Chapter 22: Noise and Vibration (In-Air)

Co-financed by the European Union
Connecting Europe Facility

NorthConnect KS
Serviceboks 603, Lundsiden
N-4606 Kristiansand
Norway

Phone +47 38 60 70 00
Mail: post@northconnect.no
Web: www.northconnect.no

Contents

22 Noise and Vibration (In-Air)

22.1 Introduction

Environmental, or community noise is a broad term that encompasses noise emitted from many sources, including road, rail & air traffic, industry, construction, public work and neighbourhood noise. All of these sources potentially contribute adversely to the overall noise environment. It is therefore reasonable to expect communities to be sensitive to any deterioration in their acoustic environment as a result of a proposed development.

This chapter considers the likely significant noise effects associated with the construction of the onshore elements of the HVDC Cabling. Specifically, the chapter considers the construction activities that are likely to occur between the landfall location at Long Haven Bay and the previously consented HVAC Converter Station at Fourfields. This chapter considers terrestrial noise effects only. Marine noise effects are dealt with in Chapter 23: Noise and Vibration (Underwater).

As the cable will be buried for the entire length of the onshore cable corridor, no operational noise effects are anticipated. As such, operational noise effects have been scoped out.

The Chapter also does not consider decommissioning noise effects as decommissioning noise effects have been scoped out.

Significant vibration effects from construction activities typically come about from either piling activities or blasting. No piling or blasting is proposed for this development. Localised vibration impacts may occur in the immediate vicinity of Horizontal Directional Drilling (HDD) rig locations, however, due to the separation distances between the HDD rig and any sensitive receptors, significant vibration impacts are unlikely to occur. Therefore, a quantitative assessment of vibration has not been undertaken.

The specific objectives of the chapter are to:

- Identify potential noise sensitive receptors in the vicinity of the onshore cable corridor and quantify the existing baseline sound levels at these locations;
- Calculate the likely levels of construction noise at the nearest receptors to determine the potential for significant noise effects associated with the proposed development; and
- Indicate any requirements for mitigation measures in order to provide sufficient levels of protection for nearby receptors.

As well as assessing the noise effects on human receptors, the Chapter also predicts the levels of noise likely to occur in areas with ornithological receptors, for both terrestrial and marine-dependent species. The potential impacts on ornithological receptors resulting from in-air noise emissions are considered further in Chapter 17: Ornithology.

The chapter is supported by:

- Appendix H.1: Baseline Noise Level Data;
- Appendix H.2: Construction Noise Assessment Data;
- Appendix H.3: 3D Noise Contours for Ornithological Assessment;
- Drawing NCFFS-NCT-X-XG-0009-01 (In-Air Noise assessment Study Area); and,
- Drawings NCFFS-NCT-X-XG-0010-01 through to NCFFS-NCT-X-XG-0010-12 (Noise Assessment Contour Plots)

Baseline sound level monitoring has been undertaken by Affric Limited, whilst the Noise Impact Assessment (NIA) and authoring of this chapter has been undertaken by TNEI Services Ltd (TNEI). All of the TNEI team contributing to this chapter are appropriately qualified and affiliated with the Institute of Acoustics (IOA).

22.2 Nomenclature

Please note the following terms and definitions, which are used throughout this Chapter:

- **Emission** refers to the sound level emitted from a sound source, expressed as either a sound power level or a sound pressure level;
- **Immission** refers to the sound pressure level received at a specific location from a noise source(s);
- **SWL** indicates the sound power level in decibels (dB);
- **SPL** indicates the sound pressure level in decibels (dB);
- **NSR** (Noise Sensitive Receptor) identified receptors which are sensitive to noise;
- **NML** (Noise Monitoring Location) refers to any location where baseline or specific noise levels have been measured; and
- **NAL** (Noise Assessment Location) refers to any location where the noise immission levels are calculated and assessed.

Unless otherwise stated, all noise levels refer to free field levels, i.e. noise levels without influence from any nearby reflective surfaces.

22.3 Sources of Information

22.3.1 Planning and Legislative Framework

The overarching European legislation in relation to terrestrial environmental noise is the '*Environmental Noise Directive'* (The European Parliament and the Council of the European Union, 2002) (END). The END aims to limit people's exposure to environmental noise but does not prescribe noise limits. Instead, it requires each member state to provide data on noise exposure, and to develop action plans to prevent or reduce noise exposure, and to preserve existing quiet areas. In Scotland the END is transposed and implemented within *'The Environmental Noise (Scotland) Regulations'* (Scottish Statutory Instruments, 2006).

At a national level the relevant policy documents are: Planning Advice Note (PAN) 1/2011 – *'Planning and Noise*,' (The Scottish Government, 2011); and the associated *Technical Advice Note (TAN) – 'Assessment of Noise' (*The Scottish Government, 2011).

PAN 1/2011 provides little guidance in respect of construction noise, other than recommending that the use of planning conditions is not the preferred method for controlling temporary construction noise. Specifically, the document states:

"32. While planning conditions can be used to limit noise from temporary construction sites, it is most effectively controlled through the Control of Pollution Act 1974 (COPA74) and the Pollution and Prevention Control Act 1999 for relevant installations. Notice can be served in advance of works and site conditions set to control activities."

BS5228:1997 'Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control' parts 1 to 5 (BSI, 1997) is the approved Code of Practice under COPA74, however, it is the 2009 version of the Standard which should be used for Environmental Impact Assessments (EIA) and planning applications. In this regards the TAN states:

"However, under Environmental Impact Assessments and for planning purposes i.e. not in regard to the Control of Pollution Act 1974, the 2009 version of BS 5228 is applicable. The 2009 version of the standard consists of Parts 1 and 2 for noise and vibration respectively."

