CONTENTS

INTRODUCTION

13.1 This Chapter presents the noise assessment for the proposed development.

13.2 Wind turbines may emit two types of noise when operating. Firstly, aerodynamic noise produced as the blades pass through the air. Secondly, mechanical noise from components within the nacelle of a wind turbine. Aerodynamic noise can be characterised as a more natural '*swish*' sound, whereas mechanical noise is generally characterised by its tonal content. Over the years mechanical noise has been engineered to much lower levels owing to its reduced acceptability when compared with aerodynamic noise. At very low wind speeds the turbine blades do not rotate or rotate very slowly and so negligible aerodynamic noise is generated. In higher winds, background noise, such as wind disturbed vegetation, will increase, along with aerodynamic noise from the turbine blades. The subjective audibility of the proposed development will be determined by the relative difference between background noise and wind turbine aerodynamic noise. This difference, as experienced at nearby dwellings, forms the basis of the noise assessment.

13.3 Whilst reasonable effort has been made to ensure that this Chapter is easy to understand, it is technical in nature; to assist the reader, a glossary of terminology is included in **Technical Appendix 13.1: Glossary of Terms** in Volume 4b of the EIA Report.

13.4 This Chapter is accompanied by the following Technical Appendices (TA):

- **Technical Appendix 13.1: Glossary of Terms**;
- **Technical Appendix 13.2: Baseline Noise Survey Details**;
- **Technical Appendix 13.3: Propagation Corrections for Topography**;
- **Technical Appendix 13.4: Wind Turbine Locations**;
- **Technical Appendix 13.5: Baseline Survey Data**;
- **Technical Appendix 13.6: ETSU-R-97 Assessment Graphs**; and
- **Technical Appendix 13.7: Wind Turbine Sound Power Data**.

13.5 This Chapter is supported by **Figure 13.1: Location of Noise Measurement Positions, Noise Sensitive Receptors and Turbines**.

13.6 Planning policies of relevance to this assessment are provided in **Technical Appendix 4.1: Legislation, Planning Policy and Guidance.**

SCOPE AND CONSULTATION

13.7 During the initial stages of the noise assessment, and prior to the baseline noise survey, the Environmental Health Officer (EHO) at The Highland Council (THC) was consulted to discuss the approach to the assessment and the potential survey locations. Consultation took place via email on 03 September 2021 based on an initial layout where the proposed approach and survey locations were detailed.

Consultation and Scoping Responses

13.8 In the consultation response dated 06 September 2021 THC agreed with the three proposed survey locations and requested that a fourth location be considered at a property along the A897, to the south of Tigh Na Breac on Loch Earacha. Also, neighbouring Ackron Wind Farm (in planning at the time) and Drum Hollistan 2 Wind Farm (appeal in progress at the time) were raised by THC to be considered in the cumulative assessment. Subsequent to the consultation, Ackron Wind Farm has been withdrawn and Drun Hollistan 2 Wind Farm was refused at appeal.

13.9 Confirmation of receipt and consideration of the points raised was issued by SLR on 07 September 2021. Further correspondence was issued by SLR on 06 October 2021 when access to survey locations had been granted. SLR confirmed that a fourth survey location had been secured as requested and an invitation was extended for THC to attend the setting up of the noise survey.

13.10 The Scoping Opinion dated June 2021 contained a section on noise that set out the Scottish Government Energy Consents Unit's (ECU) requirements for this assessment on behalf of Scottish Ministers. This document contained a consultation response from the EHO at THC, dated 10 May 2021.

13.11 **Table 13-1** summarises the points raised and where they have been addressed within this Chapter.

Table 13-1: Key Issues

Category	Summary of Key Issues	Where addressed in Chapter
Operational noise	Noise assessment required in accordance with ETSU-R-97 and the associated Good Practice Guide published by the Institute of Acoustics (IOA GPG).	Paragraphs 13.36 to 13.48
	Fixed portion of the noise limit should be 35 dB L_{A90} (daytime) and 38 dB L_{A90} (night-time)	Paragraphs 13.40 and 13.41
Cumulative noise	Assessment to take into account other wind turbine developments and their predicted and consented noise levels, in accordance with the IOA GPG.	**Table 13-3,** paragraphs 13.18 to 13.21
Background noise measurements	Background survey is to be in accordance with ETSU-R-97 and IOA GPG.	Paragraphs 13.27 to 13.35
	Recommended that EHO is consulted to agree survey locations and proposed methodology.	Paragraph 13.4
	Survey should not include noise from other turbines	Paragraph 13.28
Amplitude modulation	Confirmation that it is not appropriate to assess during planning and any complaints would be investigated in terms of a Statutory Nuisance.	Paragraph 13.9
Construction noise	Construction noise assessment may only be required under certain conditions, and when done must be in accordance with BS 5228-1:2009.	Paragraph 13.50

Effects Scoped Out

13.12 The assessment follows current best practice which scopes out inappropriate topics, including:

- amplitude modulation;
- operational vibration from the wind turbines; and
- infrasound and low frequency noise.

APPROACH AND METHODS

13.13 Details of the legislation, planning policy and guidance documentation relevant to this assessment is set out in **Technical Appendix 4.1** in Volume 4a of the EIA Report.

13.14 The noise assessment has undertaken the following:

- consultation with the EHO at THC to discuss and agree the approach to the assessment and survey locations;
- a baseline noise survey at four locations in accordance with the proposed department of Trade and Industry Noise Working Group ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG) which represents current good practice;
- determination of site-specific noise limits from baseline survey data, suitable for inclusion in noise related planning conditions, should permission be supported;
- calculation of the operational wind turbine noise from the proposed development and assessment against the site-specific noise limits in accordance with ETSU-R-97 and IOA GPG;
- determination of the total ETSU-R-97 noise limits applicable to all wind farms in the study area; and
- calculated and assessed construction and decommissioning noise at receiver locations closest to the work being carried out, based on the potential construction programme and standard wind farm construction activities.

