Issue	Date	Revision Details
1234721A	11/02/2021	Released

Appendix 10.1

Baseline Noise Measurements

Contents

10.1. INTRODUCTION

A10.1.1. Baseline noise measurements were undertaken at five nearby noise sensitive receptors as detailed at **Table 10.1** below, and at Figure 10.1, in July/August 2020. The locations were chosen to be representative of the nearest noise sensitive properties to the Proposed Development, with the exception of Daerbank which was added as the Applicant agreed with the resident to carry out measurements here despite it not being necessary for the assessment (as it is sufficiently distance from the Proposed Development).

Table 10.1: Baseline Noise Measurement Locations

Location Name	Easting	Northing
Sweetshaw Foot	298310	609080
Kirkhope Farm	296330	605455
Kirkhope Cleugh Cottage	296661	607203
Blairmack	301289	603152
Daerbank	296539	609817

10.2. MEASUREMENT LOCATION DESCRIPTIONS

A10.2.1. A description of each of the measurement locations and the instrumentation used is provided below.

Sweetshaw Foot

A10.2.2. This dwelling is located to the north of the Proposed Development. The equipment was installed on a grassed area to the north of the house and driveway, and was located so as to be away from tall trees and whistling caused by wind through the chimney pot of the property whist being representative of background noise levels around the property. Noise sources noted at installation and collection of the equipment were dog barking, seagulls, nesting birds, and wind in the trees. It should be noted that there may be times when noise from the operational Clyde Wind Farm could be audible at this location, i.e. when the property is downwind of the existing wind turbines.

Kirkhope Farm

A10.2.3. This dwelling is located to the west of the Proposed Development. The equipment was installed in the front garden of the property, and was located as far away from a nearby stream as possible whist remaining within the curtilage of the property. Noise sources noted at installation and collection of the equipment were running water from the nearby stream, sheep, and birdsong.

Kirkhope Cleugh Cottage

A10.2.4. This dwelling is located to the west of the Proposed Development. The equipment was installed in the field adjacent to the property (approximately 6 m from the boundary), and was located so as to be away from tall trees and further from the stream than the garden of the property. It was agreed with the resident that the chosen location was representative of background noise levels around the property. Noise sources noted at installation and collection of the equipment were distant running water from the stream, wind in the trees, birdsong, sheep, and a helicopter. It was also noted that a diesel generator and battery bank are used as the main power supply for the property, and the diesel generator was audible at installation of the equipment.

Blairmack

A10.2.5. This dwelling is located to the south east of the Proposed Development. The equipment was installed in the centre of the garden area as far away from tall trees as possible. Noise sources noted at installation and collection of the equipment were dog barking, wind in the foliage, and birdsong.

Daerbank

A10.2.6. This dwelling is located to the north west of the Proposed Development. The equipment was installed in the garden of the property as far away from the stream and tall trees as possible. Noise sources noted at installation and collection of the equipment were running water in the stream, insect noise, wind in the foliage, and birdsong. It should be noted that there may be times when noise from the operational Clyde Wind Farm could be audible at this location, i.e. when the property is downwind of the existing wind turbines.

10.3. INSTRUMENTATION

A10.3.1. The background/baseline noise measurements were made with RION model NL-52 Sound Level Meters and Larson Davis Model 820 Sound Level Meters, fitted with 1/2" microphones and complying with either the Class 1 standard in IEC 61672-1:2002 or Type 1 in BS5969:1981. The microphones were fitted with 45 mm radius foam ball windshields surrounded by 125 mm radius secondary windshields of 40 mm thickness (based on recommended design specifications within ETSU W/13/00386/REP, Noise Measurements in Windy Conditions) and mounted on tripods at a height of approximately 1.2 m to 1.5 m height. Pre-calibration was carried out using a Brüel & Kjær acoustic calibrator (s/n 2218188). The calibration of each meter was checked at the end of the monitoring period using the same calibrator.