22.3.2 Relevant Guidance

The BS5228:2009 standard provides useful guidance on practical noise control. Part 1, provides recommendations for basic methods of noise control including sections on community relations, training, occupational noise effects, neighbourhood nuisance and project supervision. The annexes provide information on noise sources, noise calculation procedures, mitigation measures and their effectiveness.

Part 1 also contains sound power level data for a variety of construction plant. This data was obtained from field measurements of actual plant operating on construction and open sites in the United Kingdom and is therefore appropriate to use as source level data for construction noise propagation calculations.

The 2009 version of BS5228 was subject to an additional update in 2014. Accordingly, the construction noise assessment in this chapter has been undertaken in accordance *with BS5228 1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites. Noise'*, (BSI, 2009), hereafter referred to as BS5228.

22.4 Assessment Methodology

22.4.1 Study Area

Noise Sensitive Receptors (NSRs) are properties, people or fauna which are sensitive to noise and, therefore, may require protection from nearby noise sources. The Study Area has been defined through the identification of the closest NSRs to the development and after reviewing the Scoping Report and stakeholder Scoping Responses. Specifically, the study area is defined by the closest NSRs to the development on the assumption that if noise levels are within acceptable levels at the closest receptors then it is reasonable to assume they will also be acceptable at more distant locations.

Table 22.1 details the closest identified residential NSRs to the Development considered within the NIA.

Table 22.1 Nearest Identified Residential Receptors

NSR ID	Descriptor	Grid Reference
NSR01	Denside Hill of Sandford	NK 11250 41792
NSR02	Lendrum Terrace	NK 12134 41734
NSR03	Highfield	NK 11765 41585
NSR04	Denside	NK 11212 41414
NSR05	Glen Ugie	NK 12373 40673
NSR06	Four Winds Croft	NK 11319 40520
NSR07	Longhaven Mains	NK 11582 40480
NSR08	Five Acres	NK 11367 40200
NSR09	Station House	NK 11545 40150

A number of non-residential NSRs also require consideration.

It is noted that Scottish Natural Heritage (SNH) have requested that noise impacts should be assessed within the ES to consider bird species within the following areas:

- Buchan Ness to Collieston Coast Special Protection Area (SPA); and
- Bullers of Buchan Coast Site of Special Scientific Interest (SSSI).

Accordingly, this chapter reports the predicted levels likely to occur in these areas, whilst the associated noise impacts are reported within Chapter 17: Ornithology.

SNH also suggested that it may be appropriate to assess noise impacts on recreational users of the area. Accordingly, noise levels have also been considered for the following areas:

- Longhaven Nature Reserve Footpath, part of the coastal Core Path linking Whinnyfold to Boddam (see Chapter 21: :ocal Community and Economy for more information); and,
- Rock climbing routes at 'The Warlord Cliff'.

No other NSRs have been identified within the local area for consideration within the NIA.

The study area and NSRs are detailed on Drawing NCFFS-NCT-X-XG-0009-01.

22.4.2 Baseline Data Collection

Attended baseline sound level monitoring was undertaken for NorthConnect during 2014 at nine locations for both daytime and night-time periods and this data is presented in the Noise Chapter of the HVAC Converter Station Environmental Statement. Additional monitoring was undertaken by Affric Limited at two locations during 2017 to supplement the previous data, as proposed in the Scoping Report. Data from five of the original seven locations has been considered along with the two new locations, which provides an appropriate geographical spread of monitoring points for the NSRs considered within this assessment.

22.4.3 Impact Assessment Methodology

Annex E, part E.3.2 of BS5228, clearly sets criteria for assessing the significance of construction noise effects and gives examples of acceptable limits for construction noise.

Table E.1 of BS5228 (represented here as Table 22.2) contains an example of the significance criteria that can be used to assess construction activities.

Table 222.2 Example of Threshold of Potential Significant Effect at Dwellings ($dB_{(A)}$).

Assessment Category and Threshold Value Period	**Threshold Value LAeq,T dB**		
	Category $A_{(A)}$	**Category $B_{(B)}$**	**Category $C_{(C)}$**
Night-Time (23:00 – 07:00)	45	50	55
Evenings and Weekends	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	65	70	75
(A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values; (B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values; (C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values;			

The threshold values can be considered limits for the construction noise levels (quantified using the LAeq noise metric). The limits in each category are to be used where the existing noise level at each location, rounded to the nearest 5dB, is below the level given for a particular time of day. BS5228 provides the following advice regarding the threshold limits:

"Note: 1 A potential significant effect is indicated if the LAeq,T noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total LAeq,T noise level for the period increases by more than 3dB due to site noise.

Note 3: Applied to residential receptors only."

Therefore, the assessment of significance of effects for construction noise reflects a specific noise threshold for the locality for a particular period of the day, rather than an absolute noise level.

22.4.3.1 Evaluation of Receptors

The TAN (1/2011) states; "*The initial process requires the identification of all noise sensitive receptors (NSR) that may potentially be affected by the development and to prioritise each NSR according to their level of sensitivity*."

Table 2.1 of the TAN, presented here as Table 22.3, presents the levels of sensitivity associated with a variety of receptors.

Table 22.3 Level of Sensitivity Associated with NSRs.