Study Area

13.15 The study area considers wind farms within an approximate radius of 5km and noise-sensitive receptors within a radius of approximately 3km from the proposed development.

Noise Sensitive Receptors

13.16 Noise-Sensitive Receptors (NSRs) are properties which are potentially sensitive to noise and, as such, may require protection from nearby noise sources.

13.17 All the NSRs identified within this assessment are residential properties. Wind turbine noise immission levels are predicted to a location representative of each outdoor amenity area rather the façade of the property. This is in line with the IOA GPG which states (at paragraph 4.3.8) that, "*calculations should be made at points representative of the relevant outdoor amenity area (as defined in ETSU-R-97) at locations nearest to the proposed wind farm development*".

13.18 Note that in the above, and subsequently in this assessment, the term '*noise emission*' relates to the sound power level of a wind turbine, whereas the term '*noise immission*' relates to the sound pressure level experienced at a receptor location.

13.19 It is not always appropriate to assess impacts at all nearby NSRs, and as a worst-case can be presented with a selection of NSRs. Where multiple NSRs are in the same general direction from

the proposed development, it may be appropriate to present results for just one of these which represents the worst-case for all, which is the case for this assessment. The NSRs presented in this assessment are those who are calculated to have a wind turbine noise immission level from the proposed development of 25 dB L_{A90} or greater. An immission level of less than 25 dB L_{A90} is at least 10 dB(A) below the most stringent ETSU-R-97 noise limit; and therefore, would not have the potential to cumulatively contribute to an exceedance of wind turbine noise limit.

13.20 **Table 13-2** details the identified NSRs for the assessment of operational noise and **Figure 13.1** (Volume 3 of the EIA Report) shows the location of each NSR in relation to the proposed development.

Table 13-2: Noise Sensitive Receptors

NSR ID	NSR Name	OS Grid Coordinates	
		Easting	Northing
NSR01	Ar Dachaidh	289018	961690
NSR02	Kirkton Cottage	288977	962044
NSR03	Ackron	289964	962482
NSR04	Golval	289878	962108
NSR05	Tigh Na Breac	289924	960774
NSR06	Calgary Beg	289902	959076
NSR07	Achiemore	289573	958703
NSR08	Culifearne Croft	289717	958747
NSR09	Achimore	289505	957986
NSR10	Former Free Church	289507	957801
NSR11	27 Upper Bighouse	288880	957488
NSR12	25 Upper Bighouse	288888	957156
NSR13	Craigfillan	289470	957372

Cumulative Wind farms

13.21 Noise limits derived in accordance with ETSU-R-97 apply to the total noise immission from all wind turbines and not just the proposed development. Therefore, other wind farms in the area have been considered in the assessment, as set out in **Table 13-3**.

Table 13-3: Overview of Neighbouring Wind farms

Name	Status	Approximate Position	Turbines	Type
Ackron Wind Farm	Withdrawn	3km north east	12	Vestas V136
Drum Hollistan 2 Wind Farm	Appeal refused	5km north east	7	Enercon E82
Ackron Farm wind turbine	Operational	3km north east	1	XANT M-21

13.22 Ackron Wind Farm and Drum Hollistan 2 Wind Farm are no longer in the planning system, and as such not included in the cumulative noise impact assessment.

13.23 Given the small scale of the operational wind turbine at Ackron Farm, 100kW machine on a 25m high hub, and its distance from the proposed development, cumulative noise impacts are not considered likely with the study area; and therefore, this wind turbine is not considered further.

13.24 For these reasons a cumulative noise assessment is not necessary.

Temporal Scope

13.25 Operational noise effects would be permanent and reversible at the end of the lifespan of the proposed development.

13.26 Construction noise effects would be temporary and reversible at the end of the construction of the proposed development.

Information and Data Sources

13.27 The exact model of turbine to be used at the site will be the result of a future tendering process and therefore an indicative candidate turbine model has been assumed for this noise assessment. This operational noise assessment is based upon the noise specification of the Nordex N133 wind turbine. **Technical Appendix 13.7** in Volume 4b of the EIA Report includes the turbine sound power data used in this assessment. The location of the turbines are provided in **Technical Appendix 13.4** in Volume 4b of the EIA Report. If planning permission is granted, further data would be obtained from the supplier for the final choice of wind turbine model to demonstrate compliance with the operational noise limits derived in this assessment.

13.28 The candidate turbine is a variable speed, pitch regulated machine with a rotor diameter of 133m and a hub height of 83.4m. Due to its variable speed operation the sound power output of the turbine varies with wind speed, being quieter at the lower wind speeds when the blades are rotating more slowly.

13.29 Nordex have supplied noise emission data for the N133 turbine, a further correction factor of +1 dB has been added to account for uncertainty. The sound power data has been supplied for standardised 10m wind speeds of 4ms^{-1} to 12ms^{-1}. In addition, octave band data for the turbine has been provided for a wind speed corresponding to the loudest condition. **Table 13-4** and **Table 13-5** present these data.