A10.3.2. Concurrent onsite wind speed data was provided by the developers of the site from the two installed meteorological masts. The location and wind data measurement heights used in the noise assessment are detailed below at **Table 10.2**.

Table 10.2: Metorological Mast Locations

Data	Met Mast 1	Met Mast 2
Easting	299845	607254
Northing	298097	606294
Top wind speed measurement height (m)	80	90
Lower wind speed measurement height (m)	62	70
Wind direction measurement height (m)	76	86

A10.3.3. Pluvimate rain gauges, with Dryptych loggers, were installed at Kirkhope Farm and Blairmack.

10.4. MEASUREMENT PROCEDURE

A10.4.1. The meters were programmed to measure a number of statistical noise indices, including the LA90, together with the maximum and minimum levels and the L_{Aeq} over consecutive 10-minute periods. The equipment was synchronised to a Global Positioning System (GPS) time signal and the results were automatically stored at the end of each period.

A10.4.2. Field calibration of the noise measurement equipment was carried out before the monitoring period commenced and was checked at the end. A change of no more than 0.4 dB was noted at any of the measurement locations, which is within normal tolerances.

A10.4.3. Wind shear has been addressed by relating background noise measurements to the 102.5 m hub height wind speed, calculated from the upper and lower measurement height wind speeds detailed at **Table 10.2** using the formula:

$$V_h = V_u \times \left[\frac{h_h}{h_u}\right]^{\left(\frac{\log(V_u/V_l)}{\log(h_u/h_l)}\right)}$$

A10.4.4. Where V_h is the hub height wind speed, h_h, h_u, and h_l are the hub height, upper measurement height, and lower measurement height respectively, and V_u and V_l are the wind speed measured at the upper and lower measurement heights respectively.

A10.4.5. The 102.5 m hub height wind speed has been corrected to 'standardised' 10 m height wind speed using the same methodology as is used by manufacturers to quantify sound power level data as required by IEC 61400-11 and as detailed within the GPG, i.e.

$$V_{10} = V_h \left(\frac{\ln\left(\frac{10}{z_0}\right)}{\ln\left(\frac{h_h}{z_0}\right)}\right),$$

A10.4.6. where, V_{10} and V_h are the 'standardised' 10 m height and hub height (h_h) wind speeds respectively, and z_0 is the standardised ground roughness length (of 0.05 m). In this way, it is ensured that the comparisons of predicted turbine noise level and background level (including any associated noise limits) are made on a like-for-like basis.

A10.4.7. Rainfall data was taken from the rain gauges installed at each noise measurement location, which both logged rainfall in 10-minute intervals, time synchronised to a GPS time signal. This allows for corresponding data, where noise levels may be affected by the presence of rainfall, to be removed from the analysis.

10.5. RESULTS OF NOISE MEASUREMENTS

A10.5.1. Prevailing background noise levels during the night-time and quiet daytime hours have been derived by plotting the measured L_{A90} background noise levels against the standardised 10 m height wind speeds (calculated from the nearest of the two met masts), as described within ETSU-R-97 and the GPG and shown in Diagram 10.1 to Diagram 10.10 below for each relevant period.

A10.5.2. Any 10-minute period where rainfall was recorded at the measurement location is shown with dark blue circles and has been removed from the derivation of the prevailing background noise levels from the data collected at all the measurement locations. Where atypical or extraneous noises were noted, such as when the generator was operating at Kirkhope Cleugh Cottage, these periods have been excluded from the analysis.

A10.5.3. It should be noted that under certain wind conditions wind turbine noise at the measurement locations could potentially be affected by noise from the nearby operational Clyde Wind Farm. It is unlikely that existing operational wind farm noise would have significantly affected the baseline noise measurements (and contribution from existing wind turbines should not be included in the derivation of wind farm noise limits). In this case, to minimise any contribution from existing wind farms the measured baseline noise data was filtered to exclude wind directions of 330 to 120 degrees at the two nearest measurement locations to Clyde Wind Farm; Sweetshaw Foot and Daerbank. No other wind direction filters were applied to the other measurement locations are it is very unlikely that measured baseline noise levels would have been affected by operational wind turbine noise.