Sensitivity	Description	Examples of NSR
High	Receptors where people or operations are particularly susceptible to noise.	• Residential, including private gardens where appropriate. • Quiet outdoor areas used for recreation • Conference facilities • Theatres/Auditoria/Studios • Schools during the daytime • Hospitals/residential care homes • Places of worship
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance.	• Offices • Bars/Cafes/Restaurants where external noise may be intrusive. • Sports grounds when spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise is minimal.	• Buildings not occupied during working hours • Factories and working environments with existing high noise levels • Sports grounds when spectator noise is a normal part of the event • Night Clubs

The nearest identified human NSRs are either residential receptors or "*Quiet outdoor areas used for recreation*"; therefore, this assessment assumes all receptors are of high sensitivity.

The sensitivity of different species of bird, including those that are listed in the SPA and SSSI designations, and the subsequent impact assessment, is dealt with separately in Chapter 17: Ornithology.

22.4.3.2 Magnitude of Impact

The assessment of construction noise against fixed guideline noise level limits is simply a case of pass or fail and as such cannot be used to determine the magnitude of impact.

22.4.3.3 Significance of Effect

Having due regard to the existing ambient noise levels at NSRs around the proposed development, the BS5228 threshold values for daytime, evenings and weekends (as detailed in Table 22.2) have been used for the construction noise assessment. Accordingly, any predicted levels above the relevant category threshold (A, B or C) is assessed as a significant effect, whilst predicted levels below the relevant category threshold is assessed as a non-significant effect.

22.4.4 Methodology for the Prediction of Noise

In order to predict the noise immission levels attributable to the construction of the Proposed Development, noise propagation models are produced using the propriety noise modelling software CadnaA. Within the software, complex models can be used to simulate the propagation of noise according to a range of international calculation standards.

For each Noise Assessment Location (NAL), the $L_{Aeq(12hours)}$ levels have been predicted in accordance with ISO9613-2:1996 *'Acoustics - Attenuation of sound during propagation outdoors: General method of calculation'* (International Organization for Standardization, 1996). The ISO 9613 propagation model was chosen in preference to the calculation method presented in BS5228, primarily because of some of the significant distances from source to receptor evident on this site. Specifically, BS5228

notes in F 2.2.2.2, that at distances over 300 m noise predictions using the BS5228 methodology should be treated with caution, especially where a soft ground correction factor has been applied because of the increasing importance of meteorological effects, whereas ISO 9613-2 provides equations that have been validated up to 1,000 m.

The ISO 9613 model can take account of the following factors that influence sound propagation outdoors:

- geometric divergence;
- air absorption;
- reflecting obstacles;
- screening;
- vegetation; and
- ground reflections.

The model uses the octave band sound power output of the proposed plant as its acoustic input data, and calculates on an octave band basis, attenuation due to geometric spreading, atmospheric absorption and ground effects.

For the purposes of this assessment, all noise level predictions have been undertaken using a receiver height of 1.5m above local ground level. Mixed ground (G=0.5) attenuation has been assumed at all locations except for roads and the sea, which have been modelled with a ground attenuation of G=0 (hard ground). Air absorption based on a temperature of 10°C and 70% relative humidity has been assumed.

All stationary items of plant and activities have been modelled as single point sources, however, for construction activities which will occur along a linear activity area, for example, the construction of the mains water pipes, these have been modelled as a line source. Specifically, the relevant plant has been modelled assuming the SWL is distributed along the entire length of the work area.

22.4.5 Limitations of Assessment

The noise propagation models are intended to give a good approximation of the specific noise level and the contribution of each individual source. However, it is expected that measured levels are unlikely to be matched exactly with modelled values and the following limitations in the model should be considered:

- In accordance with ISO 9613-2, all assessment locations are modelled as downwind of all noise sources and propagation calculations are based on a moderate ground-based temperature inversion, such as commonly occurs at night;
- The predicted barrier attenuation provided by local topography, embankments, walls, buildings and other structures in the intervening ground between source and receiver can only be approximated and not all barrier attenuation will have been accounted for;
- Unless specifically stated the models assume all fixed noise sources are operating continuously and simultaneously, estimating a worst-case source noise level; and
- All mobile plant (excavators, bulldozers, rollers, etc.) have been modelled as a line source along their anticipated movement paths and the sound power level of the source averaged out across the length of the entire line. This will give an approximation of the overall noise levels from mobile plant at receptor locations, however, in reality noise levels will fluctuate as construction plant and activities moves along the activity area.

22.5 Baseline Information

Baseline sound level monitoring was undertaken at multiple locations in the vicinity of the Proposed Development in 2014 in order to support the EIA for the associated HVAC Converter Station. Table 22.4 presents the noise monitoring locations (NMLs) from this survey which have been included as part of this NIA.

Table 22.4 Noise Monitoring Locations Used from Converter Station ES Noise Assessment.

Noise Monitoring Location		**Grid reference**
NML ID	**Descriptor**	
NML01	Converter site	NK 11950 41270
NML02	Highfield	NK 11730 41590
NML04	Hill of Boddam viewpoint	NK 12270 40950
NML06	Longhaven Mains	NK 11550 40480

In addition to the above, attended baseline sound level monitoring was undertaken by Affric Limited at two locations during both the daytime and night-time periods of the 28th of September and into the morning of the 29th of September 2017. Monitoring was conducted at the NMLs proposed in the Scoping Report, as detailed in Table 22.5.

Table 22.5: Supplementary noise monitoring locations.

