 - 35 dB(A)
35 - 40 dB(A)
40 - 45 dB(A)
45 - 50 dB(A)
50 - 55 dB(A)
0 m
400 m
scale = 1 : 10178
Receiver 1
Receiver 2
Receiver 3
Receiver 4
WT
420000
419000
346000
347000

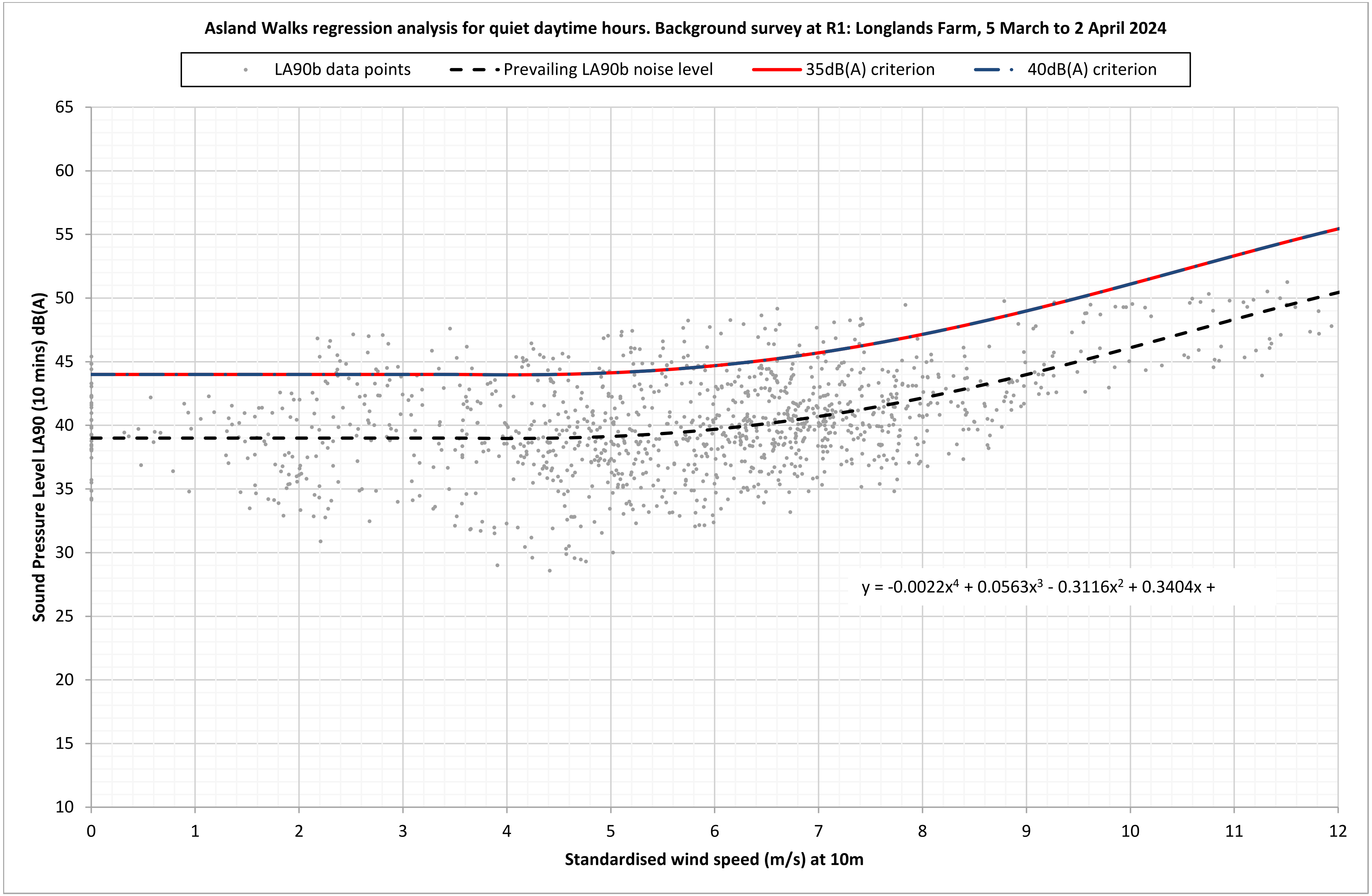
Report: Table of Results
Model: ENERCON E-138 at 10 m/s wind speed (10m height) 131m hub height
LAeq: total results for receivers
Group: (main group)
Group Reduction: No

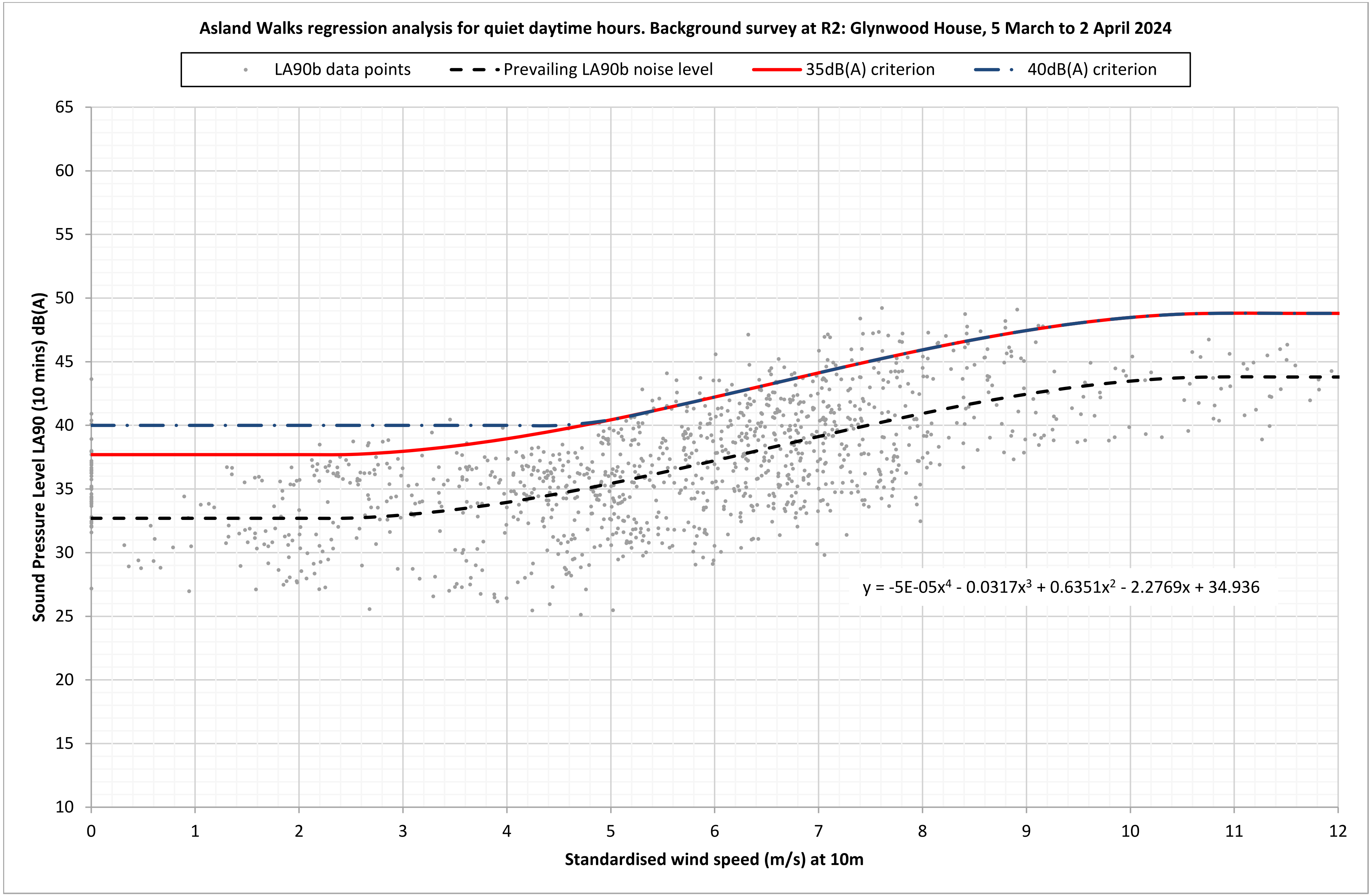
Name Receiver	Description	Height	Day
1 A	Receiver 1	4.00	35
2 A	Receiver 2	4.00	32
3 A	Receiver 3	4.00	39
4_A	Receiver 4	4.00	36