A10.5.4. Third order regression lines have been calculated through the background noise data for each time period at each measurement location to give the prevailing background noise data as required for the derivation of the ETSU-R-97 limits.

A10.5.5. **Table 10.3** and **Table 10.4** show the prevailing background noise levels for each of the relevant locations and for the two time periods suggested within ETSU-R-97 over a range of wind speeds. The baseline noise measurement results and derivation of the noise limits is shown graphically in Diagrams 10.1-10.10 which also show the exclusions.

Table 10.3: Baseline Noise Measurement Results - Night

	Standardised 10 m height wind speed (m/s)									
Location Name	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Sweetshaw Foot	23	24	26	28	31	33	36	38	39	39
Kirkhope Farm	38	38	38	38	38	39	40	41	43	45
Kirkhope Cleugh Cottage	29	29	30	31	33	35	37	39	42	44
Blairmack	33	34	35	36	37	39	42	45	48	53
Daerbank	33	34	35	36	37	39	41	44	47	51

Table 10.4: Baseline Noise Measurement Results – Quiet Daytime

	Standardised 10 m height wind speed (m/s)									
Location Name	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Sweetshaw Foot	23	25	27	29	31	34	36	38	40	42
Kirkhope Farm	38	38	38	38	38	39	40	41	42	43
Kirkhope Cleugh Cottage	28	29	30	32	34	36	38	40	43	44
Blairmack	34	34	35	37	39	41	44	46	49	51
Daerbank	33	34	36	37	39	41	43	46	48	51

A10.5.6. **Table 10.5** and **Table 10.6** show the derived night and daytime noise limits including the lower and upper daytime limits prescribed within ETSU-R-97 and the night-time noise limit of 43 dB L_{A90} or plus 5 dB above. It is understood that Sweetshaw Foot is financially involved with the Proposed Development and therefore the financially involved limits are also shown for this property.

Table 10.5: Derived Noise Limits - Night

Location Name	Standardised 10 m height wind speed (m/s) 3	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	43	43	43	43	43	43	43	43	44	44
Sweetshaw Foot (Financially Involved)	45	45	45	45	45	45	45	45	45	45
Kirkhope Farm	43	43	43	43	43	44	45	46	48	50
Kirkhope Cleugh Cottage	43	43	43	43	43	43	43	44	47	49
Blairmack	43	43	43	43	43	44	47	50	53	58
Daerbank	43	43	43	43	43	44	46	49	52	56

Table 10.6: Derived Noise Limits - Daytime

Location Name	Daytime Lower Limiting Value	Standardised 10 m height wind speed (m/s) 3	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	Lower	35	35	35	35	36	39	41	43	45	47
	Upper	40	40	40	40	40	40	41	43	45	47
	Financially Involved	45	45	45	45	45	45	45	45	45	47
Kirkhope Farm	Lower	43	43	43	43	43	44	45	46	47	48
	Upper	43	43	43	43	43	44	45	46	47	48
Kirkhope Cleugh Cottage	Lower	35	35	35	37	39	41	43	45	48	49
	Upper	40	40	40	40	40	41	43	45	48	49
Blairmack	Lower	39	39	40	42	44	46	49	51	54	56
	Upper	40	40	40	42	44	46	49	51	54	56
Daerbank	Lower	38	39	41	42	44	46	48	51	53	56
	Upper	40	40	41	42	44	46	48	51	53	56