Noise Monitoring Location		**Grid reference**
NML ID	**Descriptor**	
NML08	A90 (nr Station House)	NK 11562 40222
NML09	North Sea Trail	NK 12266 40037

Detailed information regarding the sound level monitoring at NML01, NML02, NML04 and NML06 can be found in Chapter 6 of '*NorthConnect Interconnector Converter Station and High Voltage Alternating Current Cable Route, Environmental Statement Volume 2 Main Document*' and '*Volume 3 Appendixes*' (NorthConnect, 2015), hereafter known as the *'Converter Station ES - Noise '.*

Noise measurement data and field data sheets for the most recent measurements (NML08 and NML09), including subjective observations made during the survey, are included in Appendix H.1.

All measurements were made with the sound level meter (SLM) mounted on a tripod at approximately 1.2 – 1.5 metres above the ground and away from nearby reflective surfaces i.e. building façades, fences etc.

The noise monitoring equipment consisted of a Cirrus Optimus Green integrating sound level meter (SLM) fitted with a standard wind shield. All noise monitoring equipment (calibrator, SLM and microphones) used for the study are categorised as Class 1, as specified in IEC 61672-1 '*Electroacoustics. Sound level meters. Specifications*' (International Electrotechnical Commission, 2002). The equipment was calibrated on site at the beginning and end of each

measurement period with no significant deviations noted. Appendix H.1 contains the equipment and laboratory calibration details.

22.5.1 Results of Noise Monitoring

Table 22.6 details the measured L_{Aeq} noise levels for daytime and night-time periods at each of the NMLs. For NML01, NML02, NML04 and NML06 these levels are taken from *Table 6.4.2* of Converter *Station ES - Noise*.

LAeq levels for NML08 and NML09 have been calculated after data analysis in Cirrus NoiseTools software. It should be noted that a low flying helicopter overflew the SLM at NML09 towards the end of the daytime survey period, therefore, this section of the data has been removed so as not to artificially raise the overall ambient sound level. This is detailed in Appendix H.1.

Table 22.6 Measured ambient noise levels, dB $L_{Aeq(t)}$.

Noise Monitoring Location		**Ambient Sound Level, dB $L_{Aeq(t)}$**	
NML ID	**Descriptor**	**Daytime(60mins)**	**Night-time(30 mins)**
NML01	Converter site	53	33
NML02	Highfield	43	41
NML04	Hill of Boddam viewpoint	54	40
NML06	Longhaven Mains	45	47
NML08	A90 (nr Station House)	64	55
NML09	North Sea Trail	53	54

22.5.2 Summary of Noise Monitoring Results

Having due regard to the existing ambient noise levels at NSRs around the proposed development, the BS5228 threshold values (as detailed in Table 22.2) have been determined. Table 22.7 details the Assessment Category to be used after rounding the measured ambient noise levels to the nearest 5dB.

Table 22.7 BS5228 Threshold Categories per NML.

Noise Monitoring Location		Threshold Value Category		
NML ID	**Descriptor**	**Daytime**	**Evening ***	**Night-time**
NML01	Converter site	Category A	Category A	Category A
NML02	Highfield	Category A	Category A	Category A
NML04	Hill of Boddam viewpoint	Category A	Category A	Category A
NML06	Longhaven Mains	Category A	Category A	Category A
NML08	A90 (nr Station House)	Category A	Category A	Category C
NML09	North Sea Trail	Category A	Category A	Category C

* As no evening sound level monitoring has been conducted the assessment for evening and weekend working assumes Category A threshold values, which represents a conservative approach to the assessment.

22.6 Noise Impact Assessment

Noise levels will vary throughout the construction period as construction activities, plant and locations vary. For much of the working day the noise associated with construction activities would be less than predicted, as the assessment has assumed all equipment is continually operating at full power, whereas in practice, equipment load and precise location may vary throughout the day. This approach has been adopted to represent a worst-case assessment.

At this stage, a detailed plant list is not available, so a generic plant list based upon experience of similar projects has been used, as well as input from NorthConnect's engineers on what predicted plant may be required.

Machinery onsite would produce noise levels that are transient in nature and fluctuate due both to the location of the activity and the load on any individual machine. The works would generally comprise both moving and static sources. Mobile sources include mobile construction plant and HGVs, while static construction plant such as the HDD drilling rig, generators, lighting rigs and pumps are usually located at a fixed location for an extended period of time.

22.6.1 Construction

The hours of operation are anticipated to be 07:00 to 19:00 Monday to Friday, and 07:00 to 13:00 on Saturdays for all onshore construction stages, except for cable winching and the HDD drilling operations (both landfall and under A90 and disused railway). The cable winching will occur for a concentrated period that will require 7-day, 24-hour working. The HDD drilling operations are planned to be conducted on a 7-day per week basis, between 07:00 and 23:00, however in order to ensure that the drilling works are completed in the available window prior to the bird breeding season, 24hr working may be required dependant on the rate of progress.

Construction will be carried out in two main phases: Enabling Works; and HVDC Cable Installation. Each phase will consist of a number of work activities with the possibility of some of these activities

overlapping. For the purpose of modelling the construction programme has been divided up as follows:

- **Phase 1 Enabling Works:**
  - Activity 01, Installation of waterpipe (Longhaven Mains to Fourfields);
  - Activity 02, Installation of cable ducts under footpaths (by Fourfields);
  - Activity 03, Installation of waterpipe (A90 to HDD site);
  - Activity 04, Laying of temporary access road to HDD site; and,
  - Activity 05, HDD site setup.
- **Phase 2 HVDC Cable Installation:**
  - Activity 06, Jointing Bay 1 construction (offshore/onshore connection);
  - Activity 07, HDD drilling (by onshore entrance point);
  - Activity 08, Jointing Bay 2 construction (northern connection);
  - Activity 09, HDD drilling (under A90 and disused railway);
  - Activity 10, Cable pull (landing of offshore cable); and,
  - Activity 11, HVDC onshore cable laying.

