9 Noise and Vibration

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9 Noise and Vibration

9.1 Executive Summary

9.1.1 This chapter evaluates the noise and vibration effects of the Proposed Development. The levels of noise likely to occur at local residential properties as a result of the operation of the proposed wind turbines has been assessed in respect of the Proposed Development in isolation, and cumulatively with other local wind farm developments.

9.1.2 The assessment in this chapter has been carried out using the noise date for the SG-3.4-132 turbine which was determined to be the 'worst case', *ie* noisiest turbine, from a range of candidate turbines considered for the Proposed Development.

9.1.3 The noise and vibration assessment has been conducted on the basis that the noise limits in the planning conditions for the neighbouring, and recently consented, Douglas West site will be appropriate to the Proposed Development. These noise conditions are considered more up-to-date and in line with best practice than those attached to the Existing Development. The assessment has shown that the Proposed Development will meet all the conditions regarding noise and vibration contained within the recent consent for wind energy development on the adjoining site (part of the same landholding as the Proposed Development), and it is concluded that there will be no significant residual effects on nearby residential properties in terms of noise immission or ground-borne vibration.

9.2 Introduction

9.2.1 Background noise levels in the local area were surveyed in 2012 and 2015 in connection with the adjoining (consented) Douglas West Wind Farm which was also developed by 3R Energy. The results of the 2012 and 2015 surveys were considered appropriate for use in the recent applications for the Douglas West project in 2015 and 2017. The most recent application for a tip height increase to 149.9m received planning permission on 2 May 2018, reference CL/17/0477.

9.2.2 No further background noise surveys have been carried out in connection with the Proposed Development, because the background levels, i.e. the levels with no operational turbines, are no longer measurable. Noise surveys at locations already affected by existing wind energy developments are proscribed by ETSU-R-97 at page 58 (in relation to cumulative impact) which specifically states that an existing wind farm "*should not be considered as part of the prevailing background noise*". That paragraph of the appropriate guidance also makes it clear that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area in order to assess the likely impact of the wind turbine generators on noise-sensitive receptors. Planning conditions were set by SLC when planning permission was granted for the neighbouring Douglas West project in 2018, and these noise limits and conditions previously set down remain appropriate for the protection of nearby receptors in respect of the Proposed Development.

9.2.3 The present assessment has been made against the guidelines available for wind energy developments as noted in Section 9.3.5 below. Particular attention was paid to the ETSU-R-97 report *The Assessment and Rating of Noise from Wind Farms*, the latest *Onshore wind energy planning conditions guidance note* (Renewables Advisory Board and the Department for Business, Enterprise and Regulatory Reform, BERR) and the Institute of Acoustics' (IOA) *Good Practice Guide on the application of ETSU-R-97*, May 2013 together with its supplementary guidance notes published in 2014.

9.3 Legislation, Policy and Guidelines

Legislation

9.3.1 The Control of Pollution Act 1974 sets out legislation relating to noise from construction sites, from plant and machinery and from other sources, and discusses best practicable means and codes of practice for minimising noise.

Planning Policy

9.3.2 Energy policy in Scotland has been specifically reserved to the UK parliament, but planning is a matter that has been devolved to the Scottish Government. The Scottish Government has previously stated that ETSU-R-97, supplanted by guidance on best practice, should be used to assess environmental noise from wind turbines (Scottish Government, 2014).

9.3.3 Chapter 5 sets out the planning policy framework that is relevant to the EIA. Of relevance to the noise and vibration assessment presented within this chapter, regard has been had to Paragraph 169 of Scottish Planning Policy, which notes that noise impacts on individual dwellings and communities are to be considered in development management for energy developments.

9.3.4 Relevant SLC policy relating to assessment of noise from onshore wind farms is found in the South Lanarkshire Local Development Plan (2015), and SLC Supplementary Guidance 10 Renewable Energy (2015). Part 10b of the assessment checklist (Table 7.1) also states that "*all applications for wind turbine developments should be accompanied by a site specific noise assessment*".

Guidance

9.3.5 Recognisance has been taken of the following guidance and recommendations:

- The Working Group on Noise from Wind Turbines The Assessment & Rating of Noise from Wind Farms (ETSU-R-97) (1996)
- (Institute of Acoustics, 2013) Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA Good Practice Guide) and associated Supplementary Guidance Notes
- Planning Advice Note (PAN) PAN1/2011 Planning and Noise. Information and advice on noise impact assessment methods is provided in the associated Technical Advice Note Assessment of Noise
- (Institute of Acoustics, 2009) Bulletin Article Volume 34 No. 2, March / April 2009
- ISO 9613-2:1996 Acoustics -- Attenuation of Sound during Propagation Outdoors -- Part 2: General Method of Calculation

9.4 Consultation

9.4.1 The Environmental Health department at SLC was consulted before the original background noise survey most appropriate to the Proposed Development was carried out in July 2012. The Environmental Health Officer (EHO) was consulted again in 2015 and 2017 in order to discuss the scope of any further background noise survey work and whether the results of the 2012 survey could still be considered valid for the adjoining Douglas West Wind Farm, consented in 2018.

9.4.2 The original planning consent for the Existing Development does not make any reference to wind speeds and was granted before the publication of ETSU-R-97. It sets a flat noise limit and thus no longer represents best practice.

9.4.3 Through consultation with the SLC Environmental Health department in connection with the neighbouring Douglas West project it was considered neither necessary nor appropriate to repeat the background noise measurements at any locations, because so many additional turbines have been brought into operation in recent years. In accordance with ETSU-R-97 guidance, additional

background noise measurements have similarly not been undertaken in connection with the Proposed Development.