Table 13-4: Wind Turbine Sound Power Levels, Nordex N133

Standardised wind speed, ms^{-1}	Sound Power Level, dB L_{Aeq}
4	96.7
5	102.2
6	106.4
7	108.5
8	108.5
9	108.5
10	108.5

Standardised wind speed, ms^{-1}	Sound Power Level, dB L_{Aeq}
11	108.5
12	108.5
Source:	F008_272_A13_EN

Table 13-5: Wind Turbine Octave Band Sound Power Spectrum at max SWL

Octave Band Centre Frequency, Hz	Sound Power Level, dB(A)
63	90.0
125	95.8
250	99.0
500	101.4
1000	103.3
2000	102.4
4000	97.0
8000	83.2
Source:	F008_272_A14_EN

Field Surveys

13.30 A baseline noise survey was carried out between Wednesday 13 October and Monday 22 November 2021 at a total of four noise measurement positions that are considered to represent the NSRs in the study area. This equates to a total of 40 days of background noise data, which exceeds the one-week requirement set out in ETSU-R-97 and is compliant with the IOA GPG. **Table 13-6** details the background noise survey locations and **Figure 13.1** shows their location relative to the proposed development.

Table 13-6: Background Noise Survey Measurement Positions

Position ID	Property Name	OS Grid Coordinates	
		OS Easting	OS Northing
MP1	Ar Dachaidh	288999	961695
MP2	Tigh Na Breac	289965	960767
MP3	Calgary Beg	289917	959029
MP4	25 Upper Bighouse	288886	957167

13.31 The nearest operational wind turbine is a single 100kW machine located at Ackron Farm. Given the scale and distance away from the survey locations, it is considered unlikely to contribute to the measured background noise level. The nearest large-scale wind turbines are located at Strathy North, approximately 4.47km away. Similarly, it is considered unlikely that noise from these turbines would contribute to the measured background noise levels.

13.32 In line with ETSU-R-97 and the IOA GPG, the background survey data has been used as a proxy for some NSRs where monitoring was not carried out. This is considered appropriate due to the comparable distances from local roads or burns. Furthermore, as set out in paragraph 13.16, it is not appropriate to assess at every NSR in the area. Details of which survey location has been used as a proxy for the corresponding assessment location are included in **Table 13-7.**

Table 13-7: Proxy Locations for Noise Sensitive Receptors

NSR ID	NSR Name	Survey Proxy	MP Name
NSR01	Ar Dachaidh	MP1	Ar Dachaidh
NSR02	Kirkton Cottage	MP1	Ar Dachaidh
NSR03	Ackron	MP2	Tigh Na Breac
NSR04	Golval	MP2	Tigh Na Breac
NSR05	Tigh Na Breac	MP2	Tigh Na Breac
NSR06	Calgary Beg	MP3	Calgary Beg
NSR07	Achiemore	MP2	Tigh Na Breac
NSR08	Culifearne Croft	MP2	Tigh Na Breac
NSR09	Achimore	MP2	Tigh Na Breac
NSR10	Former Free Church	MP2	Tigh Na Breac
NSR11	27 Upper Bighouse	MP4	25 Upper Bighouse
NSR12	25 Upper Bighouse	MP4	25 Upper Bighouse
NSR13	Craigfillan	MP2	Tigh Na Breac

13.33 The equipment used for the background noise survey comprised four Rion NL-52 logging sound level meters enclosed in environmental cases to protect from the weather. Outdoor enhanced windshields WS-15 were used to reduce wind induced noise on the microphones and provide protection from rain. These windshields were supplied by the sound level meter manufacturer and maintain the required performance of the whole measurement system when fitted. The installed microphone height was approximately 1.3m.

13.34 The sound level meters were located between 3.5m and 20m from the façade of the property and as far away as was practical from obvious atypical localised sources of noise such as running water, tall trees or boiler flues. Details and photographs of the measurement locations can be found in **Technical Appendix 13.2** in Volume 4b of the EIA Report.

13.35 Sound level meters were all field calibrated during their installation and collection, with no acoustically significant (>0.5 dB(A)) drifts in calibration observed.

13.36 The sound level meters logged the $L_{A90,10min}$ and $L_{Aeq,10min}$ noise levels continuously over the survey period, using Greenwich Mean Time (GMT) time reference. Wind data measured by an 80m tall meteorological (met) mast that also logged data using the same 10-minute periods and GMT time reference.

13.37 The use of a tall met mast with anemometers mounted at multiple heights to monitor the wind data is endorsed by the IOA GPG as one of three preferred methods of capturing such data. The met mast was installed on site (NGR 287934, 959510) by Dulas, experts in wind measurements for such applications.

13.38 Survey location MP1, Ar Dachaidh, had a rain logger installed to monitor periods of rainfall during the background noise survey. The rain logger comprised a Davis tipping bucket 7852-00, set to record if any rain was detected during the same 10-minute measurement period used by the sound level meters and wind data. The rain logger also used the GMT time reference.

Assessment Methods

Assessment Overview

13.39 It is set out in ETSU-R-97, and subsequently the IOA GPG, that noise limits for wind turbines should be set relative to existing background noise levels at the nearest properties and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. The wind speed range which should be considered is that of the operation of the turbines, typically between the cut-in speed and 12ms^{-1}. It should be noted that within this assessment, unless specified otherwise, all references to wind speeds are to a standardised 10m height, derived in accordance with Section 2.6 of the IOA GPG. Whilst the assessment should cover this range of wind speeds, often modern pitch-regulated wind turbines reach maximum sound power levels at a wind speed less than 12ms^{-1}. Therefore, the IOA GPG recommends that the baseline noise survey data is captured during a range of wind speeds from the cut-in speed and the wind speed corresponding to the turbine's maximum sound power level, and for the proposed development this is 7ms^{-1}.

13.40 Separate noise limits apply for the daytime and night-time, chosen to protect a property's external amenity and to prevent sleep disturbance indoors, respectively. Noise limits comprise two elements: a lower fixed value; and a derived relative value equal to the prevailing background curve plus 5 dB(A). The noise limit will be equal to the greater of these two elements. The assessment needs to consider the combined operational noise of the proposed development with the other wind farms in the area to ensure that the combined cumulative noise levels are within the relevant ETSU-R-97 criterion.