A detailed description of the cable installation methods is included within Chapter 2: Project Description. The equipment and machinery assumed to be operational during each of the above stages and included within the noise models are detailed in Appendix H.2 along with the associated noise data split into octave bands (where available). All SPL data has been sourced from Annex C of BS5228 and have been converted to sound power levels for input into CadnaA, except for the following items/activities:

HDD Drilling (Activities 07 and 09)

The HDD rig will likely be a PD 250 or similar. Manufacturer supplied data provides a SWL of 86 dBA for the drilling unit, and this has been input directly into the noise model.

A Fluid Recycling System will also be required and for the purposes of modelling the specification of an American Augers MPR-600 has been used. Manufacturer supplied data quotes the SPL of the unit, including generator, to be 104 dBA at 1 m.

A number of mud pumps will be connected to the recycling unit and these have been modelled separately as individual point sources. No specific noise level data is available for the pumps, however, to predict their operational noise levels the model calculates the noise output from each pump based on the following formula:

$$SWL = 73 + s + 10\,Log\,(a)$$

Where *s* represents a variable for the octave band of interest and *a* is the power of the pump in kW. Appendix H.2 details the calculation used and the octave band sound power levels for each pump.

Cable Pull (Activity 10)

Three main vessels will be required during the cable pull from offshore to onshore, with additional small work boats possibly required. The noise model assumes that the following vessels will be in use:

A Diver Support Vessel (Mulitcat or similar) has been modelled close to the base of the cliffs at the HDD exit point. No specific noise data is available for this type and size of vessel, however, a Noise Impact Assessment undertaken for the Aberdeen Harbour Expansion Project does provide sound level measurement data for a tug vessel and this has been used as appropriate proxy data. Specifically,

Appendix 20-D of the Aberdeen Harbour Expansion Project Environmental Statement (Fugro, 2015) details a SWL of 87 dBA for a 'Waiting tugboat engine' i.e. not manoeuvring. This is likely to be the state of the vessel during these operations for the majority of the time. The vessel has been modelled as single point source with a broadband SWL of 87 dBA.

The Cable Lay Vessel has not been specified as a Contractor has not yet been appointed. However, a vessel with an assumed Dead Weight Tonnage (DWT) of 10,000 has been modelled located at a distance of approximately 80 m further out from the diver support vessel. Although no specific noise data for this type of vessel is available, the noise level output has been estimated as 102 dBA SWL, which has been calculated follows:

$$\mathrm{SWL} = 66 + 9\ \mathrm{Log}\ (\mathrm{DWT})$$

This method was detailed in the paper, '*Acoustic research - mobile sources in the GRW-area Rotterdam'* (Witte, J 1994), which found a correlation with the DWT of various classes of vessels and their noise output.

A guard vessel is predicted to be positioned close to the Peterhead Pilot Station, approximately 5km from the HDD exit point. The guard vessel will be stationary for the majority of the time. Due to the distance from the cable pull activity, the guard vessel has been excluded from the noise modelling.

Small work boats may be required for additional assistance during the cable pull, operating between the dive support vessel and the cable lay vessel. These are likely to be zodiacs (or similar) with outboard engines. It is not possible to accurately predict the noise emissions for these craft, however, the work boats will be stationary for the majority of the time, and as a precautionary approach, the input data of an additional Diver Support Vessel has been modelled as a proxy for these craft.

TNEI undertook measurements in January 2018 for a similar project, in which a winch was used for the pulling of onshore electrical cables from the Aberdeen Offshore Windfarm to the Blackdog Substation. This octave band SPL measurement data has been used to model the winch and power packs as individual point sources located at the HDD drilling location (onshore landing) and at Jointing Bay 01. The model assumes that winching at both locations is occurring concurrently, however, in reality only one location is likely to be active at any one time.

22.6.1.1 Impact Assessment – Residential Receptors

Table 22.8 (overleaf) provides the noise immission levels for each modelled construction activity at each of the residential NALs. The location of each NAL has been selected to represent a worst-case scenario, i.e. the assessment location represents the most exposed facade or garden boundary to the proposed construction activities.

As the receptor at Longhaven Mains will be exposed to sound from more than one direction (depending on which activity is occurring), two NALs have been selected. This allows the most exposed facade of this receptor for any given activity to be assessed.

Baseline noise level monitoring has identified that the Category A threshold values (as detailed in Table 22.2) are appropriate for all of the residential NALs, therefore the strictest of the BS5228 noise limits are used for assessment. Accordingly, the thresholds for significance are:

- 65dB $L_{Aeq(t)}$ for weekdays (07:00 – 19:00) and Saturday mornings (07:00 – 13:00);
- 55dB $L_{Aeq(t)}$ for evenings (07:00 – 19:00), Saturday (13:00 – 23:00) and all-day Sunday; and
- 45dB $L_{Aeq(t)}$ for night-time (23:00-07:00).

The predicted noise levels at all of the NSRs during all construction stages are below the 65dBA daytime thresholds. In addition, the winching operations (Activity 10), which will occur for a limited 24-hour period, will be below the 55 dBA Evening and Weekend and 45 dBA night-time threshold levels. The HDD operations which will be conducted on a 7-day per week basis from 07:00-23:00 result in immission levels at all receptors which are below the 55 dBA Evening and Weekend criteria. However, if the HDD operations at the landfall (activity 07) require 24hr working, this may result in exceedances of the Night Time 45 dBA criteria at Longhaven Mains #02, Station House, and Jehrada Cottage (52, 48, and 45 dBA respectively).