9.5 Assessment Methodology and Significance Criteria

Study Area

9.5.1 Preliminary noise predictions for a matrix of 14 turbines indicated the area within which a noise immission level of 35dB $L_{A90,10min}$ could be exceeded. The extent of this area depends on the disposition of the nearest turbines to the receptor in question, and the area possibly affected by noise from the Proposed Development could extend to 5 km from the site boundary, although at such distance the noise immission level will be considerably less than 35 dB. The nearest noise-sensitive receptors within the study area which could be subject to more than approximately 30 dB were identified so that noise predictions could be made for all residential properties in accordance with the relevant guidance. It is worthy of note that in any given direction from the Proposed Development, if the noise impact is acceptable at the nearest noise-sensitive location then it must necessarily also be acceptable at more distant locations.

9.5.2 Given that the separation distances between the Proposed Development and the nearest residential properties are of the order of hundreds of metres, vibration effects would be imperceptible, so only a brief qualitative vibration assessment was conducted. The levels of vibration depend not only on the input excitation, but also on the ground conditions close to the surface (in the unconsolidated layer) and the nature of the property in which vibration might be detected. None of these can be predicted other than in terms of the order of magnitude.

Methodology

PAN45 and Subsequent Web-based Guidance

9.5.3 Until early 2011 Planning Advice Note 45 specified the issues that should be taken into account by local planning authorities when assessing the development of renewable energy projects. Regarding wind turbines in particular, the guidance stated that the framework for the measurement of wind farm noise in the ETSU-R-97 report (see below) should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from such developments, until such time as an update was available. PAN 45 also cited the UK Government's statement regarding the findings of the Salford University report into aerodynamic modulation of turbine noise, which concludes that there is no evidence of health effects arising from infrasound or low frequency noise generated by turbines.

9.5.4 In March 2011, PAN 45 was revoked and replaced by web-based planning guidance on renewable energy. This web-based guidance refers to ETSU-R-97 as a framework for the measurement of wind farm noise which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. It goes on to cite ETSU-R-97, stating that it "*…gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions*".

ETSU-R-97

Background noise

9.5.5 A development of this type should be assessed using ETSU-R-97, since the current web-based guidance recommends this approach. The report describes a framework for the measurement of turbine noise and indicates desirable noise levels, so that without placing unreasonable restrictions on wind energy developments, neighbouring residential properties can be protected from excessive noise. A primary objective of the report is to suggest noise limits in a form suitable for adoption as planning conditions. The Noise Working Group that produced the report considered that absolute noise limits regardless of wind speeds were not suited to wind energy

schemes in the UK, and that it was more appropriate in the majority of cases to set noise limits relative to background noise.

9.5.6 The background noise levels are to be measured over a range of wind speeds so that the impact of turbine noise, which is also wind-speed dependant, can be evaluated. The parameters to be measured include the equivalent continuous noise level and the 90% exceedance level. The equivalent continuous noise level L_{Aeq} is the noise level in 'A' weighted decibels which, if present for the entire measurement period, would produce the same sound energy to be received as was actually received as a result of the real, time-varying signal. The abbreviation often includes a specification of the time period (such as 1 hour, or 5 minutes) indicating the period of time to which the measured value has been normalised; for example, '$L_{Aeq,1h}$'.

9.5.7 The statistical indicator of the form L_n resulting from an environmental noise measurement is the level which was exceeded for *n* percent of the measurement period. Thus, an L_{A90} of 40dB means that an A-weighted sound pressure level of 40dB was exceeded at the microphone for 90% of the measurement period. Any value of *n* between 0 and 100 is meaningful, but the indices most widely used in the UK are L_{A90}, L_{A50} and L_{A10}. The L_{A90} index is generally taken to be representative of the steady background noise level. The L_{A50} is the arithmetic average of all the instantaneous values during the measurement period. The principal use of L_{A10} is in the assessment of road traffic noise. Again, the time period over which the measurement took place can be specified, so the $L_{A90,10min}$ is the level which was exceeded for 90% of a ten-minute measurement period: in other words, the level was exceeded for nine of the ten minutes.

9.5.8 One of the most important recommendations in the ETSU-R-97 report is that the statistical index $L_{A90,10min}$ should be used for both the background noise and the wind farm noise. This allows reliable measurements to be made without them being corrupted by louder, transitory noise events from other sources, which would be unavoidable in the countryside. The report notes that for a typical turbine the $L_{A90,10min}$ is between 1.5 and 2.5 dB lower than the L_{Aeq} over the same measurement period. This is worthy of note because for conventional noise measurements in the environment, the L_{Aeq} index is generally regarded as the most appropriate descriptor, and it is normal practice to use it when noise limits are being set. In the present assessment, a constant difference of 2dB between $L_{A90,10min}$ and L_{Aeq} is assumed for wind turbine noise.

9.5.9 A methodology is provided in ETSU-R-97 for the measurement of background noise levels under various wind conditions. The report recommends that data which may be corrupted by extraneous noise sources, including periods when rain falls or when watercourses have abnormally high flows, should be discarded. At all times, the noise levels measured in the environment are to be correlated with wind speed measurements at the site, at a reference height of 10m above ground. Because the noise levels can vary by several decibels at any given wind speed, a curve is to be fitted to the raw data (having discarded measurements that were possibly rain-affected, as noted above) in order to determine the typical variation in background noise level with wind speed. The exercise is carried out for 'quiet' daytime amenity periods and night-time periods, defined as follows. Daytime amenity periods are from 18:00h to 23:00h on weekdays, 13:00h to 23:00h on Saturdays, and all day Sunday. Night-time is between 23:00h and 07:00h daily. All other periods (weekdays and Saturday mornings) are defined as normal daytime, when it would be expected that the ambient noise levels may be somewhat elevated because of human activity, distant road traffic, and natural noise sources.