13.41 The prevailing background curve is derived from noise data, using the $L_{A90,\ 10min}$ parameter, measured at a representative location of a receptor and wind data measured on the proposed development site. Data measured during the ETSU-R-97 '*quiet periods of the day*' inform the daytime prevailing background curve. These quiet periods are: weekdays between 18:00 and 23:00, Saturdays between 13:00 and 23:00 and all day on Sundays (07:00 to 23:00). Data measured between 23:00 and 07:00 inform the night-time prevailing background curve.

13.42 The fixed lower value of the daytime noise limit is provided in ETSU-R-97 as a single value in the range between 35 dB L_{A90} and 40 dB L_{A90}. The exception to this is when a property is financially involved with the project and in such cases the appropriate fixed lower limit is 45 dB L_{A90} during the day and night-times. For non-financially involved properties, there are three factors that should be considered when determining an appropriate value for the lower fixed daytime noise limit:

- the number of noise-affected properties;
- the potential impact on the power output of the wind turbines; and
- the likely duration and level of exposure.

13.43 For the case of the proposed development, 35 dB L_{A90} is considered appropriate for the fixed lower value element of the daytime noise limit. The reasons for this are primarily based on the low number of properties affected by noise when compared to the power output of the wind turbines in the assessment area, including those within the proposed development. Whilst this would initially indicate a higher fixed lower value to be more appropriate, a lower value has been selected

so as not to preclude further wind development in the area and to comply with OWESG and the Scoping Opinion.

13.44 The fixed lower value of the night-time noise limit for non-financially involved properties is given in ETSU-R-97 as 43 dB L_{A90}; however, THC has confirmed that in accordance with OWESG and the Scoping Opinion a value of 38 dB L_{A90} is to be used. Therefore, this assessment uses a value of 38 dB L_{A90} for the lower fixed value of the night-time noise limit.

Baseline Data Analysis

13.45 Wind speed data was provided at several heights by the met mast. Wind speed data measured at 80.5m and 62.0m heights were used to extrapolate to the hub height of 83.4m and then standardised to a 10m reference height, in accordance with the IOA GPG. Wind directional data measured at a height of 76.5m has been taken to be representative of hub height wind direction. The measured background noise data, standardised 10m wind speed data and rain data for identical periods have been collated and reviewed for atypical relationships between noise level and wind speed, periods of rain fall and any extraneous data. Where these traits have been identified these data has been excluded from the analysis. In the case of rainfall, its effects on noise can be detected both during (as it hits vegetation and car tyre noise increases on roads), and immediately after it stops (roads remain wet), and in some cases for a short while after it has stopped (as streams and burns swell to carry run-off rainwater). Therefore, periods of rain plus the proceeding 60 minutes have been excluded. The exception to this being Calgary Beg (MP3), where noise data measured within 2 hours after rainfall has been excluded, as evidence suggests a slight increase in background noise during these periods.

13.46 Best fit lines were generated through the remaining data using a polynomial fit of a maximum of 4th order, so as to best represent the typical values. These lines form the prevailing background noise level curve for each measurement location which were used to derive the noise limits in accordance with ETSU-R-97.

Noise Model

13.47 The sound predictions for the operational assessment have been undertaken using a proprietary software-based noise model, CadnaA®, which implements the full range of UK calculation methods. The calculation algorithms set out in ISO 9613-2 have been used and the model assumes:

- mixed ground absorption factor of G = 0.5;
- air absorption based on temperature of 10°C and 70% relative humidity;
- receiver height 4m;
- screening effects limited to 2 dB(A);
- and downwind propagation assumed between all turbines and receivers.

13.48 The model accounts for the attenuation due to geometric spreading, atmospheric absorption, screening (limited to 2 dB) and ground effects. All attenuation calculations have been made on an octave band basis and therefore account for the sound frequency characteristics of the turbines.

13.49 A separate topographical assessment of the sound propagation path between each turbine and receiver has been carried out to determine if concave ground is present. **Technical Appendix 13.3** in Volume 4b of the EIA Report summarises the results of the topographical assessment. Its need is in response to the IOA GPG which states that a +3 dB correction should be added when wind turbine noise propagates across a valley due to the presence of additional reflection paths that are

not present over more flat ground. ISO 9613-2 does not account for this which is why this correction is not applied as part of the model. The following formula has been used to determine if concave ground is present:

$$h_m \geq 1.5 \times \left(\frac{abs(h_s - h_r)}{2}\right)$$

13.50 Where h_m is the mean height above the ground of the direct line of sight from the receiver to the source, and h_s and h_r are the heights above local ground level of the source and receiver respectively.

13.51 This method is consistent with the recommendations of the IOA GPG. The IOA GPG also allows for directional effects to be included within the noise modelling: under upwind propagation conditions the wind farm noise immission level at a receiver can be as much as 10 dB(A) to 15 dB(A) lower than the level predicted using the ISO 9613-2 model. However, predictions have been made assuming downwind propagation from every turbine to every receptor at the same time as a worst case.

Construction Impacts

13.52 Any development of this nature has the potential to generate noise during the construction phase, should appropriate mitigation not be employed. However, disruption due to construction noise is a localised phenomenon, and is both temporary and intermittent in nature.

13.53 BS 5228-1 has been used as the appropriate reference for the calculation of construction noise impacts. At this stage of a project, it is not feasible to accurately specify exact construction techniques or locations where construction activity is likely to take place. Therefore, various assumptions have been made based on best practice and typical wind farm construction projects. **Table 13-8** details the overall sound power level assumed for all plant that would be operational during the corresponding construction activity. The calculation follows Annex F of BS 5228-1 and assumes the following:

- plant is operational for between 75% and 100% of the working day;
- there would be no screening effects;
- propagation over mixed ground (50% hard 50% soft); and
- construction activity assumed to occur at a single point from receiver.