Diagrams – Baseline Noise Measurement Results and Derivation of Limits

Diagram 10.1 – Sweetshaw Foot Night

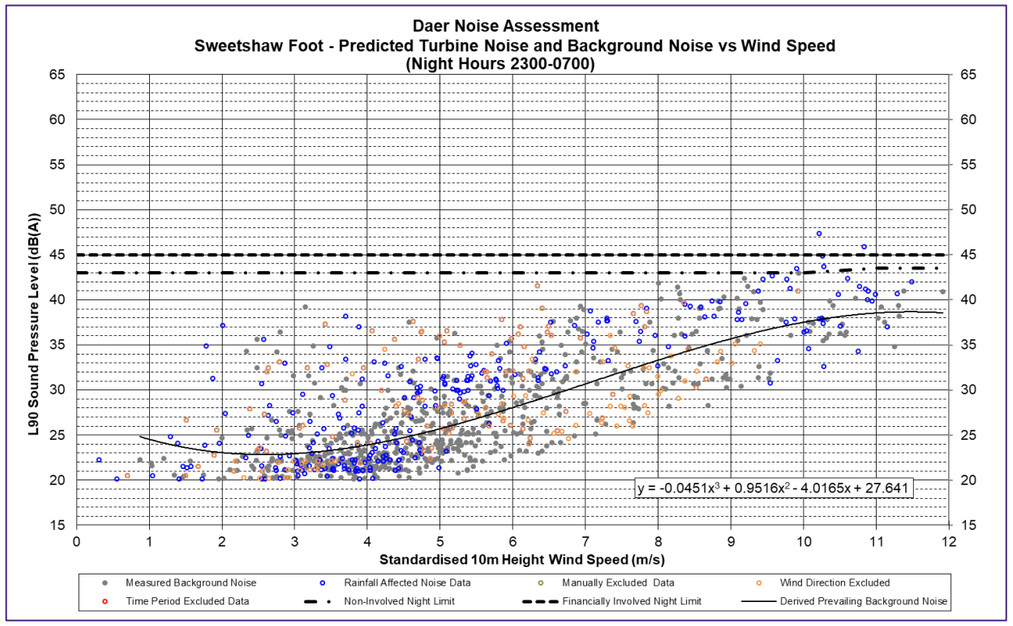