There is the possibility that some construction activities may overlap. Specifically, activities 06, 08 and 11 could occur concurrently. Noise level predictions for all three activities occurring at the same time indicate that the highest noise level would be 53 dB $L_{Aeq(t)}$ at NAL07 Longhaven Mains. This below the BS5228 threshold levels. Drawing NCFFS-NCT-X-XG-0010-12 details the relevant noise contour plot for this propagation model.

Accordingly, comparison of the predicted levels against the BS5228 Threshold Values for each residential receptor and each construction activity with the exception of night time operations during the landfall HDD drilling works, indicates that construction noise impacts are **Non-Significant.** If 24hr working is required in order to complete the landfall HDD operations within the available window, this activity results in minor exceedances of the night time noise criteria, and hence has the potential to result in **Significant** night time noise impacts at 3 receptors.

Table 22.8 Predicted Noise Immission Levels, dB $L_{Aeq(12\ hours)}$.

Receiver		Activity 01	Activity 02	Activity 03	Activity 04	Activity 05	Activity 06	Activity 07	Activity 08	Activity 09	Activity 10	Activity 11
Name	**NAL ID**	**Water pipe (LM to Fourfields)**	**Cable ducts (Fourfields)**	**Water pipe (A90 to HDD site)**	**Site access road**	**HDD setup**	**Jointing Bay 1**	**HDD Drilling (onshore landing)**	**Jointing Bay 2**	**HDD Drilling (A90)**	**Cable pull**	**Cable laying**
Denside Hill of	**NAL1**	65	31	35	23	26	27	28	32	35	34	23
Lendrum Terrace	**NAL2**	65	35	36	24	25	28	29	33	36	34	25
Highfield	**NAL3**	65	42	41	25	28	29	30	34	40	36	26
Denside	**NAL4**	65	34	38	24	29	29	30	34	38	36	24
Glen Ugie	**NAL5**	65	31	35	35	38	44	42	46	35	46	34
Four Winds	**NAL6**	65	40	36	35	41	39	40	41	37	45	33
Longhaven Mains#01	**NAL7a**	65	40	38	38	44	43	43	41	39	48	33
Longhaven Mains #02	**NAL7b**	65	35	30	44	51	51	52	44	31	55	40
Five Acres	**NAL8**	65	32	32	40	47	42	42	43	33	48	35
Station House	**NAL9**	65	32	33	51	61	50	48	46	34	54	40
Jehrada Cottage	**NAL10**	65	32	33	45	54	46	45	45	34	51	37

22.6.1.2 Impact Assessment – Longhaven Nature Reserve Footpath

Drawings NCFFS-NCT-X-XG-0010-01 through to Drawing NCFFS-NCT-X-XG-0010-12 presents the noise contour plots for each construction stage showing the predicted noise immission levels in the vicinity of the site. The 65 dB LAeq noise contour is shown where the contour colours change from green to blue. The 55 dB LAeq noise contour is shown where the contour colours change from blue to pink. The Longhaven Nature Reserve Footpath is shown as a dashed pink line.

Walkers using the Nature Reserve footpath will experience varying noise levels during the construction period, depending upon which section of the path they are on, wind conditions and the construction activities that are occurring. The drawings illustrate that the activities that generate the highest levels of noise along the footpath are those activities occurring within the HDD areas and detail where the footpath crosses over the 55 dBA and 65 dBA contours.

Existing ambient noise levels measured on the path (NML09), varied between 52 dB and 53 dB $L_{Aeq(t)}$ and remained relatively constant throughout the daytime and night-time periods. The change of level at those locations where the path intercepts the 55dBA contour, therefore, will be around 3 dB.

At the closest locations to the HDD areas the increase in noise level will be in the region of 13 dB, which will be noticeable, intrusive and clearly audible. As such it is recommended that mitigation measures are put in place to limit the noise exposure along this short section of path.

For short sections of the path during some activities at the HDD locations, therefore, noise levels are indicated as failing the BS5228 criteria, which in simple numerical terms it does, however the duration of exposure for walkers along these sections is very limited, typically lasting a few minutes, while the BS5228 thresholds are based upon 12 hours of exposure.

To put this into context, Table 22.9 presents the length and percentage of the path exposed to levels above the 55 dBA and 65 dBA thresholds for each construction activity.

Table 22.9 Length and Percentage of Path Exposed to Noise Above Threshold Levels.

Activity	Length of Path (m)			Percentage of path (%)		
	Above 65 dBA	Above 55 dBA	Below 55 dBA	Above 65 dBA	Above 55 dBA	Below 55 dBA
1) Water pipe (LM to Fourfields)	0	0	4401	0%	0%	100%
2) Cable ducts (Fourfields)	0	0	4401	0%	0%	100%
3) Water pipe (A90 to HDD site)	0	3	4398	0%	0%	100%
4) Site access road	0	16	4385	0%	0%	100%
5) HDD setup	0	111	4291	0%	3%	97%
6) Jointing Bay 1	0	0	4401	0%	0%	100%
7) HDD Drilling (onshore landing)	75	461	3941	2%	10%	90%
8) Jointing Bay 2	0	0	4401	0%	0%	100%
9) HDD Drilling (A90)	0	211	4190	0%	5%	95%
10) Cable pull	0	0	4401	0%	0%	100%
11) Cable laying	0	74	4327	0%	2%	98%