Table 13-8: Construction Activity Sound Power Levels

Construction Activity	Plant Details	Sound Power Level $L_{WA,T}$ dB
Upgrade access track	2 x 67kW hydraulic breaker, 2 x 17t excavators, 2 x 11t bulldozers, 2 x 4t vibratory rollers and 2 x 60kg vibratory compactor	121
Construct temporary site compound	8t backhoe loader, 40t articulated dump truck, concrete mixer truck	118
Build new access tracks	2 x 40t excavators, 2 x 25t articulated dump truck, 2 x articulated dump truck, 35t bulldozer & 4t vibratory roller	118
Construct substation	25t excavator, concrete mixer truck, 4-axle lorry	112
Crane hardstandings	2 x 32t excavators, 4 x 23t articulated dump truck and concrete mixer truck	116

Construction Activity	Plant Details	Sound Power Level $L_{WA,T}$ dB
Turbine foundations	CFA piling, 2 x 32t excavator, 4 x 40t dump truck, 4 x concrete mixer trucks, 100t mobile crane, 2 x 100kg diesel water pumps, 2 x pneumatic road breakers + compressors and 4 vibratory pokers	121
Constructing turbines	1200t crane, 400t crane, delivery vehicles, 10 x articulated lorries, diesel generator and hand tools	117
Borrow pit quarrying	37t hydraulic excavator, 19t hydraulic excavator, 2 x semi-mobile crushers, 17t screen, hopper feed and field conveyors with drive units	127

13.54 The calculated construction noise levels are compared with absolute noise limits for temporary construction activities which are commonly regarded as providing an acceptable level of protection from the short-term noise levels associated with construction activities.

13.55 Some rock extraction from borrow pits by means of blasting operations would be required in some instances. Blasting operations can generate airborne pressure waves or "air overpressure" which contains both audible (approximately 20Hz to 20kHz) and infrasonic pressure waves (<20Hz), which, although outside the range of human hearing, can sometimes be felt. The relevant guidance documents advise controlling air overpressure with good practices during the setting and detonation of charges as opposed to absolute limits on the levels produced; therefore, no absolute limits for air overpressure or noise from blasting can be presented in the assessment. Other site activity associated with blasting, such as stone crushing and screening and the operation of plant including excavators, breakers and conveyors will be included in noise assessment as the final activity listed in **Table 13-8**.

13.56 Separate consideration is also given to the possible noise impacts of construction related traffic passing to and from the site along local surrounding roads. In considering potential noise levels associated with construction traffic movement on public roads, reference is made to the accepted UK prediction methodology provided by *'Calculation of Road Traffic Noise'* (CRTN).

13.57 Road traffic data has been provided for A836 Road, as summarised in **Table 13-9** which represents the daily total flows for the worst-case period of construction. The full prediction given in CRTN results in an absolute road traffic noise level at a receiver location. For the purpose of this assessment the change in road traffic noise is of concern and not the absolute level. This has been achieved by calculating the Basic Noise Level (BNL) with corrections for heavy vehicles and low flow as described in CRTN. This is considered acceptable to provide a reasonable estimate of the likely change in road traffic noise. In reality, noise from vehicles using the A836 is not likely to be dominant for all dwellings in the assessment area. Therefore, any increase in road traffic noise reported is likely to constitute a worst-case as the corresponding increase in total ambient noise would be smaller.

Table 13-9: Construction Traffic Flow Data

Road Link	Scenario	Total Vehicles	% HGV
A836	2021 without construction traffic	1,235	0.7
A836	2024 / 2025 with worst-case construction traffic	1,303	2.2

Significance of Effect

13.58 The significance of effect that a noise impact has upon a receptor has been determined through a standard method of assessment based on professional judgement of the Competent Expert, considering the sensitivity of the NSR and the magnitude of noise impact.

13.59 The only relevant NSRs within the assessment area are dwellings, which are of high sensitivity. Operational noise impacts have been determined following ETSU-R-97 and the IOA GPG, which if they do not exceed noise limits derived following the same guidance, are considered to be not significant in EIA terms.

13.60 The calculated construction noise levels have been compared against absolute noise limits for temporary construction activities which are commonly regarded as providing an acceptable level of protection from the short-term noise levels associated with construction activities. BS 5228-1 Annex E provides example criteria of absolute noise limits for construction activities and has been used to determine the significance of any construction noise impacts within this assessment. The criteria do not represent mandatory limits but rather a set of example approaches intended to reflect the type of methods commonly applied to construction noise. In broad terms, the example criteria are based on a set of fixed limit values which, if exceeded, may result in a significant effect unless ambient noise levels are sufficiently high to provide a degree of masking of construction noise.

13.61 The range of guidance values detailed in BS 5228-1 Annex E and other reference criteria such as PAN50 have been used to numerically define the magnitude of impact. As construction noise will always be an introduction of a noise source which would otherwise not be there, where impacts are identified to occur, they will always be adverse:

- where construction noise levels at receptors are below the adopted daytime noise limit of 70 dB L_{Aeq}, this is determined to be 'not significant'; and
- where construction noise levels at receptors are above the adopted daytime noise limit of 70 dB L_{Aeq}, this is determined to be 'significant'.

13.62 The significant effect of change in the BNL of vehicles using the A836 has been determined using guidance found in CRTN and the *'Design Manual for Roads and Bridges'* criteria for short-term noise impacts:

- where the change in BNL (due to construction traffic) is predicted to be less than 3 dB, this is determined to be 'not significant'; and
- where the change in BNL (due to construction traffic) is predicted to be more than 3 dB, this is determined to be 'significant'.

13.63 These adverse effects, while important at a local scale, are temporary and would only occur during the anticipated construction period.