All shown dB values are A-weighted

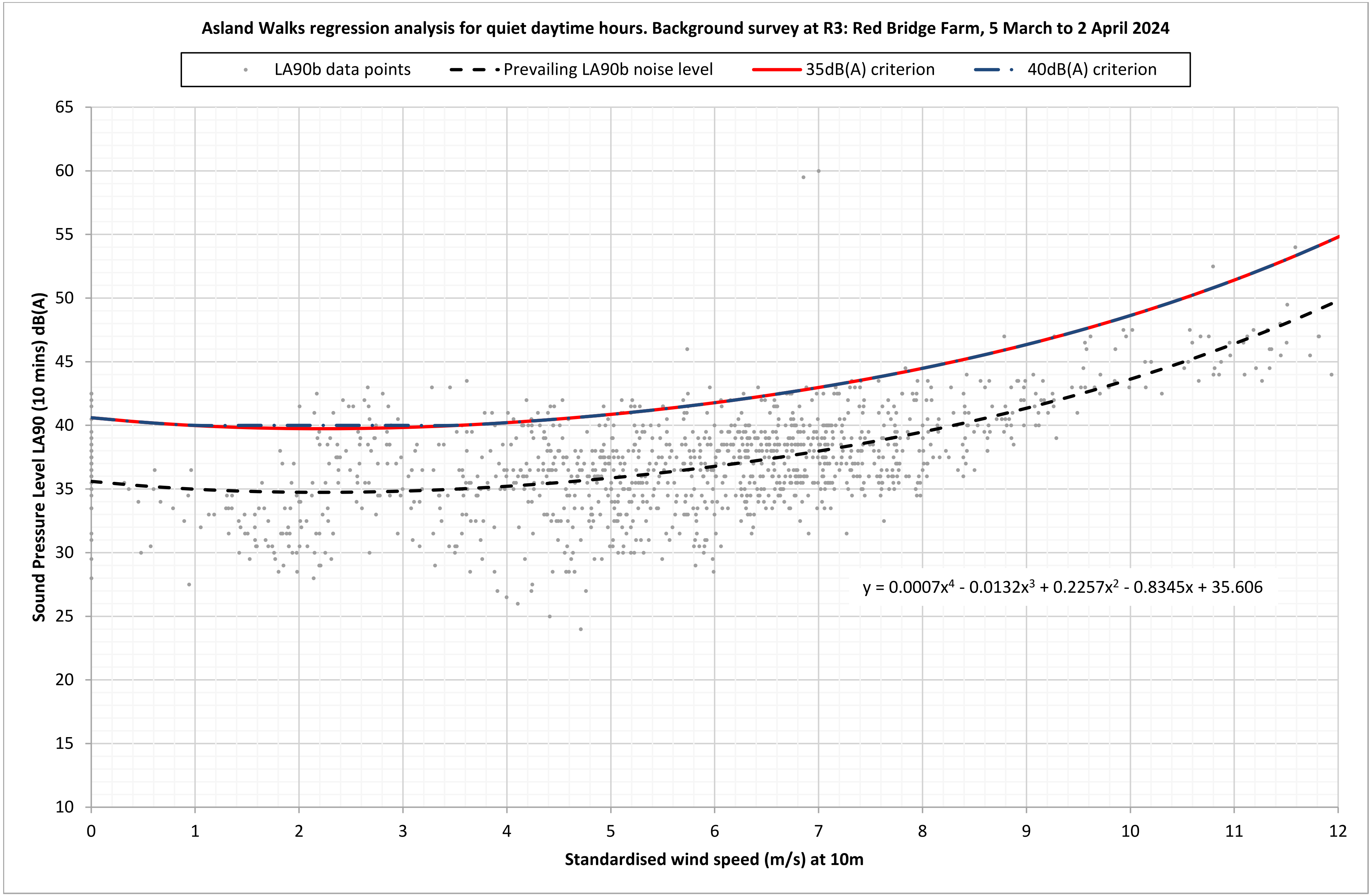
APPENDIX D

Wind turbine noise criteria curves

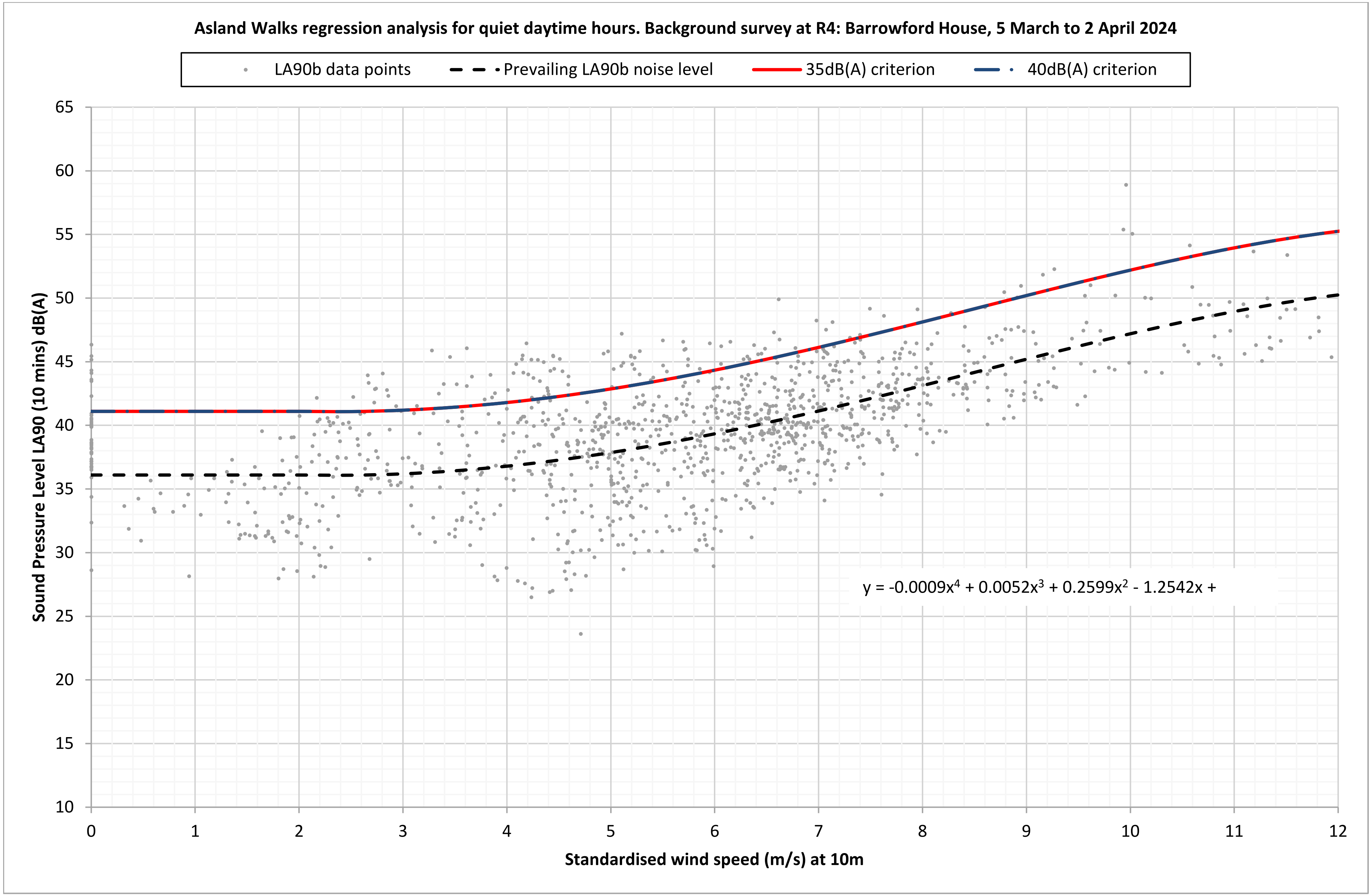

Asland Walks regression analysis for quiet daytime hours. Background survey at R1: Longlands Farm, 5 March to 2 April 2024
LA90b data points
Prevailing LA90b noise level
35dB(A) criterion
40dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
Standardised wind speed (m/s) at 10m