9.5.10 No specific method is prescribed for the calculation of turbine noise, although there is a basic requirement for the sound power level of the machine to be determined by a standard test method (such as the IEA Recommended Practice). It should be noted that background noise levels are to be determined by best-fit curves through the survey data once extraneous data points have been removed. The ETSU-R-97 report has been supplemented with good practice guidance published by the IOA; this is described below.

Noise Limits

9.5.11 The practice of controlling turbine noise by means of noise limits at the nearest noise-sensitive properties is appropriate to the Proposed Development, and this was the practice adopted when

the existing planning conditions for the nearby developments were set. Noise limits are applied at external locations and only to those areas frequently used for relaxation or activities for which a quiet environment is highly desirable. Noise limits were set relative to the background noise at the nearest noise-sensitive properties. Thus, the limits reflect the variation in both turbine source noise and background noise with wind speed. According to ETSU-R-97 and RAB/BERR guidance, separate noise limits are appropriate for daytime and for night-time, because during the night the emphasis is on preventing sleep disturbance rather than protecting external amenity. Absolute noise limits and margins above background relate to the cumulative effect of all turbines in the area contributing to the noise received at the properties in question. Noise from the turbine or combination of turbines is limited to 5dB above background for daytime and night-time, remembering that the background level of each period may be different.

9.5.12 The process by means of which the noise limits were reached is described for completeness in the following section.

Guidance on the use of ETSU-R-97

Acoustics Bulletin Article

9.5.13 After some years of applying the ETSU-R-97 recommendations, there was a perceived need to update the guidance in order to keep it relevant to modern large turbines. A panel of acoustics practitioners in the field held a number of discussions, the product of which was an agreed procedure published in Acoustics Bulletin in the March/April 2009 issue (volume 34, number 2). In the years between the appearance of that publication and the date of this planning application, two enhancements or clarifications of ETSU-R-97 in the article have received widespread acceptance among local planning authorities and at Public Inquiries into wind farm applications. The enhancements relate to (i) the issue of site-specific wind shear and (ii) the assumptions to be made when predicting turbine noise at remote locations. These topics are also dealt with in the IOA Good Practice Guide.

IOA Good Practice Guide (2013)

9.5.14 The IOA Good Practice Guide includes a number of important recommendations, many of which originally appeared in the Acoustics Bulletin article of March/April 2009. The guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50kW, reflecting the original principles within that guidance and the results of research and experience since its publication. The document was prepared by an IOA working group but further comments were received from the relevant UK Government Oversight Group at DEFRA and absorbed into the Guide.

9.5.15 As far as the Proposed Development is concerned, the Guide is particularly relevant to the consideration of turbine noise emission characteristics (noise input data) and to the determination of background noise levels and wind speeds, and thus noise limits. A method of allowing for wind shear in situations where a full height meteorological mast is not available is also recommended in the Guide. Summary points are provided as numbered Summary Boxes (SB): those relevant to the present study are provided below with explanation. Additional supplementary guidance notes, published separately, expand on some of the aspects considered.

9.5.16 SB2 states that the study area should cover at least the area predicted to exceed 35dB L_{A90} at up to 10m/s wind speed from all existing and proposed turbines. There is no requirement to consider noise levels at wind speeds above 10m/s because the subject turbine reaches its maximum noise output at a lower wind speed than 10m/s (derived at 10 m height), and its wind speed versus noise characteristic reaches a plateau level. SB3 requires that any contribution to background noise levels from an existing wind farm must be excluded when assigning background noise and setting noise limits for a new development.

9.5.17 SB4 relates to the selection of background noise monitoring locations. SB6 confirms that surveys may be carried out at any time of year. SB7 dictates the standard of measurement equipment to be used, and SB8 informs the choice of measurement locations. SB9 requires the correlation of

noise measurements with standardised 10m wind speed, and SB10, SB11 and SB12 give further recommendations for the conduct of background noise surveys and their duration.

9.5.18 SB13 confirms that the definitions of 'amenity hours' and 'night-time hours' in ETSU-R-97 remain applicable. SB14 requires the removal of data showing the presence of noise sources 'not common to the representative measurement locations', and SB15 recommends that the 'dawn chorus', where present, should also be removed from the data set. SB16 formalises the removal of rain-affected data, and SB17 allows the routine inclusion of noise from rush hour traffic. SB18 is a recommendation for data analysis by regression but states that the order of that regression depends on the nature of the noise environment.

9.5.19 SB20 deals with the prediction of noise immission levels from wind turbines. In summary, it confirms the recommendations of the Acoustics Bulletin article of March/April 2009 in respect of the difference between L_{A90} and L_{Aeq}, the adoption of a ground factor G of 0.5, the inclusion of a margin of uncertainty in the turbine noise emissions, together with a statement of its robustness, and the basic parameters for source and receiver heights and atmospheric conditions.

9.5.20 SB21 describes the issues in cumulative noise assessment, where a new wind energy development is proposed in an area where one or more turbines are already operational or proposed.

9.5.21 Under Section 7, Other Guidance, the IOA Guide covers points including planning conditions, (of which a sample is provided), and states that the evidence in relation to 'excess' or 'other' amplitude modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM, because it has not proved possible to develop a workable and valid form of condition. An IOA Working Group has recently defined a metric for the detection and definition of AM but has not given any indication as to how the findings might be incorporated into planning conditions.