Diagram 10.2 – Sweetshaw Foot Daytime

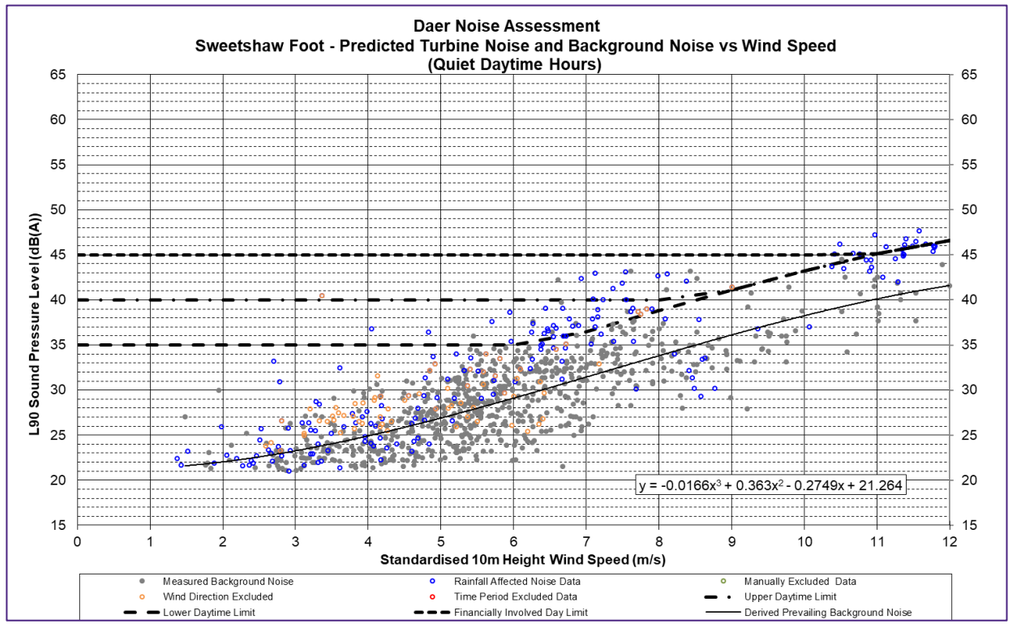

Diagram 10.3 – Kirkhope Farm Night

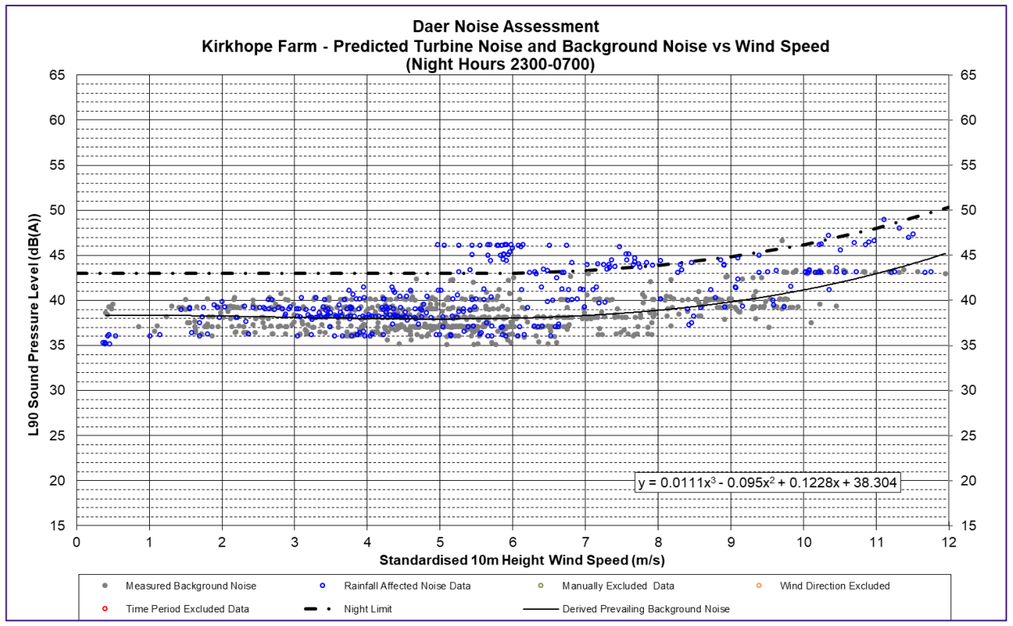

Diagram 10.4 – Kirkhope Farm Daytime