It can be seen that for the majority of the time, walkers using the path will not be exposed to levels above the BS5228 thresholds. Without additional mitigation the threshold exceedance will occur for a maximum of 10% of the path length during some of the HDD activity and only during weekend operations. Considering that the BS5228 threshold limits are based on a 12 hour time period and the fact that walkers are unlikely to be exposed to noise levels above the BS5228 thresholds for only a few minutes, the impacts on the path has been classed as **Non-Significant.**

22.6.1.3 Impact Assessment – Climbing Routes

Table 22.9 presents the noise immission levels at the nearest cliff detailed within local climbing guidebooks and shown to be active on ukclimbing.com, namely The Warlord Cliff. Two NALs have been used, one positioned on the cliff top and one positioned at the base of the cliff face. The highest anticipated noise level at the cliff top NAL is 54 dB $L_{Aeq(12hours)}$, which will occur during Activity 07 HDD Drilling (onshore landing). At the base of the cliff the highest levels are predicted to be 42 dB $L_{Aeq(12hours)}$, which will occur during Activity 10 Cable Pull.

At both NALs the noise levels will remain below the BS5228 Category A threshold levels, therefore, noise levels when assessed in simple accordance with BS5228 are deemed to be **Non-significant**, however, the effects of construction noise on nearby climbing routes may have a detrimental impact on safety through the masking of vocal communication between climbers. Accordingly, further assessment is required.

Standard climbing practice requires climbing partners to communicate vocally to establish when it is or isn't safe to climb and to indicate any potential hazards. ANSI/ASA S3.5 *'American National Standard Methods for Calculation of the Speech Intelligibility Index'* (ANSI, 1997) presents the SWL of typical speech for a range of 'vocal effort' and this is detailed in Table 22.10. For climbing activities TNEI have assumed that the level of vocal effort would be 'Shouted', as communication between climbers generally requires the participants to shout to one another due to the separation distances involved and the potential for rock faces and other topographical features to interrupt the direct line of sight between participants.

Table 22.10 Speech Spectrum by Vocal Effort, from ANSI S3.5, SWL dBZ.

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	SWL dBA
Normal	45.0	55.0	65.3	69.0	63.0	55.8	49.8	44.5	68.4
Raised	48.0	59.0	69.5	74.9	71.9	63.8	57.3	48.4	75.5
Loud	52.0	63.0	72.1	79.6	80.2	72.9	65.9	54.8	82.6
Shouted	52.0	63.0	73.1	84.0	89.3	82.4	74.9	64.1	91.0

Using the ISO9613 model, two scenarios have been modelled in CadnaA: Scenario 1 assumes a climber is on the clifftop and is shouting down to their climbing partner at the base of the cliff; and Scenario 2 assumes a climber is shouting from the base of the cliff up to their partner on the cliff top.

At the base of the cliff the predicted noise level from the cliff top climber communicating is 49 dBA. At the cliff top the predicted level from the climber shouting at the base of the cliff is 48 dBA. This is based on a simplistic model with no directivity, i.e. noise propagation from the point source (climber) is assumed to have an omnidirectional (spherical) radiation. In reality, voices are directional and therefore, levels may be higher than predicted by the model (assuming the speaker is facing in the approximate direction of the listener).

In simple numerical terms, during Activity 07 there is the potential for noise levels from the construction activities to mask communication between climbers. For all other construction activities construction noise levels will be below the predicted communication levels. However, it should be noted that the measured ambient noise levels in the area of the clifftop are already between 52 dBA and 53 dBA, therefore, ambient noise levels are already likely to mask vocal communication. Furthermore, although not quantified through measurement, the existing ambient noise levels at the base of the cliffs is likely to be higher still than at the measurement location, as this is closer to the dominant noise source in this area, which are the waves breaking.

Therefore, given that the increase in noise levels on the existing soundscape is likely to be minimal, noise impacts are expected to be **non-significant.**

22.6.1.4 Impact Assessment – Areas of Ornithological Interest

The effects of construction noise on ornithological interests are presented in Chapter 17: Ornithology.

22.7 Mitigation measures

Once a main contractor is appointed, careful consideration will be given to the type of plant to be used for each stage of construction as well as construction work schedules.

Section 8 of BS5228 recommends a number of simple control measures, which will be incorporated into the construction plans. The principal contractor would:

- keep local residents informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern;
- ensure that haulage vehicles would not arrive at or leave the site between 19.00 and 07.00 hours;
- ensure all vehicles and mechanical plant would be fitted with effective exhaust silencers and 'smart' reversing alarms and be subject to programmed maintenance;
- select inherently quiet plant where appropriate - all major compressors, pumps and generators would be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which would be kept closed whenever the machines are in use;
- ensure all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers;
- instruct that machines would be shut down between work periods or throttled down to a minimum;
- ensure regular maintenance of all equipment used on site, including maintenance related to noise emissions;
- ensure that vehicles are loaded carefully to ensure minimal drop heights so as to minimise noise during these operations; and
- ensure all ancillary plant such as generators and pumps would be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures should be provided.

If it is identified that 24hr working is required for the landfall HDD operations, then a Section 61 Consent will be applied for under the Control of Pollution Act 1974. The application will be informed by additional noise modelling once further details of the HDD equipment are available. Depending on the output of the model, further mitigation measures may be identified in order to reduce the night time noise impacts on residential receptors, which will also be detailed in the application.