y = -0.0022x4 + 0.0563x3 - 0.3116x2 + 0.3404x +
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12

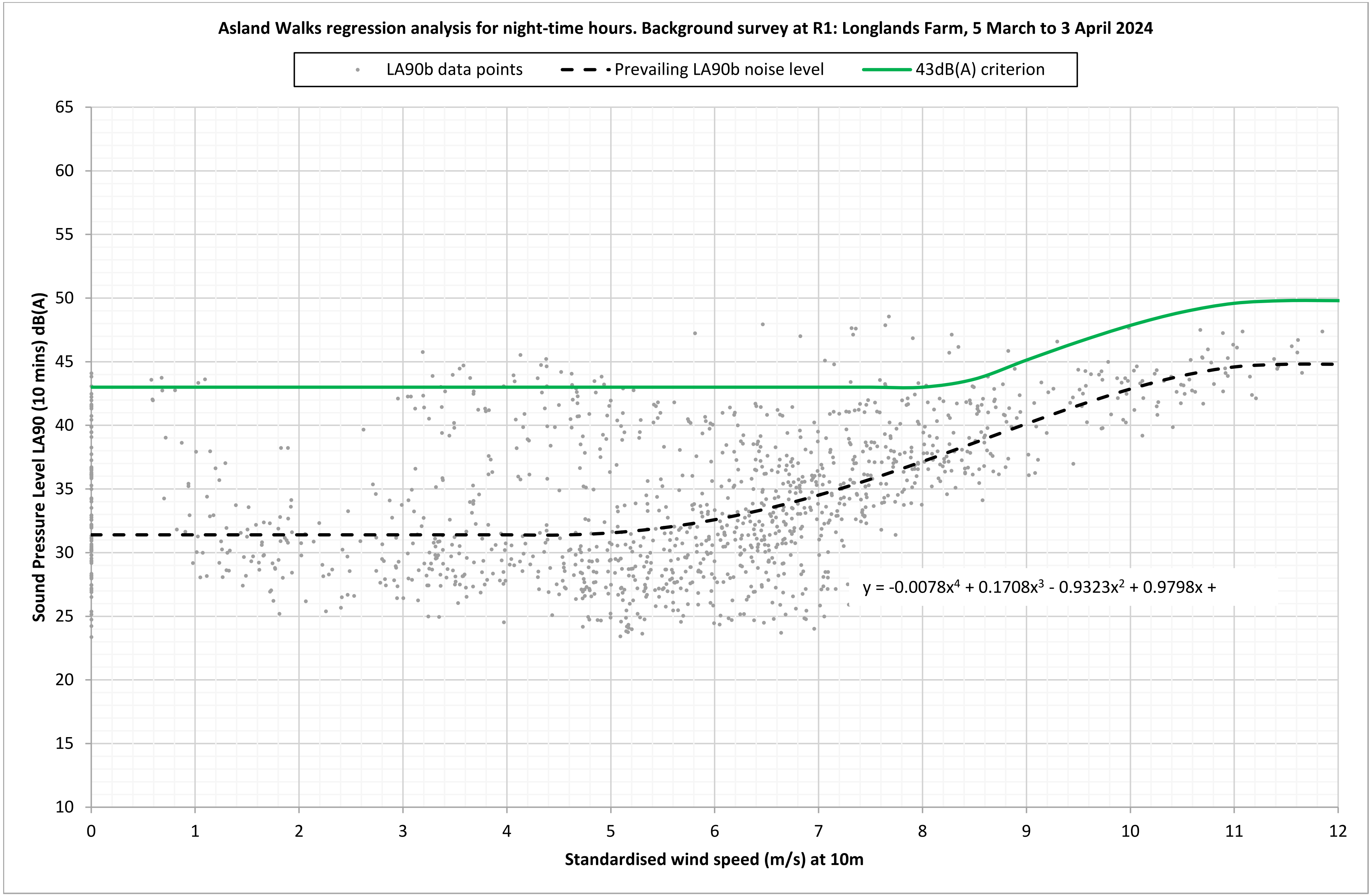


Asland Walks regression analysis for quiet daytime hours. Background survey at R2: Glynwood House, 5 March to 2 April 2024
LA90b data points
Prevailing LA90b noise level
35dB(A) criterion
40dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12
Standardised wind speed (m/s) at 10m
y = -5E-05x4 - 0.0317x3 + 0.6351x2 - 2.2769x + 34.936