9.5.22 Six Supplementary Guidance Notes are referred to in the IOA Good Practice Guide. Four of these were published in July 2014, and the other two in September 2014. Supplementary Guidance Notes numbers 1 to 4 inclusive are applicable to the present assessment: they relate to data collection, sound power level data, data processing and filtering, and the derivation of wind shear.

Significance Criteria

9.5.23 Predicted noise levels which exceed relevant limits at noise-sensitive receptors, calculated by the above methodology, are considered to be **significant**. Noise levels which do not exceed the relevant limits at noise-sensitive receptors are **not significant**.

9.6 Baseline Conditions and Noise Limits

9.6.1 The area surrounding the Proposed Development is sometimes subject to the wind turbine noise emitted by the various operational wind energy developments, and it is no longer possible to determine the background sound levels in the absence of wind turbine noise. In order to compare the noise immission from the Existing Development with the noise immission from the Proposed Development, the same calculation procedure may be used for both scenarios, substituting the 14 proposed turbines for the 26 existing turbines. For convenience this is discussed in the following section.

9.6.2 The noise limits for the recently consented wind energy development at the adjoining Douglas West site were derived from two background noise survey campaigns. The proposed noise limits resulting from the background measurements are expressed to the nearest whole decibel in Table 9.1.

9.6.3 Station House is a financially involved property for Douglas West Wind Farm, but not for the Proposed Development, so the noise limits were higher in relation to Douglas West; this does not apply to the Proposed Development.

9.6.4 Different noise limits apply to daytime and night-time, and the limits are expressed against the derived integer wind speeds at 10 m height on site.

9.6.5 The owners of Hazelside Farm and Blackwood Cottage have a financial interest in the Proposed Development and therefore qualify for the higher noise limits specified in ETSU-R-97. Noise sensitive receptor locations are shown on Figure 9.1.

Table 9.1 – Noise Limits for the Proposed Development

Name	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Daytime (07:00h – 19:00h)									
Hazelside Farm and Blackwood Cottage	45	45	45	45	45	45	47	50	52
All other locations (see Figure 9.1)	40	40	40	42	43	45	47	50	52
Night-time (19:00h – 07:00h)									
Hazelside Farm and Blackwood Cottage	45	45	45	45	45	45	45	45	45
All other locations (see Figure 9.1)	43	43	43	43	43	43	43	43	43

9.7 Predictive Calculations

Characteristics of Wind Turbine Noise

9.7.1 Noise from turbines is typically made up of a reasonably steady, broad-band noise of aerodynamic origin, which depends on blade tip speed, and mechanical noise from within the nacelle. On older designs of turbine, there may be a tonal noise element from mechanical components within the nacelle. Modern large turbine designs emit noise primarily of aerodynamic origin, with very little mechanical noise being transmitted into the environment. In general, none of the noise emission is tonal in character. The broadband noise is amplitude modulated, *ie* it varies in amplitude as the three turbine blades rotate, with the maximum modulation occurring on the downward movement of each blade from roughly horizontal to near-vertical. This variation of the instantaneous sound level is accounted for in the noise prediction methodology.

Turbine Sound Power Data

9.7.2 The Existing Development turbines are Bonus B44 types with hub heights of 35 m. Manufacturer's data indicate that the turbines each emit a maximum sound power level of 99.8 dB(A) at the reference wind speed (v_{10}) of 8 m/s. Spectral information for the calculation of excess attenuation over distance was approximated from the manufacturer's data with an appropriate adjustment to ensure equivalence to the assumed overall warranted level plus 2dB uncertainty.

9.7.3 The noise data used in the predictive calculations are those for the Siemens Gamesa SG-3.4-132 turbine (with an assumed hub height of 135m) in its normal operational mode (i.e. not noise-restricted), which is the candidate turbine considered to represent a 'worst case' analysis. The method used to obtain sound power data conformed to the IEC 61400-11 standard, the most commonly used procedure, which calls for measurements close enough to the turbine that background noise is insignificant. The data are derived from the manufacturer's published data (specification) for the physically similar SG-3.4-132, and an uncertainty of 2 dB was included in the sound power levels used for noise prediction purposes as required by the IoA guidance documents.

9.7.4 The turbines would be configured for a maximum overall sound power level (each turbine, manufacturer's reported test levels plus uncertainty) of 108.2 dB(A) at the reference wind speed (v_{10}) of 8 m/s. The SG-6.0-155PG turbine, which is also worthy of analysis, has reported overall

noise emissions 0.9dB lower than this. The sound power depends on wind speed up to the maximum governed rotational speed of the turbine, and the closest approach of wind farm noise to the limit curve is almost invariably within the 6 to 8 m/s wind speed range. Spectral information for the calculation of excess attenuation over distance was also taken from the manufacturer's specification with an appropriate adjustment to ensure equivalence to the overall warranted level plus uncertainty.

Turbine Locations

9.7.5 The proposed turbine coordinates are shown in Table 9.2.

Table 9.2 – Turbine Coordinates for Noise Predictions

Turbine No.	Easting	Northing	Turbine No.	Easting	Northing
T1	278749	629561	T8	279327	630246
T2	279149	629586	T9	278976	630329
T3	279760	629664	T10	279546	630730
T4	279042	629950	T11	279242	630900
T5	279595	630026	T12	278864	630881
T6	280015	630194	T13	278604	631053
T7	279831	630506	T14	279590	631291

Calculation Procedure for Wind Turbine Noise

9.7.6 The method adopted for the prediction of noise from the turbines is the ISO 9613-2:1996 method interpreted in the light of the IOA Good Practice Guide. The model assumes sound radiation from a point source with only slight attenuation by ground effects. The attenuation resulting from ground effects and atmospheric absorption varies with frequency and distance, and the predictions are carried out in octave bands with the overall A-weighted levels being calculated from the results. The source sound power levels used for calculation purposes take no account of the available noise reduction methods on the candidate turbine or similar types, although various modifications may be available.