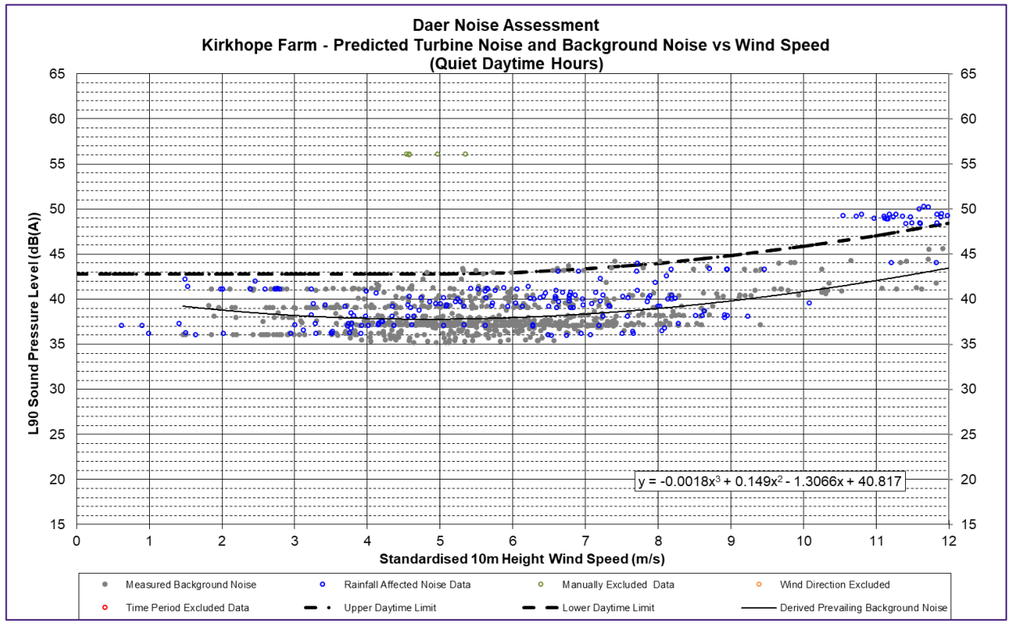

Diagram 10.5 – Kirkhope Cleugh Cottage Night

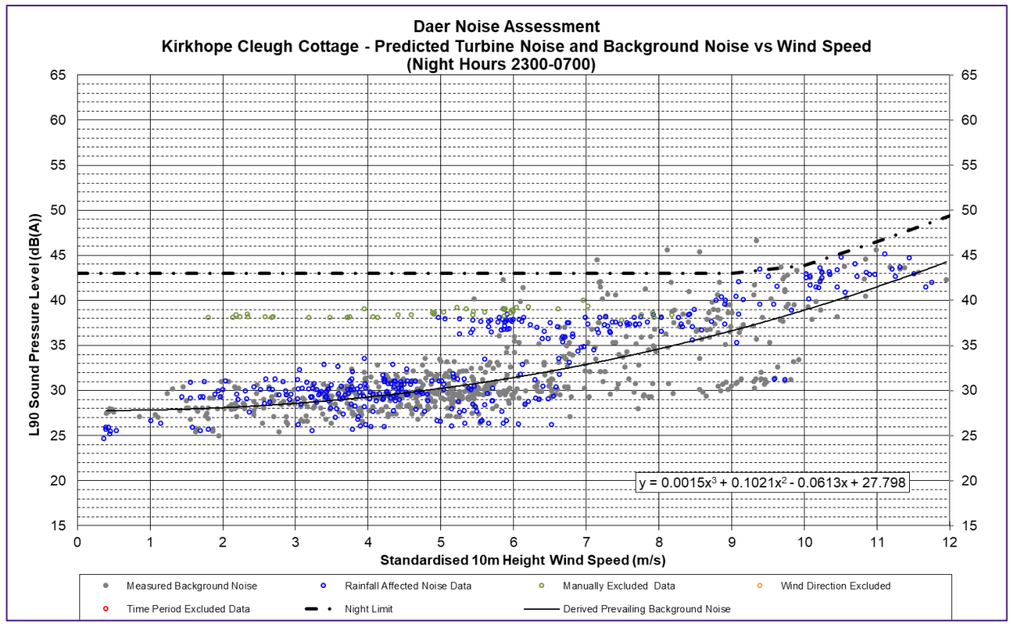