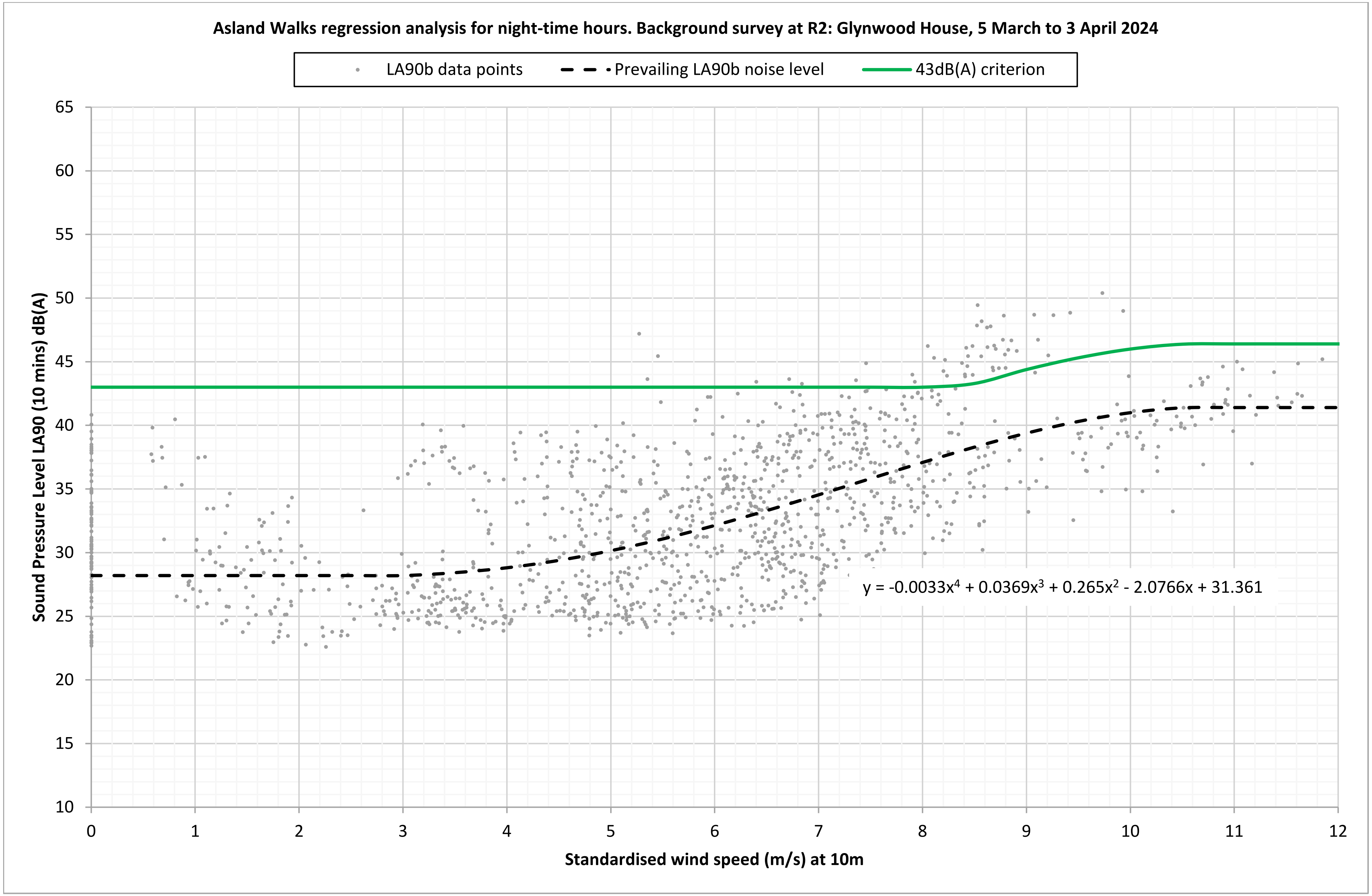


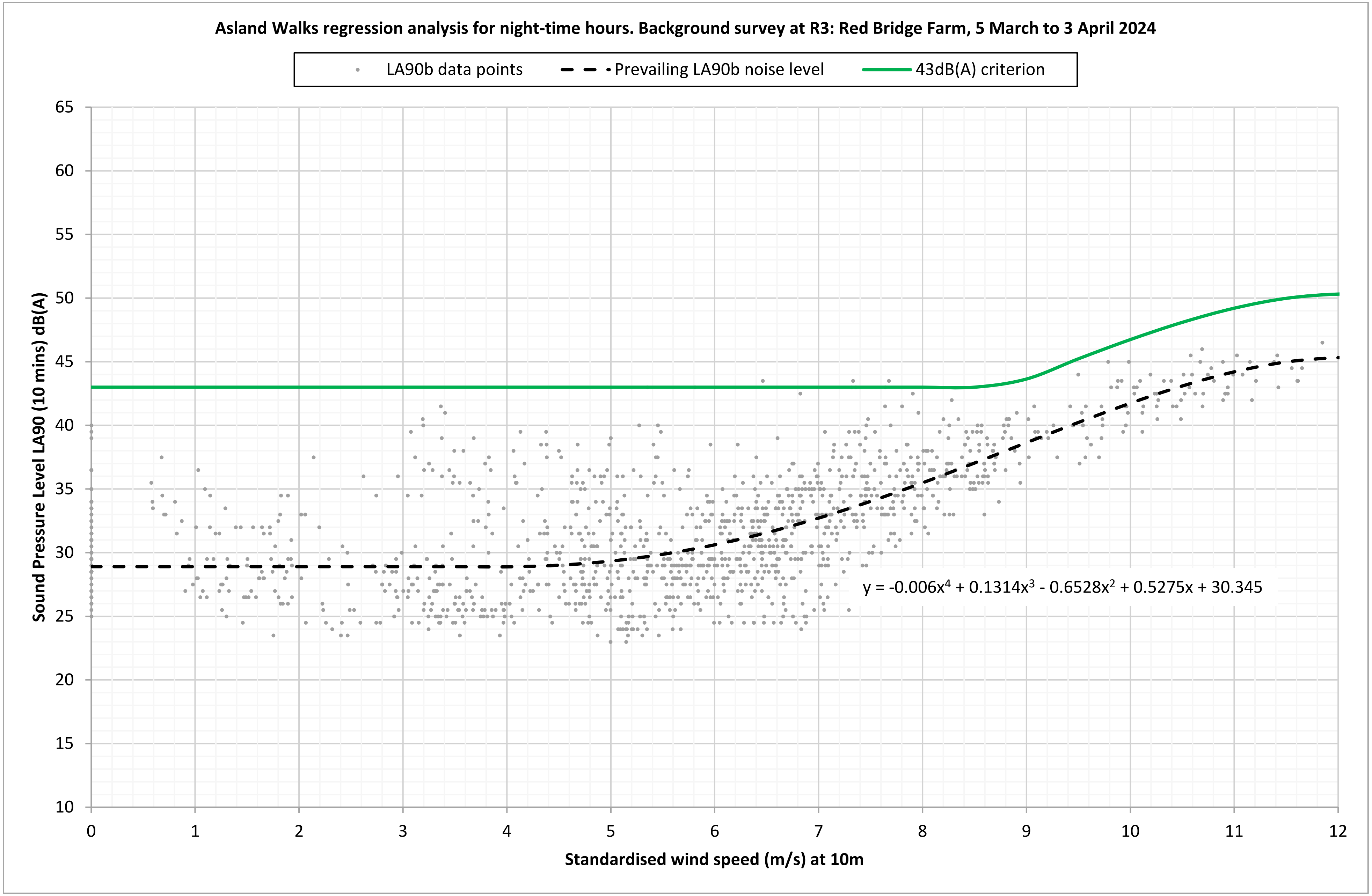
Asland Walks regression analysis for quiet daytime hours. Background survey at R3: Red Bridge Farm, 5 March to 2 April 2024
LA90b data points
Prevailing LA90b noise level
35dB(A) criterion
40dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12
Standardised wind speed (m/s) at 10m
y = 0.0007x4 - 0.0132x3 + 0.2257x2 - 0.8345x + 35.606