9.7.7 The IOA Good Practice Guide states that in order to give reliable predictions of the aggregate noise levels at receptor locations, certain assumptions should be made. These represent the worst case for noise immission of each receiver, i.e. for the condition when the wind blows from the turbines to the receptor. The assumptions are:

- All turbines are directly upwind of the receptor;
- The manufacturer's warranted noise data, or published test data, plus an allowance for uncertainty, are used as input to the acoustical model;
- A ground attenuation factor G = 0.5, representing a mix of soft and hard ground, for G_s, G_m and G_r (the ground types in the source region, middle region and receiver region as defined by ISO 9613-2);
- The noise source of each turbine is concentrated at turbine hub height; and
- A receptor height of 4 m, corresponding to a first-floor window (note that this conflicts with ETSU-R-97 recommendations).

9.7.8 In order to calculate the steady noise from the proposed wind turbines the effect of each turbine at each receptor location is calculated. ETSU-R-97 suggests that the steady nature of the noise emitted by wind turbines is such that the level difference between L_{Aeq} and L_{A90} is typically 2 dB, and this has been confirmed by readings from several turbines in various types of terrain; the

approach is advocated by the IOA Good Practice Guide. A 2 dB deduction was therefore made from the overall sound power level to yield the typical L_{A90} for calculation purposes. The direction of the wind makes the noise from the turbine effectively directional, since the noise level at a given distance upwind of the turbine will be considerably lower than at the same distance downwind.

9.7.9 The OS grid coordinates of the noise prediction locations are shown in Table 9.3. The coordinates were selected to represent the nearest point to any turbine within the curtilage of the property named and therefore may not coincide exactly with the locations used in other chapters. Locations R9 (Hazelside Farm) and R11 (Blackwood Cottage) are owned by the developer and may therefore be presumed to qualify as locations having a financial involvement with the Proposed Development. The noise immission levels at unnamed properties adjacent to the listed locations can be taken to be the same as at the listed locations: for example, the noise immission levels at The Shieling and Inches Cottage will be the same as those at Monksfoot (location R2).

Table 9.3 –Coordinates for Noise Prediction Locations

Receptor	Easting	Northing	Receptor	Easting	Northing
R1 Shielpark	277537	628023	R8 Ayr Road/ Hillview Crescent	280901	628448
R2 Monksfoot	278588	628510	R9 Hazelside Farm	281511	628771
R3 Carmacoup Fm Cott	279239	627782	R10 Station House	282095	630960
R4 Viaduct Cottage	279626	627868	R11 Blackwood Cottage	282134	631007
R5 Bungalow Cottage	279884	627688	R12 Scrogton	282644	630470
R6 Longhouse Cottage	280215	627963	R13 Scrogtonhead	282275	630245
R7 Braeface Cottages	280389	628085			

Results of Noise Predictions

9.7.10 The predicted worst-case noise levels for the receptor locations from the Existing Development are presented to the nearest whole decibel in Table 9.4.

Table 9.4 – Current Worst-Case Noise Immission Levels dB $L_{A90,10min}$ against 10m Wind Speed (Existing Development)

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Shielpark	17	20	23	24	25	26	27	28	29
Monksfoot	21	24	27	28	29	30	31	32	33
Carmacoup Fm Cott	18	21	24	25	26	27	28	29	30
Viaduct Cottage	18	21	24	25	26	27	28	29	30
Bungalow Cottage	17	20	23	24	25	26	27	28	29
Longhouse Cottage	18	21	23	24	25	26	27	28	29
Braeface Cottage	18	21	24	25	26	27	28	29	30
Hillview Crescent	18	21	24	25	26	27	28	29	30
Hazelside Farm	17	20	23	24	25	26	27	28	29
Station House	18	21	24	25	26	27	28	29	30

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Blackwood Cottage	18	21	23	24	25	26	27	28	29
Scrogton	15	18	21	22	23	24	25	26	27
Scrogtonhead	17	20	23	24	25	26	27	28	29

9.7.11 The predicted worst-case noise levels for the receptor locations from the Proposed Development are presented graphically in Appendix 9.1. The curves shown represent the aggregate turbine noise based on the noise data for the SG-3.4-132, and the assumed daytime or night-time noise limit curves applied at each location as appropriate. The results are also shown to the nearest whole decibel in Table 9.5. The amounts by which the wind farm complies with the assumed noise limits are presented in Table 9.6. Please note that Tables 9.5 and 9.6 and the graphs shown in Appendix 9.1 refer to predicted noise generated by the Proposed Development on its own. Cumulative noise effects are discussed in Section 9.9 of this chapter. Table 9.5 can be recalculated for the SG-6.0-155PG turbine type and this is presented for comparison in Appendix 9.2. The differences are less than 1dB at all locations and at all wind speeds, with the SG-6.0-155PG giving the lower noise immission levels.