13.64 The assessment of the significance of effects from operational and cumulative (wind turbine) noise is made as follows, with reference to ETSU-R-97 and the IOA GPG:

- where operational and cumulative noise levels at receptors are below the relevant ETSU-R-97 noise limits, this is determined to be 'not significant'; and
- where operational and cumulative noise levels at receptors are above the relevant ETSU-R-97 noise limits, this is determined to be 'significant'.

Assumptions, Limitations and Confidence

13.65 No significant information gaps were identified, and the assessment was undertaken in line with relevant standards, policy and guidance documents and current best practice.

13.66 The road traffic noise model used in this assessment is dependent upon the predicted future traffic data, which will have inherent uncertainties associated with them, details of which are set out in **Chapter 12: Site Access, Traffic and Transport**.

13.67 Details of specific construction activity, plant used or likely programme are not available at this stage of the proposed development. The construction noise assessment assumes typical activity for the type and scale of the proposed development and that all plant and equipment used are operated continuously throughout the 10-hour working day and are located at the same distance from the noise sensitive receptor. This is unlikely to occur in practice and therefore represents a likely worst-case scenario.

BASELINE CONDITIONS

13.68 The proposed development is located approximately 2.1km south of Melvich in Sutherland, situated to the west of Halladale River and the A897. The area around the proposed development is rural with a noise climate considered typical for its setting.

Current Baseline

13.69 Baseline (background) noise levels were measured at four locations as detailed in **Table 13-6**, to inform this assessment. Overall, it was found that noise levels at these properties were predominantly influenced by wind disturbed vegetation, and also from agricultural sources such as livestock and distant machinery, and occasional road traffic using nearby and more distant roads. Further details regarding the baseline survey can be found in **Technical Appendix 13.2** in Volume 4b of the EIA Report.

13.70 **Technical Appendix 13.5** in Volume 4b of the EIA Report provides graphs of the measured background noise levels plotted against standardised 10m high wind speed. Each measurement location has two graphs: one displaying data for the quiet daytime period; and the second for the night-time period, as defined in paragraph 13.38. The corresponding ETSU-R-97 noise limits are summarised in **Table 13-10** and **Table 13-11**. It should be noted that Ar Dachaidh (MP1) is financially involved (owned by landowners participating in the wind farm development) with the proposed development and as discussed in paragraph 13.39 an increased noise limit can be applied. The noise limit shown in **Table 13-10** and **Table 13-11** for MP1 has been applied where it is used as a proxy location for a non-financially-involved property. A flat noise limit of 45 dB L_{A90} has been applied to Ar Dachaidh (NSR01) for all wind speeds during the daytime and night-time periods.

13.71 Also included in **Technical Appendix 13.5** in Volume 4b of the EIA Report are figures illustrating the range of wind speed and direction data measured during the noise survey. There are four wind speed and direction figures in total covering the daytime and night-time periods for MP1: Ar Dachaidh, MP2: Tigh Na Breac and MP4: 25 Upper Bighouse (combined) and MP3: Calgary Beg. The reason MP3 has different wind data to MP1, MP2 and MP4 is due to more rain-data being excluded, as discussed in paragraph 13.42.

Table 13-10: Daytime ETSU-R-97 Noise Limits, dB L_{A90}

Position ID	Standardised 10m Height Wind speed, ms^{-1}								
	4	5	6	7	8	9	10	11	12
MP1	35.0	35.0	35.0	35.1	36.7	38.5	40.4	42.3	44.2
MP2	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
MP3	38.4	39.1	40.0	41.2	42.6	44.2	46.1	48.1	50.3
MP4	35.0	35.0	36.0	37.6	39.3	41.1	42.7	44.1	45.2

Table 13-11: Night-time ETSU-R-97 Noise Limits, dB L_{A90}

Position ID	Standardised 10m Height Wind speed, ms^{-1}								
	4	5	6	7	8	9	10	11	12
MP1	38.0	38.0	38.0	38.0	38.0	38.0	39.8	41.8	43.9
MP2	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
MP3	40.3	40.5	41.0	41.8	42.9	44.3	45.9	47.8	49.9
MP4	38.0	38.0	38.0	38.0	38.1	39.7	41.4	43.1	44.8

Cumulative Situation

13.72 ETSU-R-97 advises that when undertaking a background noise survey for a proposed wind farm, measurements should not include contribution from another wind farm. In accordance with this, the prevailing background noise level has been measured in the absence of noise from any wind turbines.

13.73 If other wind farms in the area are consented in future, they would not influence the existing baseline, derived from the background noise survey, as any such data should not be included.

THE PROPOSED DEVELOPMENT (FUTURE BASELINE)

13.74 The existing baseline is not expected to change by the time the proposed development would be implemented, if approved.

ASSESSMENT OF EFFECTS

Construction Effects

13.75 **Table 13-12** details the predicted worst-case construction noise levels for each of the key activities identified in **Table 13-8**. It must be emphasised that these predictions only relate the noise level occurring during the time when the activity is closest to the referenced property. In many cases such as access track construction and turbine erection, the separating distances will be considerably greater for the majority of the construction period and the predictions are therefore the worst-case periods of the construction phase.

Table 13-12: Construction Activity Sound Power Levels

Construction Activity	Worst-Case Receptor	Noise Level $L_{Aeq,T}$ dB
Upgrade access track	NSR01, Ar Dachaidh	58
Temporary site compound	NSR01, Ar Dachaidh	49
Build new access tracks	NSR01, Ar Dachaidh	45
Construct substation	NSR01, Ar Dachaidh	45
Crane hardstandings	NSR11, 27 Upper Bighouse	44
Turbine foundations	NSR11, 27 Upper Bighouse	49
Constructing turbines	NSR11, 27 Upper Bighouse	45
Borrow pit quarrying	NSR01, Ar Dachaidh	55

13.76 All predicted worst-case construction noise levels are below the threshold of significance set out in paragraph 13.58 and would therefore be **not significant**.