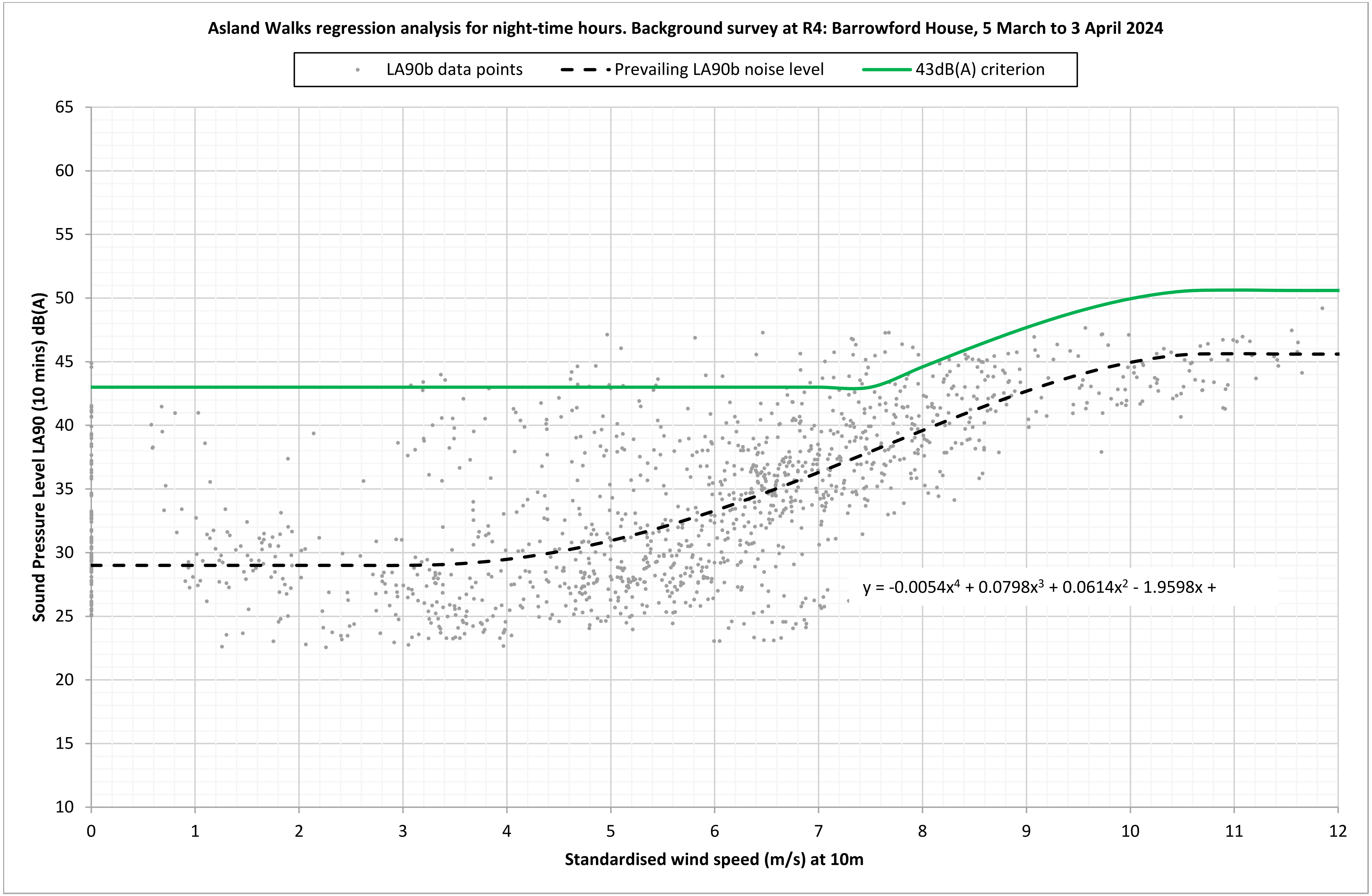

Asland Walks regression analysis for quiet daytime hours. Background survey at R4: Barrowford House, 5 March to 2 April 2024
LA90b data points
Prevailing LA90b noise level
35dB(A) criterion
40dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
Standardised wind speed (m/s) at 10m
y = -0.0009x4 + 0.0052x3 + 0.2599x2 - 1.2542x +
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12



Asland Walks regression analysis for night-time hours. Background survey at R1: Longlands Farm, 5 March to 3 April 2024
LA90b data points
Prevailing LA90b noise level
43dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12
Standardised wind speed (m/s) at 10m
y = -0.0078x4 + 0.1708x3 - 0.9323x2 + 0.9798x +


Asland Walks regression analysis for night-time hours. Background survey at R2: Glynwood House, 5 March to 3 April 2024
LA90b data points
Prevailing LA90b noise level
43dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
Standardised wind speed (m/s) at 10m
y = -0.0033x⁴ + 0.0369x³ + 0.265x² - 2.0766x + 31.361
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12


Asland Walks regression analysis for night-time hours. Background survey at R3: Red Bridge Farm, 5 March to 3 April 2024
LA90b data points
Prevailing LA90b noise level
43dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
65
60
55
50
45
40
35
30
25
20
15
10
$y = -0.006x^4 + 0.1314x^3 - 0.6528x^2 + 0.5275x + 30.345$
0
1
2
3
4
5
6
7
8
9
10
11
12
Standardised wind speed (m/s) at 10m


Asland Walks regression analysis for night-time hours. Background survey at R4: Barrowford House, 5 March to 3 April 2024
LA90b data points
Prevailing LA90b noise level
43dB(A) criterion
Sound Pressure Level LA90 (10 mins) dB(A)
Standardised wind speed (m/s) at 10m
y = -0.0054x4 + 0.0798x3 + 0.0614x2 - 1.9598x +
65
60
55
50
45
40
35
30
25
20
15
10
0
1
2
3
4
5
6
7
8
9
10
11
12

APPENDIX E

Solar farm noise data

From:	Sakthisekar Rangasamy
To:	Jonathan Bensted
Cc:	Krishan Tailor
Subject:	RE: Re[4]: Sunny Central 2.2MVA
Date:	29 April 2024 16:51:45
Attachments:	image001.png image002.png image003.png image006.png image007.png image008.png image009.png White Paper BU-LS-001 Sound Power Measurements on SC_SCS UP (-US) V1.2.pdf

Hello Lauren,

Please find enclosed the whitepaper on Sound power measurement data of SMA SC(S) UP inverters.