Diagram 10.6 – Kirkhope Cleugh Cottage Daytime

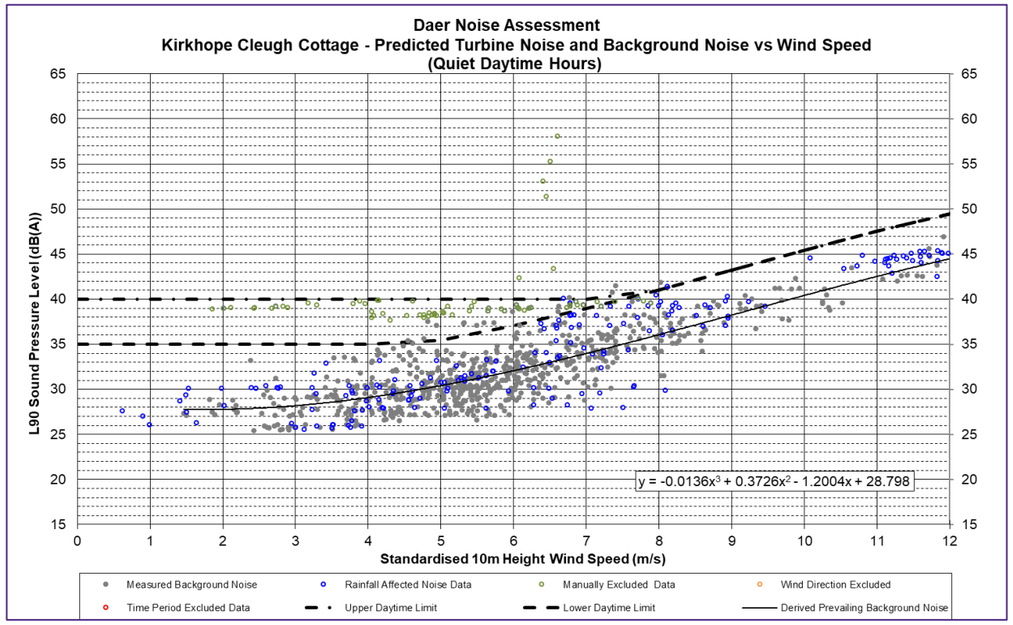

Diagram 10.7 – Blairmack Night

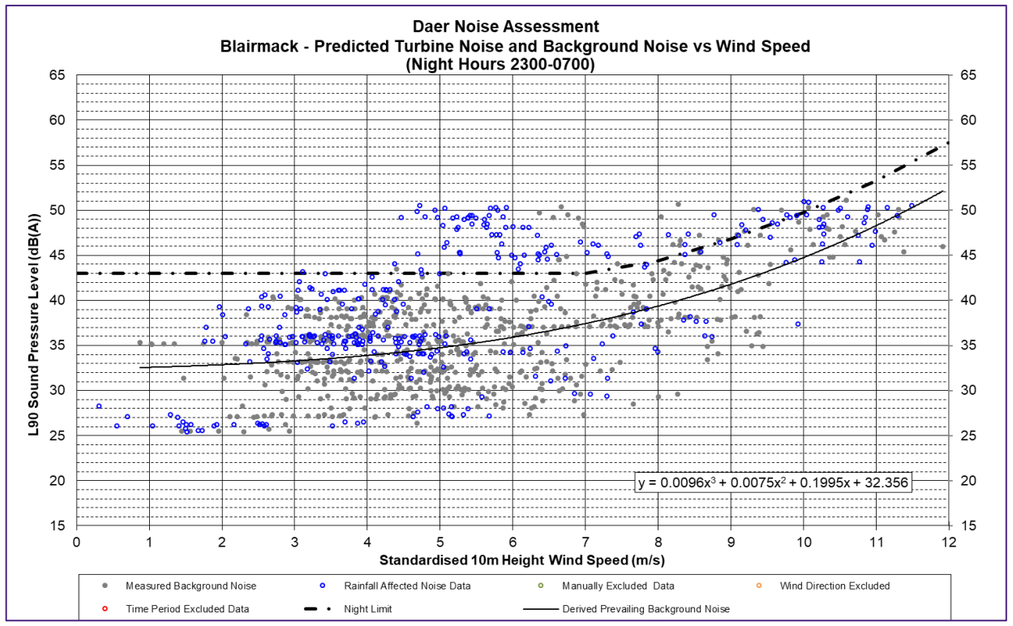