13.77 Changes in road traffic noise due to construction vehicles are set out in **Table 13-3.** The change in road traffic noise would be 0.6 dB, which is not significant (see paragraph 13.59).

Table 13-13: Change in Road Traffic Noise

Road Link	Scenario	BNL, dB L_{A10}
A836	2021 without construction traffic	60.9
A836	2024 / 2025 with construction traffic	61.5
A836	With – without construction traffic	0.6

Proposed Mitigation and Enhancement

13.78 Construction noise levels have been determined to be **not significant**, therefore, mitigation is not deemed necessary.

Residual Construction Effects

13.79 No mitigation is required, so the residual construction noise effects remain **not significant**.

Operational Effects

13.80 The predicted operational noise immission levels of the proposed development, noise limit and margin, at each the identified receptors are presented numerically in **Table 13-14** and **Table 13-15**, for the daytime and night-time periods respectively. A positive margin value indicates the turbine immission exceeds the limit and a negative value shows it is below the limit. **Technical Appendix 13.6** in Volume 4b of the EIA Report contains this information graphically. The noise levels shown in these tables are predicted for a standardised 10m height wind speed range of 4 – 12ms^{-1}.

Table 13-14: Daytime Noise Assessment of the Proposed Development

NSR	Detail	Standardised 10m Height Wind speed, ms^{-1}								
		4	5	6	7	8	9	10	11	12
NSR01	Immission	23.3	28.8	33.0	35.1	35.1	35.1	35.1	35.1	35.1
	Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Margin	**-21.7**	**-16.2**	**-12.0**	**-9.9**	**-9.9**	**-9.9**	**-9.9**	**-9.9**	**-9.9**
NSR02	Immission	19.8	25.3	29.5	31.6	31.6	31.6	31.6	31.6	31.6
	Limit	35.0	35.0	35.0	35.1	36.7	38.5	40.4	42.3	44.2
	Margin	**-15.2**	**-9.7**	**-5.5**	**-3.5**	**-5.1**	**-6.9**	**-8.8**	**-10.7**	**-12.6**
NSR03	Immission	19.3	24.8	29.0	31.1	31.1	31.1	31.1	31.1	31.1
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-15.7**	**-10.2**	**-6.1**	**-5.4**	**-7.1**	**-9.1**	**-11.3**	**-13.7**	**-16.2**
NSR04	Immission	20.7	26.2	30.4	32.5	32.5	32.5	32.5	32.5	32.5
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-14.3**	**-8.8**	**-4.7**	**-4.0**	**-5.7**	**-7.7**	**-9.9**	**-12.3**	**-14.8**
NSR05	Immission	21.8	27.3	31.5	33.6	33.6	33.6	33.6	33.6	33.6
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-13.2**	**-7.7**	**-3.6**	**-2.9**	**-4.6**	**-6.6**	**-8.8**	**-11.2**	**-13.7**
NSR06	Immission	22.7	28.2	32.4	34.5	34.5	34.5	34.5	34.5	34.5
	Limit	38.4	39.1	40.0	41.2	42.6	44.2	46.1	48.1	50.3
	Margin	**-15.7**	**-10.9**	**-7.6**	**-6.7**	**-8.1**	**-9.7**	**-11.6**	**-13.6**	**-15.8**
NSR07	Immission	23.8	29.3	33.5	35.6	35.6	35.6	35.6	35.6	35.6
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-11.2**	**-5.7**	**-1.6**	**-0.9**	**-2.6**	**-4.6**	**-6.8**	**-9.2**	**-11.7**
NSR08	Immission	24.0	29.5	33.7	35.8	35.8	35.8	35.8	35.8	35.8
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-11.0**	**-5.5**	**-1.4**	**-0.7**	**-2.4**	**-4.4**	**-6.6**	**-9.0**	**-11.5**
NSR09	Immission	23.9	29.4	33.6	35.7	35.7	35.7	35.7	35.7	35.7
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-11.1**	**-5.6**	**-1.5**	**-0.8**	**-2.5**	**-4.5**	**-6.7**	**-9.1**	**-11.6**
NSR10	Immission	23.4	28.9	33.1	35.2	35.2	35.2	35.2	35.2	35.2
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-11.6**	**-6.1**	**-2.0**	**-1.3**	**-3.0**	**-5.0**	**-7.2**	**-9.6**	**-12.1**
NSR11	Immission	23.8	29.3	33.5	35.6	35.6	35.6	35.6	35.6	35.6
	Limit	35.0	35.0	36.0	37.6	39.3	41.1	42.7	44.1	45.2

NSR	Detail	Standardised 10m Height Wind speed, ms^{-1}								
		4	5	6	7	8	9	10	11	12
	Margin	**-11.2**	**-5.7**	**-2.5**	**-2.0**	**-3.7**	**-5.5**	**-7.1**	**-8.5**	**-9.6**
NSR12	Immission	21.9	27.4	31.6	33.7	33.7	33.7	33.7	33.7	33.7
	Limit	35.0	35.0	36.0	37.6	39.3	41.1	42.7	44.1	45.2
	Margin	**-13.1**	**-7.6**	**-4.4**	**-3.9**	**-5.6**	**-7.4**	**-9.0**	**-10.4**	**-11.5**
NSR13	Immission	22.3	27.8	32.0	34.1	34.1	34.1	34.1	34.1	34.1
	Limit	35.0	35.0	35.1	36.5	38.2	40.2	42.4	44.8	47.3
	Margin	**-12.7**	**-7.2**	**-3.1**	**-2.4**	**-4.1**	**-6.1**	**-8.3**	**-10.7**	**-13.2**