Noise data	3-stack Inverters without noise reduction kit	2-stack Inverters without noise reduction kit
Sound pressure Lwa [dB]*	92.97	90.78
Sound Power Lxpa10 (10m distance) [dBA]**	65	63
Sound Power Lxpa50 (50m distance) [dBA]**	51	49
Sound Power Lxpa100 (100m distance) [dBA]**	45	43

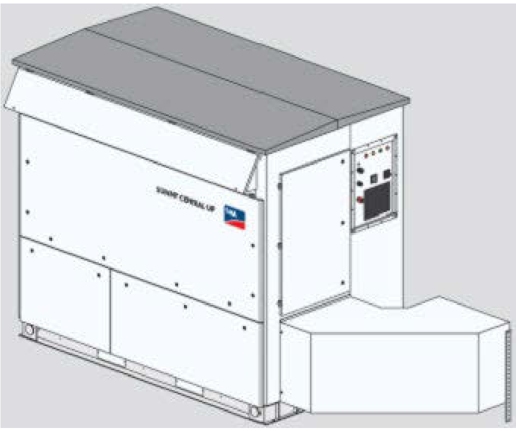
*measured; **calculated

Option-1: Standard Noise Reduction Kit:

The Noise Reduction Kit for the Sunny Central (Storage) XXXX UP(-XT) series can be used for noise sensitive installation areas to limit to **90 dBA** sound power for 3 stack version and 89dBA for 2 stack versions. The Noise Reduction Kit consists of one air outlet baffle which can be assembled easily at the inverter during commissioning or also later as a retrofit measure.

Noise reduction capabilities	3-stack Inverters without noise reduction kit	3-stack Inverters with noise reduction kit	2-stack Inverters without noise reduction kit	2-stack Inverters with noise reduction kit
Sound pressure Lwa [dB]*	92.97	**90**	90.78	**88.98**
Sound Power Lxpa10 (10m distance) [dBA]**	65	62	63	61
Sound Power Lxpa50 (50m distance) [dBA]**	51	48	49	47

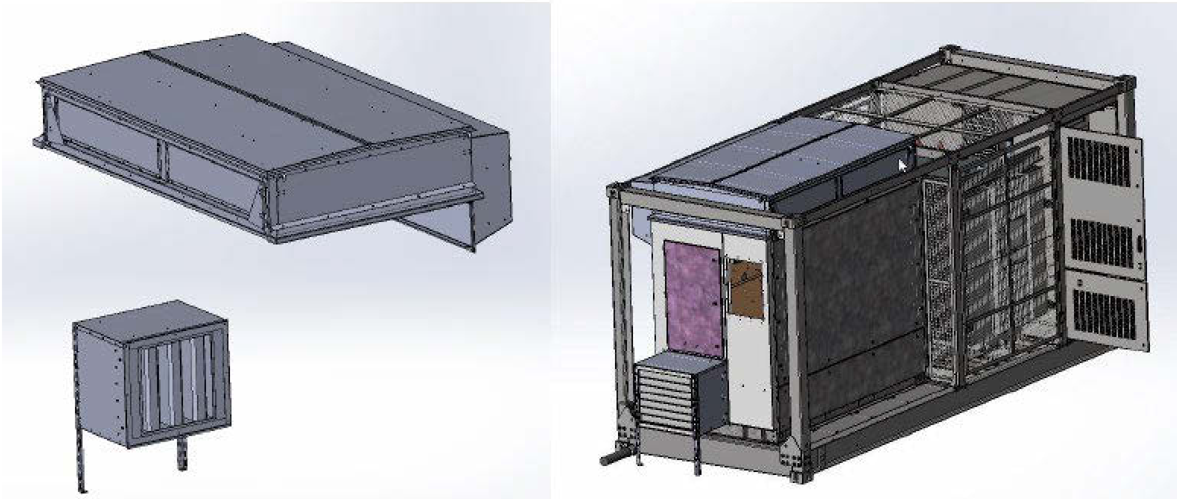
*measured; **calculated




Option-2: New Noise Reduction Kit:

Also there is a new Silencer kit to reduce the noise level to <87dBA for 3-stack version, but this kit results in <5% current deration of Inverter.

3D design and dimensions of the Silencer Kit



Hope this helps.

Best Regards,

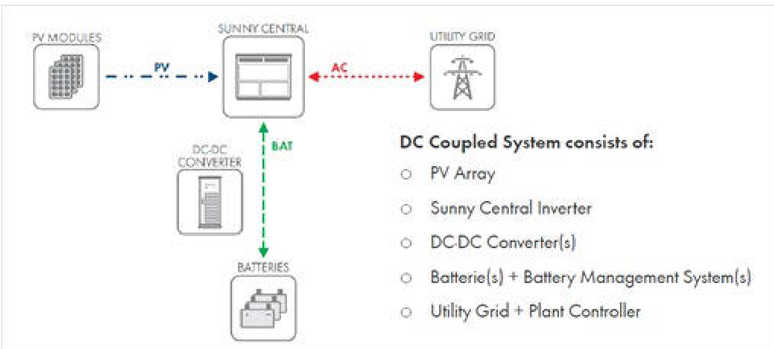
Sakthi | SMA UK | Application Engineer – Large Scale Storage and Solar| Mobile +44 7512 327201

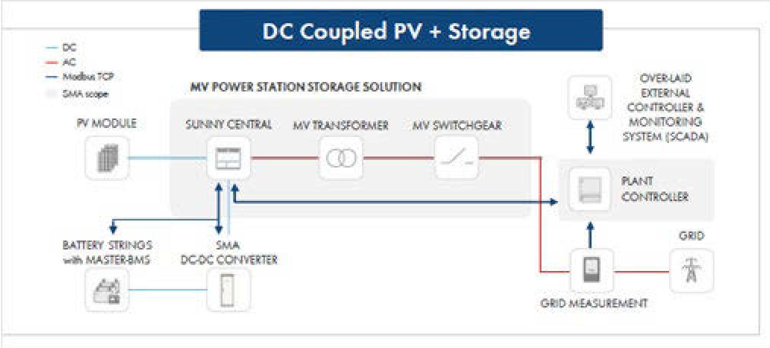
From: Jonathan Bensted <jmbensted@8minuteenergy.uk>
Sent: Monday, April 29, 2024 4:40 PM
To: Sakthisekar Rangasamy <Sakthisekar.Rangasamy@SMA-UK.com>
Cc: Krishan Tailor <Krishan.Tailor@SMA-UK.com>
Subject: Re[4]: Sunny Central 2.2MVA

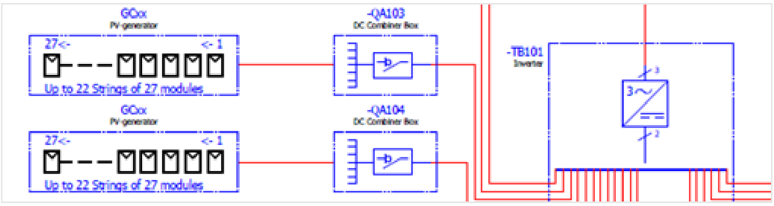
Hi Sakthi,
Could you please provide noise data for the Sunny Central UP inverter?
Kind regards,
Jonathan

------ Original Message ------
From "Sakthisekar Rangasamy" <Sakthisekar.Rangasamy@SMA-UK.com>
To "Jonathan Bensted" <jmbensted@8minuteenergy.uk>
Cc "Krishan Tailor" <Krishan.Tailor@SMA-UK.com>
Date 14/03/2024 16:00:16
Subject RE: Re[2]: Sunny Central 2.2MVA

> Hello Jonathan,
>
> As requested for sample representation, I have compiled few options. You can finalise a suitable one.