Table 9.5 – Predicted Worst-Case Noise Immission Levels dB $L_{A90,10min}$ against 10m Wind Speed (Proposed Development)

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Shielpark	24	30	32	33	32	32	32	32	32
Monksfoot	30	36	38	39	38	38	38	38	38
Carmacoup Fm Cott	26	32	34	35	34	34	34	34	34
Viaduct Cottage	27	32	35	35	35	35	35	35	35
Bungalow Cottage	25	31	33	34	33	33	33	33	33
Longhouse Cottage	26	31	34	34	34	34	34	34	34
Braeface Cottage	27	32	34	35	35	35	35	35	35
Hillview Crescent	27	32	35	35	35	35	35	35	35
Hazelside Farm	25	30	33	33	33	33	33	33	33
Station House	24	30	32	33	32	32	32	32	32
Blackwood Cottage	24	29	32	32	32	32	32	32	32
Scrogton	22	27	30	30	30	30	30	30	30
Scrogtonhead	24	29	32	32	32	32	32	32	32

9.8 Assessment of Potential Effects

9.8.1 All receptor locations are assumed to be noise-sensitive, although properties occupied by persons with a financial interest in the project are deemed slightly less sensitive: this subjective reaction is anticipated by ETSU-R-97 which considers that higher noise limits are appropriate for such locations.

9.8.2 The magnitude of change in noise levels depends on the degree to which sounds from the turbines exceed the prevailing background sound level, and thus on how audible the sound may be under different wind conditions.

Construction of the Proposed Development

9.8.3 During the removal of the existing turbines and construction of the repowered wind farm there will inevitably be additional road traffic in the vicinity of the site, but vehicle routes will be carefully prescribed in consultation with SLC, in order to minimise disruption and disturbance. The frequency and numbers of such vehicle movements will be insufficient to affect the road traffic noise experienced by local residents, and site access will be gained directly from the national motorway network avoiding the need to pass through any local villages: there will be no significant effects on the local road network in residential areas. The permitted hours for deliveries and for working hours on site can be limited by planning condition.

9.8.4 The construction process involves ground excavation, placement of steel reinforcement, and concrete pouring. The process is relatively quiet, with the typical 360^{o} excavator emitting a maximum noise level of around 85 dB(A) at a distance of 5 m. There will also be on site, from time to time, tipper lorries to deliver stone for tracks and remove spoil, and other lorries to deliver materials. Each of these events will be short-lived, and the noise levels emitted by the machinery will be comparable with those for an agricultural tractor. Since the operations will be restricted to the normal working day, and because of the separation distances between turbines and local noise-sensitive locations, no significant noise will be received at residential properties.

9.8.5 The effects of distance, ground effects and air absorption mean that at the nearest noise-sensitive property, the minimum separation distance to construction of any proposed turbine infrastructure being around 1 km, the resulting noise levels will be less than 40 dB L_{Aeq}. Operations at an individual turbine foundation would take no more than a day or two, but even in a flat calm the resulting noise would only slightly exceed the daytime background noise level.

9.8.6 The construction of access tracks will be limited to local ground levelling operations, movement of road stone or gravel by tipper lorry, and compaction of the tracks using rollers. The maximum noise levels from the machinery used will be of the order of 80 dB(A) at 5 m distance, and although the activities may be audible from time to time at the closest noise receptor locations, they will not be intrusive and will only be short-term as that localised stretch of road is made and construction work moves on. The noise from construction is low in magnitude of change and is **not significant**.

9.8.7 Vibration from construction operations, whether at wind turbine locations or near site access tracks, will be undetectable beyond a few tens of metres from the vibration source. Blasting may be used if suitable stone is found on site. There are three borrow pit search areas from two of which stone may be extracted, and if this resource is to be used only a single blast pattern will be required. The minimum separation distance between any potential borrow pit for stone and the nearest non-involved residential property will be over 1 km. It is possible that the peak particle velocity (ppv) from the blast might marginally exceed 1.5 mm/s, this being the typical threshold of detection by a human, but there is no possibility that the BS.7385-2:1993 threshold for cosmetic damage to property, 15 mm/s at a frequency of 4 Hz, will be reached. In any event, the weight of explosive charge required to remove and fragment the rock would be kept to a minimum and the expected ppv calculated from that information. The vibration impact from the single blast pattern is **not significant**.

9.8.8 The vibration arising as a result of the passage or operation of an item of construction machinery, including rock processing and handling machinery, will be such that no ground vibration during construction or rock winning operations will be detectable to a human observer inside neighbouring properties. The levels of vibration inside these properties will be several orders of magnitude lower than the architectural damage criteria given in BS.7385-2:1993, and at least two orders of magnitude below the levels perceptible to a human observer. This magnitude of change is negligible, and **not significant**.

Operation of the Proposed Development

Table 9.6 – Predicted Margins of Compliance with Assumed Noise Limits, dB

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Daytime									
Shielpark	16	10	8	9	11	13	15	18	20
Monksfoot	10	4	2	3	5	7	9	12	14
Carmacoup Fm Cott	14	8	6	7	9	11	13	16	18
Viaduct Cottage	13	8	5	7	8	10	12	15	17
Bungalow Cottage	15	9	7	8	10	12	14	17	19
Longhouse Cottage	14	9	6	8	9	11	13	16	18
Braeface Cottage	13	8	6	7	8	10	12	15	17
Hillview Crescent	13	8	5	7	8	10	12	15	17
Hazelside Farm	20	15	12	12	12	12	14	17	19
Station House	16	10	8	9	11	13	15	18	20
Blackwood Cottage	21	16	13	13	13	13	15	18	20
Scrogton	18	13	10	12	13	15	17	20	22
Scrogtonhead	16	11	8	10	11	13	15	18	20
Night-time									
Shielpark	19	13	11	10	11	11	11	11	11
Monksfoot	13	7	5	4	5	5	5	5	5
Carmacoup Fm Cott	17	11	9	8	9	9	9	9	9
Viaduct Cottage	16	11	8	8	8	8	8	8	8
Bungalow Cottage	18	12	10	9	10	10	10	10	10
Longhouse Cottage	17	12	9	9	9	9	9	9	9
Braeface Cottage	16	11	9	8	8	8	8	8	8
Hillview Crescent	16	11	8	8	8	8	8	8	8
Hazelside Farm	20	15	12	12	12	12	12	12	12
Station House	19	13	11	10	11	11	11	11	11
Blackwood Cottage	21	16	13	13	13	13	13	13	13
Scrogton	21	16	13	13	13	13	13	13	13
Scrogtonhead	19	14	11	11	11	11	11	11	11