Whilst the noise impacts on the path and climbing routes were determined to be non-significant, however there are potential safety concerns for climbers due to the possible masking of vocal communication between climbers during the landfall HDD operations. As such, NorthConnect will liaise with local climbing groups and conduct construction monitoring during HDD activities to check on noise levels in the area of the Warlord Cliff. If it is found that the noise is causing a safety concern, additional mitigation will be considered at this time.

22.8 Residual effects

Use of best practice noise control measures will reduce construction noise levels to lower levels than reported in the noise assessments, however, this will not result in a change of assessment outcome for individual construction activities.

22.9 Cumulative effects

It is necessary to consider the construction of the HVAC Converter Station which may overlap with the construction of the proposed HVDC cable.

Both the HVAC and HVDC cables will run close to each other from the Converter Station to the north-west corner of Fourfields, at which point the HVDC cable route heads south and the HVAC cable route heads north. Hence for the majority of the routes there is a significant spatial separation which will mean that cumulative noise effects on any given receptor do not occur.

When the routes converge, the civils work will be coordinated and due to space constraints and health and safety implications, the amount of equipment will be restricted to that utilised for the HVAC cabling.

Predicted cumulative noise levels at NAL03 Highfield, the closest NSR to both developments, are therefore expected to be similar to those predicted for Activity 11 Cable Laying. Similarly, construction noise levels at properties further afield are expected to be no higher than those reported for Activity 11. Accordingly, cumulative noise impacts are anticipated to be **Non-Significant**.

There are no other developments which need to be considered within the cumulative assessment.

22.10 Summary of effects

Table 22.11 presents a summary of the anticipated in-air noise impacts.

The assessment has considered the existing noise environment at local residential receptors and presented the anticipated construction and operational noise immission levels for a number of construction activities.

The assessment of construction noise on nearby residential receptors has been undertaken following the guidance contained within BS5228. All predictions assume that all plant is operating concurrently in full operational mode in order to provide a worst-case scenario (whereas in reality only a proportion of the plant may be operating for a proportion of time).

The construction noise levels at all of the assessed residential receptors during all individual assessed construction stages are below the daytime, weekend, evening and night-time thresholds adopted for this project.

The assessment also considers noise levels along the Longhaven Nature Reserve footpath and local climbing routes. Predicted noise levels indicate that small sections of the path will be exposed to noise levels above the BS5228 threshold values for some construction activities, however, given the short lengths of path affected and the limited duration of exposure, the assessment concludes that noise impacts on the path are Non-Significant.

Predicted noise levels will remain below the BS5228 threshold levels at all times for the closest climbing routes. There is the potential during HDD drilling for communication between climbers to be masked by construction noise, however, it is possible that this situation already occurs due to the high ambient noise levels in the area, and the increase in noise levels attributable to construction activities is anticipated to be minimal. Accordingly, the assessment concludes that noise impacts on nearby climbing routes are Non-Significant.

In practice, for much of the working day the noise associated with construction activities would be less than predicted as the predictions assume that all plant is operating concurrently and continuously,

whereas in reality only a certain proportion of plant would be operating at any one time, while others maybe idling or turned off.

Table 22.11 Summary of Effects

Nature of Impact	Receptor Sensitivity	Significance of Effect	Mitigation Summary	Residual Significance of Effect
Noise from construction activities (daytime) on residential receptors.	High	Non-Significant Effect	Best practice mitigation measures to be employed as detailed in BS5228	Non-Significant Effect
Noise from HDD activities (daytime and evening/weekend) on residential receptors.	High	Non-Significant Effect	Best practice mitigation measures to be employed as detailed in BS5228	Non-Significant Effect
Noise from HDD activities (night time) on residential receptors.	High	Significant effect at Longhaven Mains, Station House, and Jehrada Cottage.	Best practice mitigation measures to be employed as detailed in BS5228 Additional modelling once equipment details are better understood. Provision of additional mitigation as required. Section 61 Consent.	Non-Significant Effect
Noise from winching activities (evening, weekend and night-time) on residential receptors.	High	Non-Significant Effect	Best practice mitigation measures to be employed as detailed in BS5228	Non-Significant Effect
Noise from construction activities (daytime, evening and weekend) on Nature Reserve path.	High	Non-Significant Effect	Best practice mitigation measures to be employed as detailed in BS5228	Non-Significant Effect
Noise from construction activities (daytime, evening and weekend) on nearby climbing routes.	High	Non-Significant Effect	Monitoring to be undertaken to determine actual noise levels associated with HDD activities at climbing routes to ensure no increased safety risks.	Non-Significant Effect

Key

	Significant Effect

22.11 References

BSI (2014). *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Noise*. UK: British Standards Institute.

IEC (2013*). IEC 61672-1:2013 Electroacoustics - Sound level meters - Part 1: Specifications*. Geneva: Commission Electrotechnique Internationale.

ISO (1996). *ISO 9613-2:1996 Acoustics – Attenuation of Sound during Propagation Outdoors: Part 2 – General Method of Calculation*. Geneva: International Organization for Standardization.

Scottish Statutory instruments (2006). *2006 No. 465 Environmental Protection. The Environmental Noise (Scotland) Regulations 2006*. Scotland: The Crown.

The European Parliament and the Council of the European Union (2002), *Relating to the Assessment and Management of Environmental Noise*. European Parliament

The Scottish Government (2011). *PAN 1/2011 Planning and Noise*. Scotland: The Crown

The Scottish Government (2011). *Technical Advice Note, Assessment of Noise*. Scotland: The Crown