Regarding the BOM:

(1) Inverter:

Sl. No.	Inverter	Qty
1	SC 2660 UP Inverter	1 nos.
2	UPSys DC-Fuse (2x750A per each DPS-500) for installation within the SC inverter	8 nos. total
3	DC coupling with AC charging	Option code to be selected.
4	Q@Night	Option code to be selected.
5	DC Insulation Monitoring	Option code to be selected.
6	Inverter Commissioning	1 nos.

(2) DC-DC Converter

Sl. No.	Inverter	Qty
1	DPS-500	4 nos.
2	Fuse 750A 1500V Size NH3L/SQB DC153 100kA (Fuse protection between Battery racks and DC Converter – 1 no. per DPS - located inside of the DPS	4 nos.
3	High accuracy DC metering kit (Located inside of each DPS)	4 nos.
4	DPS and high accuracy DC metering kit Commissioning	4 nos.

(3) Plant controller and accessories:

Sl. No.	Plant Controller	Qty
1	Hybrid Controller	1 Nos.
2	Battery Interface package	1 nos.

Also, enclosed the list of battery models which had already undergone direct communication interface compatibility test with SMA inverters.

Best Regards,

Sakthi | SMA UK | Application Engineer – Large Scale Storage | Mobile +44 7512 327201

/ DPS-500

SMA DC-DC Converter

Greater efficiency for large PV power plants

Flexible
• Wide range for battery and PV voltages
• Scalable
• Retrofittable (storage solution can be integrated anytime)

4-Quadrant Operation
• Step-up/step-down converter with battery charge/discharge function
• Limits high short-circuit currents of the battery
• Compatible with 1,500-V batteries

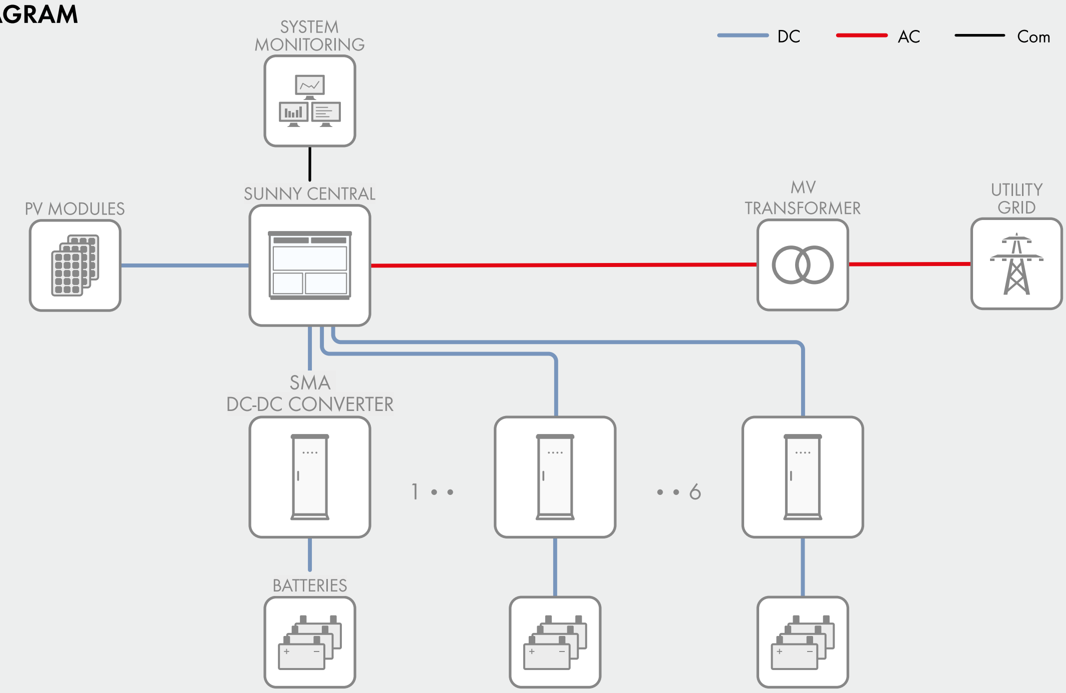
Integrated Solution
• Intelligent power flow control of the system in the Sunny Central
• Coordinated protection concept with Sunny Central
• Uniform warranty and service concept

Efficient
• Enables new business models
• High efficiency at different DC voltages as well as partial and full load
• Overnight charging/discharging

The new SMA DC-DC converter allows designers to increase their PV power plant's yields by oversizing the DC array without compromising energy losses.

This is accomplished with the new DC-coupling option and the generous DC–AC ratios of the Sunny Central EV and Sunny Central UP inverter series. The inverter can intelligently control the flow of power for many different use-cases, including clipped-loss capturing. The stored energy can be fed in at attractive times, for example, in the morning or at night, to achieve a better price-point for the energy. Grid operators are able to benefit from grid services, such as frequency control or time-based feed-in schedu-les. Up to six DC-DC converters can be connected and operated simultaneously on the Sunny Central inverter. This minimizes bat-tery short-circuits currents for high energy applications and avoids the need for additional and expensive protection measures inside the battery container.

SYSTEM DIAGRAM



Technical Data	SMA DC-DC CONVERTER without installed Metering Kit	SMA DC-DC CONVERTER with installed Metering Kit
Electrical Data		
Max. continuous power (at 30 °C)	500 kW at 1000 VDC 600 kW at 1200 VDC to 1500 VDC	
Battery input voltage range	550 V to 1500 V	
PV input voltage range	550 V to 1500 V	
Max. continuous current (at 30 °C)	+/− 500 A	
Supply voltage	120 V, 1-ph, 60 Hz, 600 VA 230 V, 1-ph, 50 Hz, 600 VA 277 V, 1-ph, 60 Hz, 600 VA	
Accuracy on power and energy measurements	<1.5 %	<0.5 %
Battery technology	compatible with all common battery technologies	
Efficiency		
Average efficiency	98.2 %	
Protective devices		
Battery-side disconnection point	Circuit breaker in the battery system and/or internal converter fusing	
PV-side disconnection point	Fusing inside the Sunny Central	
Ground-fault monitoring and insulation monitoring	Use of monitoring in the Sunny Central	
Overvoltage protection for auxiliary supply	●	
General Data		
Dimensions (W / H /D)	960.1 / 2029.5 / 983.0 mm (37.8 / 79.9 / 38.7 in)	
Weight	653 kg (1440 lb)	
Operating temperature	−25 °C to 55 °C (−13 °F to 131 °F)	
Storage temperature	−40 °C to 70 °C (−40 °F to 158 °F)	
Noise emission (sound pressure level at a distance of 10 m)	< 65 db(A)	
Cooling method	Forced air-cooling	
Degree of protection of enclosure	IP54 / UL Type 3R	
Application in unprotected outdoor environments	●	
Max. permissible value for relative humidity (non-condensing)	95%	
Maximum operating altitude above MSL 1000 m / 2000 m / 3000 m	● / ○ / ○ (earlier temperature-dependent de-rating)	
Fresh air consumption	2720 m³/h (96000 ft³/h)	
Equipment		
Cable entry	Bottom	
Communication / protocols	Modbus TCP / IP	
System monitoring	Real-time monitoring with automated alerts and data storage	
Status lights	On the front for operating mode, alert and error state	
Factory-installed DC meter (Metering Kit) with high accuracy (0.2%)	–	●
Warranty: 5 / 10 / 15 years	● / ○ / ○	
Certificates and approvals	CE Label, CISPR 11:2015+A1:2016, CSA 22.2 #107, EN 62109-1, FCC Part 15 Class A, ICC-ES-AS156, IEC 61000-6-2, IEC 62109-1, IEEE 693, UL 1741, UL 62109-1	
Type designation and material number	DPS-500 without installed Metering Kit 205607-00.01	DPS-500 with installed Metering Kit 205606-00.01