Diagram 10.8 – Blairmack Daytime

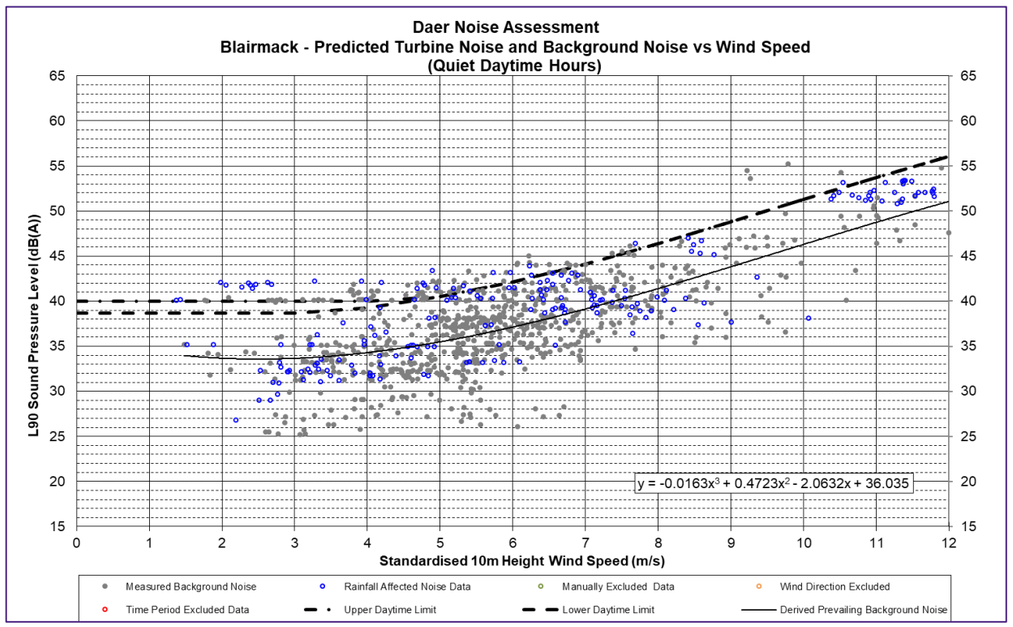

Diagram 10.9 – Daerbank Night

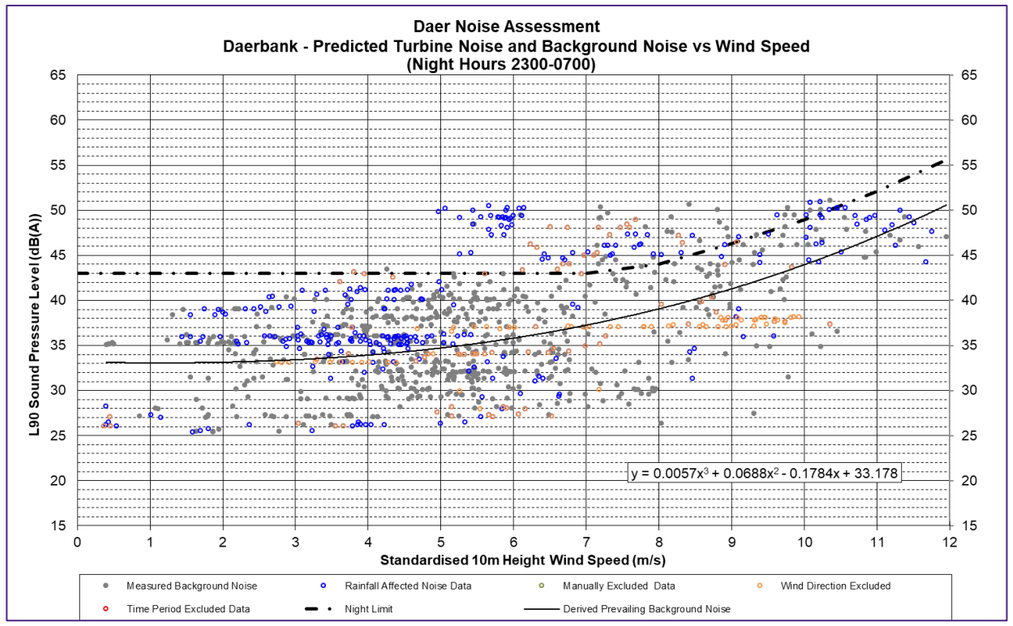

Diagram 10.10 – Daerbank Daytime