Table 13-15: Night-time Noise Assessment of the Proposed Development

NSR	Detail	Standardised 10m Height Wind speed, ms^{-1}								
		4	5	6	7	8	9	10	11	12
NSR01	Immission	23.3	28.8	33.0	35.1	35.1	35.1	35.1	35.1	35.1
	Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Margin	**-21.7**	**-16.2**	**-12.0**	**-9.9**	**-9.9**	**-9.9**	**-9.9**	**-9.9**	**-9.9**
NSR02	Immission	19.8	25.3	29.5	31.6	31.6	31.6	31.6	31.6	31.6
	Limit	38.0	38.0	38.0	38.0	38.0	38.0	39.8	41.8	43.9
	Margin	**-18.2**	**-12.7**	**-8.5**	**-6.4**	**-6.4**	**-6.4**	**-8.2**	**-10.2**	**-12.3**
NSR03	Immission	19.3	24.8	29.0	31.1	31.1	31.1	31.1	31.1	31.1
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-18.7**	**-13.2**	**-9.0**	**-6.9**	**-6.9**	**-7.3**	**-9.5**	**-12.0**	**-14.6**
NSR04	Immission	20.7	26.2	30.4	32.5	32.5	32.5	32.5	32.5	32.5
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-17.3**	**-11.8**	**-7.6**	**-5.5**	**-5.5**	**-5.9**	**-8.1**	**-10.6**	**-13.2**
NSR05	Immission	21.8	27.3	31.5	33.6	33.6	33.6	33.6	33.6	33.6
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-16.2**	**-10.7**	**-6.5**	**-4.4**	**-4.4**	**-4.8**	**-7.0**	**-9.5**	**-12.1**
NSR06	Immission	22.7	28.2	32.4	34.5	34.5	34.5	34.5	34.5	34.5
	Limit	40.3	40.5	41.0	41.8	42.9	44.3	45.9	47.8	49.9
	Margin	**-17.6**	**-12.3**	**-8.6**	**-7.3**	**-8.4**	**-9.8**	**-11.4**	**-13.3**	**-15.4**
NSR07	Immission	23.8	29.3	33.5	35.6	35.6	35.6	35.6	35.6	35.6
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-14.2**	**-8.7**	**-4.5**	**-2.4**	**-2.4**	**-2.8**	**-5.0**	**-7.5**	**-10.1**
NSR08	Immission	24.0	29.5	33.7	35.8	35.8	35.8	35.8	35.8	35.8

NSR	Detail	Standardised 10m Height Wind speed, ms^{-1}								
		4	5	6	7	8	9	10	11	12
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-14.0**	**-8.5**	**-4.3**	**-2.2**	**-2.2**	**-2.6**	**-4.8**	**-7.3**	**-9.9**
NSR09	Immission	23.9	29.4	33.6	35.7	35.7	35.7	35.7	35.7	35.7
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-14.1**	**-8.6**	**-4.4**	**-2.3**	**-2.3**	**-2.7**	**-4.9**	**-7.4**	**-10.0**
NSR10	Immission	23.4	28.9	33.1	35.2	35.2	35.2	35.2	35.2	35.2
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-14.6**	**-9.1**	**-4.9**	**-2.8**	**-2.8**	**-3.2**	**-5.4**	**-7.9**	**-10.5**
NSR11	Immission	23.8	29.3	33.5	35.6	35.6	35.6	35.6	35.6	35.6
	Limit	38.0	38.0	38.0	38.0	38.1	39.7	41.4	43.1	44.8
	Margin	**-14.2**	**-8.7**	**-4.5**	**-2.4**	**-2.5**	**-4.1**	**-5.8**	**-7.5**	**-9.2**
NSR12	Immission	21.9	27.4	31.6	33.7	33.7	33.7	33.7	33.7	33.7
	Limit	38.0	38.0	38.0	38.0	38.1	39.7	41.4	43.1	44.8
	Margin	**-16.1**	**-10.6**	**-6.4**	**-4.3**	**-4.4**	**-6.0**	**-7.7**	**-9.4**	**-11.1**
NSR13	Immission	22.3	27.8	32.0	34.1	34.1	34.1	34.1	34.1	34.1
	Limit	38.0	38.0	38.0	38.0	38.0	38.4	40.6	43.1	45.7
	Margin	**-15.7**	**-10.2**	**-6.0**	**-3.9**	**-3.9**	**-4.3**	**-6.5**	**-9.0**	**-11.6**

13.81 It can be seen in **Table 13-14** and **Table 13-15** that the wind turbine noise immission level from the proposed development does not exceed the ETSU-R-97 noise limit at any receptor for any given wind speed and would therefore be not significant.

Proposed Mitigation and Enhancement

13.82 Operational noise levels have been determined to be not significant, therefore, mitigation is not deemed to be necessary.

Residual Operational Effects

13.83 No mitigation is required, so the residual operational noise effects remain not significant.

FURTHER SURVEY REQUIREMENTS AND MONITORING

13.84 No further noise surveys are required to inform this assessment.

SUMMARY OF PREDICTED EFFECTS

13.85 The effect of construction and decommissioning noise, including construction traffic, is predicted to be not significant and no specific mitigation measures are considered necessary.

13.86 The effect of operational noise is also predicted to be not significant and no specific mitigation measures are considered necessary.

STATEMENT OF SIGNIFICANCE

13.87 The effect of construction and decommissioning noise, including construction traffic, is predicted to be not significant and no specific mitigation measures are considered necessary.

13.88 The effect of operational noise is also predicted to be not significant and no specific mitigation measures are considered necessary.

13.89 No other wind turbines would cumulatively add to the operational or construction noise assessed. The operational and construction noise from the proposed development would not add cumulatively to noise from other wind developments.

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