9.8.9 The noise immission levels from the 14 turbines will fall within the noise limits derived according to ETSU-R-97 and the IOA Good Practice Guide. It is also worthy of note that the Proposed Development will also meet the noise limit of 40 dB(A) specified in the planning conditions for the Existing Development. It follows that the magnitude of change is slight, and the effect of noise from the Proposed Development on local receptors is **not significant**.

9.8.10 Ground-borne vibration from wind turbines is neither discernible by a human observer, nor measurable under normal circumstances, at distances greater than a few tens of metres from the turbine. The magnitude of change in vibration is therefore negligible, and the significance of effect is therefore **none**.

Decommissioning of the Proposed Development

9.8.11 The noise impact during decommissioning and removal of the turbines will be no greater or more significant than that during construction.

Requirements for Mitigation

9.8.12 Although no noise mitigation measures are indicated to be necessary, it is possible to mitigate the noise impact of a turbine or turbines under certain operating conditions depending on the type of turbine and the options offered by the manufacturer. Particular wind speeds with the wind blowing from a particular sector will give rise to 'worst case' noise impacts, and under such conditions it will be possible to reduce the noise emissions from individual turbines under software control. These mitigation measures do not need to be specified in advance of turbine construction and can be implemented and adjusted if proven necessary in order to meet noise limits imposed by planning conditions.

9.8.13 The need for operational mitigation measures will be established as part of the post-construction commissioning process, and will involve noise limit compliance measurements.

9.8.14 Noise mitigation during the construction phase of the turbines and infrastructure will be accomplished by limiting the permitted hours of work, and of deliveries to site by HGV (abnormal loads excepted). Consented hours of 07:00h to 19:00h weekdays, and 07:00h to 13:00h on Saturdays, with no audible works at any other time, would be appropriate.

Assessment of Residual Effect Significance

9.8.15 Following implementation of mitigation measures, the construction noise effects on noise-sensitive receptors are assessed as **not significant**. Operational noise effects of the Proposed Development are also assessed as **not significant**.

Limitations to Assessment

9.8.16 The assessment is based on best practice guidelines at the time of writing and the worst-case scenario was modelled. There may be variations in the instantaneous sound levels from turbines which mean that they may be heard from time to time by a casual observer.

9.9 Cumulative Assessment

Methodology

9.9.1 There are several operational and consented wind farms of which one or more turbines are within approximately 5 km of the Proposed Development. Those considered of relevance to the cumulative noise assessment are: the Hagshaw Hill Extension consisting of 20 turbines; Douglas West (13 turbines); Dalquhandy (15 turbines); Nutberry (6 turbines); Galawhistle (22 turbines); Poniel (3 turbines); Hazelside (2 turbines); Cumberhead (11 turbines); Glentaggart (5 turbines), Andershaw (14 turbines); Kennoxhead (19 turbines); and Middle Muir (15 turbines). The wind energy developments at Kype Muir and its extension, Penbreck, Broken Cross and Auchrobert are too distant from the receptor locations closest to the Proposed Development to need any consideration as they will make no detectable contributions to the noise immission levels. It is noted that two other wind farm proposals in the local area are at the scoping stage, namely a proposed extension to the Douglas West project and a revised scheme for the Cumberhead Wind Farm. Sufficient data is not yet available for these projects to take them into account in the model, however, in respect of Cumberhead Revised it is noted that this is a proposal to amend an already approved wind farm which has been taken into account in the cumulative assessment below, and

does not constitute an additional set of turbines. It will be for the Douglas West Extension proposal to take account of the Proposed Development cumulatively when that application comes forward. The locations of the relevant turbines are shown in Figure 9.2.

9.9.2 For initial screening purposes, all turbines in the projects listed above, as well as the 14 turbines within the Proposed Development, were regarded as a single development using various different turbine types as appropriate, and the ISO9613-2 noise prediction methodology was applied on the basis that all turbines are approximately upwind of each receptor in turn. If this approach identified any potential cumulative noise issues then a more detailed assessment could be made, taking into account wind direction.

9.9.3 The results of the cumulative noise predictions at the receptor locations used for the present assessment, with every relevant windfarm within a radius of 5 km of the proposed turbines being included, are shown to the nearest whole decibel in Table 9.7. These results are compared with the proposed noise limits for the Proposed Development in Table 9.8. This can be considered a broad-brush approach to the recommendations of the IOA Good Practice Guide. No allowance is made for directivity, and every turbine was treated as if it were directly upwind of the receptor at a single point in time, which in reality would never be the case.