● Standard features ○ Optional features – Not available

SYL

2.2 BLOCK SPECIFICATION

Table 2-2: BESS Block Specification

SYSTEM INFORMATION	
Nominal power	1,500kW
Nameplate Capacity	3064.32kWh
BATTERY INFORMATION	
Battery Chemistry	LFP
Cell Make	280Ah
Configuration	380S9P
Number of Racks/Cabinets	9
Number of Modules per Rack	38
Nominal Voltage	1216V
Voltage Range	1064Vdc ~ 1368Vdc
Depth of Discharge	97.5%
PROTECTIONS AND SAFETY DEVICES	
Rack Level Lockable Disconnect	Yes
Short Circuit Protection	Yes
Lightning Protection	Yes
Over-charge / Over-discharge Protection	Yes
Over-temperature Protection	Yes
Fire Detection	Yes
Intrusion Detect System	Yes
External Accessible E-stop	Yes
System Controller	Yes
Uninterruptible Power Supply (UPS)	Yes
WORKING CONDITIONS	
Degree of Protection	IP54
Noise Emission	≤70dB @1m
Operating Temperature Range	-22°F ~ 113°F / -30°C ~ 45°C
Relative Humidity	0~95% (Non condensing)
Max. Working Altitude	6,500' / 2,000m
Seismic Zone	UBC Zone-4
Wind Load	120mph / 49.9m/s
Snow Load	40psf. /1.91×10^{-3}MPa
GENERAL INFORMATION	
Cooling Concept	Air Cooling
Aux. Power Supply	400VAC 50Hz 3P4L
Max. Current of Aux. Power Supply	70A
Communication Interface	Ethernet
Communication Protocol	Modbus TCP/IP
Certificate & Compliance	UL 1973, UL 9540A, IEC 62619

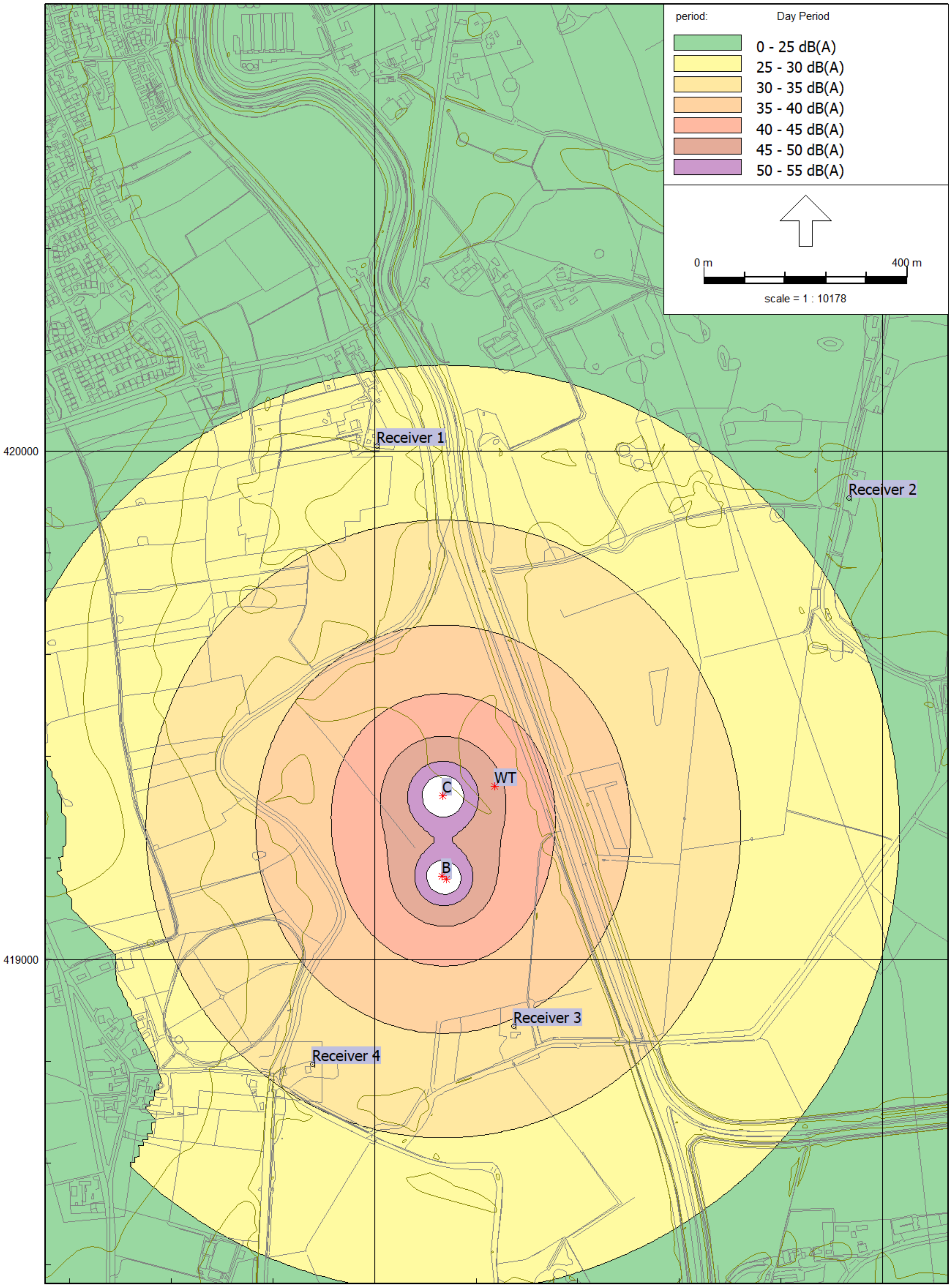
APPENDIX F

Predicted solar farm noise levels in tabular and contour formats

Report: Table of Results
Model: Solar Farm Rev 0
LAeq: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day
1 A	Receiver 1	1.50	27
2 A	Receiver 2	1.50	23
3 A	Receiver 3	1.50	35
4_A	Receiver 4	1.50	32

All shown dB values are A-weighted


period: Day Period
0 - 25 dB(A)
25 - 30 dB(A)
30 - 35 dB(A)
35 - 40 dB(A)
40 - 45 dB(A)
45 - 50 dB(A)
50 - 55 dB(A)
0 m
400 m
scale = 1 : 10178
420000
419000
346000
347000
Receiver 1
Receiver 2
Receiver 3
Receiver 4
WT
C
B

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