Table 9.7 – Worst-case Cumulative Noise Immission Levels, dB (Proposed Development)

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Shielpark	29	35	38	39	39	39	40	40	40
Monksfoot	33	39	42	43	43	43	43	43	43
Carmacoup Farm Cottage	29	34	37	38	38	39	39	39	39
Viaduct Cottage	29	34	37	38	38	39	39	39	39
Bungalow Cottage	28	33	36	37	37	38	38	38	38
Longhouse Cottage	29	34	37	38	38	38	38	38	38
Braeface Cottage	29	34	37	38	38	38	38	38	38
Hillview Crescent	29	34	37	38	38	38	38	38	38
Hazelside Farm	28	33	36	37	37	38	38	38	38
Station House	32	37	40	41	41	42	42	42	42
Blackwood Cottage	32	37	40	41	41	42	42	42	42
Scrogton	28	33	36	37	38	38	38	38	38
Scrogtonhead	29	34	37	38	38	39	39	39	39

Table 9.8 – Worst-case Compliance of Cumulative Noise with Noise Limits, dB (Proposed Development)

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Daytime									
Shielpark	11	5	2	3	4	6	7	10	12
Monksfoot	7	1	-2	-1	0	2	4	7	9
Carmacoup Farm Cottage	11	6	3	4	5	6	8	11	13

Receptor	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Viaduct Cottage	11	6	3	4	5	6	8	11	13
Bungalow Cottage	12	7	4	5	6	7	9	12	14
Longhouse Cottage	11	6	3	4	5	7	9	12	14
Braeface Cottage	11	6	3	4	5	7	9	12	14
Hillview Crescent	11	6	3	4	5	7	9	12	14
Hazelside Farm	17	12	9	8	8	7	9	12	14
Station House	8	3	0	1	2	3	5	8	10
Blackwood Cottage	13	8	5	4	4	3	5	8	10
Scrogton	12	7	4	5	5	7	9	12	14
Scrogtonhead	11	6	3	4	5	6	8	11	13
Night-time									
Shielpark	14	8	5	4	4	4	3	3	3
Monksfoot	10	4	1	0	0	0	0	0	0
Carmacoup Farm Cottage	14	9	6	5	5	4	4	4	4
Viaduct Cottage	14	9	6	5	5	4	4	4	4
Bungalow Cottage	15	10	7	6	6	5	5	5	5
Longhouse Cottage	14	9	6	5	5	5	5	5	5
Braeface Cottage	14	9	6	5	5	5	5	5	5
Hillview Crescent	14	9	6	5	5	5	5	5	5
Hazelside Farm	17	12	9	8	8	7	7	7	7
Station House	11	6	3	2	2	1	1	1	1
Blackwood Cottage	13	8	5	4	4	3	3	3	3
Scrogton	15	10	7	6	5	5	5	5	5
Scrogtonhead	14	9	6	5	5	4	4	4	4

Results and Commentary, Cumulative Noise Levels

9.9.4 This broad-brush approach exaggerates the cumulative noise effects, because as can be seen from Figure 9.2, there are no receptor locations that can ever simultaneously fall downwind of every wind farm in the locality. Nevertheless, the proposed noise limits for the Proposed Development can be met under these exaggerated conditions at all receptor locations except Monksfoot and its immediate neighbours, at 6 to 7 m/s wind speed during the daytime. This location therefore requires further consideration.

9.9.5 The properties at Monksfoot, The Shieling and Inches Cottage lie quite close to one another and similar cumulative noise immission levels can be expected at all three locations. Inspection of the map shows that the wind farms likely to have the greatest effect on the noise levels there are the Proposed Development, Hagshaw Hill Extension, Galawhistle and Cumberhead to the north, and

Kennoxhead to the south. There is no wind direction in which all these turbines will be substantially upwind of the receptor location, and this factor alone means that the cumulative noise immission levels will be 2 dB lower than those shown in Table 9.7. It is also noted that the prevailing wind direction is from the property towards the Proposed Development to the north-east, and not the other way around.

9.9.6 Moreover, no screening of individual turbines by landform has been taken into account, whereas any turbine not visible from the location in question will contribute noise levels at least 2 dB lower than the unscreened case assumed. It is therefore concluded that the appropriate noise limits will be met by the cumulative case, and the assumed noise immission 'budget' in the area will not be exceeded by replacing the Existing Development with the Proposed Development.

9.9.7 Should the final turbine type used on site be the SG-6.0-155PG, as opposed to the SG-3.4-132 which has been modelled, it would result in either a very slight improvement (reduction in level) or is negligible.

9.9.8 The cumulative noise effect is therefore considered to be **not significant**.

9.10 Summary

9.10.1 Baseline noise surveys to establish the pre-existing sound levels at selected local dwellings were not possible or required in this case, due to existing operational wind turbines in the local area. Data from previous noise survey campaigns by the developer led to the noise limits in effect for the existing and consented wind energy development at the neighbouring Douglas West site and these limits provide a noise immission budget within which the Proposed Development must also operate, in accordance with best practice guidance. The noise immission levels at local noise-sensitive locations were calculated using internationally recognised prediction methods and the robust results were then compared with the relevant noise limits. The design of the Proposed Development was found to be capable of meeting these limits. Its effect on the noise environment experienced by local residents is therefore **not significant**.

9.10.2 The cumulative effects of the Proposed Development, plus all relevant operational and consented wind turbines within 5 km of the proposed turbines were calculated in the same way. The methodology was expected to over-predict the cumulative noise immission levels and the small number of excesses over the proposed noise limits were slight. The increase in noise from the Proposed Development turbines over that already occurring as a result of the Existing Development, or likely to occur from operational and permitted wind farms in the locality, will be subjectively unnoticeable at most locations, and within acceptable limits. The effect is therefore **not significant**.

Table 9.9 – Summary Table – Noise

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect		Comparison with Existing Development
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse	
Construction noise	Not Significant	Adverse	Control of working hours and best working practices	Not Significant	Adverse	No change of significance
Operational noise	Not Significant	Adverse	Operational monitoring to ensure compliance, with the option of selective constraint of turbine operation if found to be a requirement.	Not Significant	Adverse	No change of significance

9.11 References

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