VOLUME 2: CHAPTER 13 – NOISE AND VIBRATION

Figures and Visualisations (Volume 3a and 3b of this EIA Report)

There are no figures or visualisations associated with this chapter.

Appendices (Volume 4 of this EIA Report)

Appendix 13.1 – Acoustic Glossary

Appendix 13.2 – Calibration Certificates

Appendix 13.3 – Source Noise Levels

Appendix 13.4 – Meteorological Data

Appendix 13.5 – Histograms of Sound Level Meter Data LAEQ

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Appendix 13.9 – Noise Contour Map

13. NOISE AND VIBRATION

13.1 Introduction

This chapter details the noise impact assessments for the Proposed Development. This chapter (and its associated appendices) is not intended to be read as a standalone assessment and reference should be made to the introductory chapters of this EIA Report (**Chapters 1 to 7**).

This chapter identifies the likely impacts on noise sensitive receptors associated with the construction and operation of the Proposed Development. The objectives of the chapter are to:

- describe the assessment methodology and significance criteria used in the assessment;
- identify the noise sensitive receptors (NSR) in the vicinity of the Proposed Development and the baseline noise environment;
- assess the potential direct and indirect impacts on noise sensitive receptors; and
- describe any mitigation measures proposed to address likely impacts.

High Voltage Direct Current (HVDC) converter stations contain similar equipment to 400 kV substations. These contain various potential sources of environmental noise, the most significant of which are transformers and associated cooling equipment. Additional sources in HVDC converter stations are items such as reactors and capacitors. The noise from these sources is usually steady and is assessed using standard noise assessment techniques.

Transformers and other electrical equipment associated with substation developments emit noise at frequencies of twice the normal operating current frequency due to magnetostriction of the transformer core. In the UK the supply current frequency is 50 Hz, which results in 100 Hz and harmonics thereof being produced by the transformer. The nature of the noise generation mechanism results in tonal noise being emitted. The noise is steady state under normal operating conditions, however, with changes in electrical load, noise levels may fluctuate. The equipment is not expected to have any impulsive characteristics.

This chapter is necessarily technical in nature so, to assist the reader, a glossary of acoustic terminology is included in **Volume 4, Technical Appendix 13.1 Acoustic Glossary**.

Additional information which supports this chapter is presented in the following technical appendices:

- **Volume 4, Technical Appendix 13.1 Acoustic Glossary**
- **Volume 4, Technical Appendix 13.2 Calibration Certificates**
- **Volume 4, Technical Appendix 13.3 Source Noise Levels**
- **Volume 4, Technical Appendix 13.4 Meteorological Data**
- **Volume 4, Technical Appendix 13.5 Histograms of Sound Level Meter Data LAEQ**
- **Volume 4, Technical Appendix 13.6 LZEQ Spectra**
- **Volume 4, Technical Appendix 13.7 Construction Activities**
- **Volume 4, Technical Appendix 13.8 Construction Noise Assessment**
- **Volume 4, Technical Appendix 13.9 Noise Contour Map**

Refer to **Volume 4, Technical Appendix 1.3 EIA Team** for details on the competent experts who undertook the assessment.

13.2 Assessment Methodology and Significance Criteria

Scope of the Assessment

The scope of this assessment is to quantify the impact that may result from the construction and operational phases (including cumulative) of the Proposed Development. The assessment methodology has been discussed and agreed with the Local Authority Environmental Health Officer (EHO), see **Table 13.3** for further information on consultation carried out to date.

Legislation, Policy and Guidance

Legislation

The following legislation, policy and guidance documents of relevance have been considered in undertaking the assessment of effects of noise from the Proposed Development:

- The Control of Pollution Act, 1974 (COPA)1 - Section 60 of the Control of Pollution Act enables Local Authority officers to serve a notice in respect of noise nuisance from construction works, instructing the contractor to minimise nuisance to neighbouring properties through specific conditions. Section 61 of the Control of Pollution Act provides a method by which a contractor can apply to the Local Authority for prior consent to undertake construction works in advance of their commencement. If consent is given, the application is exempt from any enforcement action under Section 60 of the same act
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017

Policy

The following policies of relevance to the assessment have been considered:

Planning Advice Note (PAN) 1/2011: 'Planning and Noise[2]

Published in March 2011, PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit adverse effects of noise (Scottish Government, 2011). Information and advice on noise assessment methods are provided in the accompanying Technical Advice Note (TAN): Assessment of Noise. Included within the PAN document and the accompanying TAN are details of the legislation, technical standards, and codes of practice for specific noise issues.

Neither PAN 1/2011 nor the associated TAN provides specific guidance on the assessment of noise from fixed plant, but the TAN includes an example assessment scenario for 'New noisy development (incl. commercial and recreation) affecting a noise sensitive building', which is based on British Standard (BS) 4142:1997: Method for rating industrial noise affecting mixed residential and industrial areas. In 2014, BS4142: 1997 was replaced with BS4142:2014: Methods for rating and assessing industrial and commercial sound.

Construction Noise

The assessment of construction noise will comply with the following standards and guidance.

British Standard 5228-1:2009 +A1:2014 (BS5228), Code of Practice for Noise and Vibration Control on Construction and Open Sites[3]

Guidance on the prediction and assessment of noise and vibration from construction sites is provided in British Standard (BS) 5228 2009 +A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise. BS5228-1 provides recommended limits for noise from construction sites.

The construction noise impact assessment (CNIA) has been carried out according to the ABC method specified in Table E.1 of BS5228-1, in which noise sensitive receptors (NSRs) are classified in categories A, B or C according to their measured or estimated background noise level.

In line with best practice (BS 5228-1), a Construction Noise Management Plan (CNMP) will be developed by the principal contractor prior to starting construction works. The details of the CNMP will be agreed with the Highland Council and is expected to be secured by an appropriately worded planning condition.

Part 2: Vibration. BS5228-2 provides recommended limits for vibration from construction sites. The construction vibration impact assessment (CVIA) will be carried out against the guidance on effects of vibration levels specified in Table B.1 of BS5228-2. The level of vibration ranging from 0.14 $mm.s^{-1}$ to 10 $mm.s^{-1}$ indicates where vibration may be perceptible however acceptable, or intolerable.

1 Control of Pollution Act 1974, UK Government, 1974

2 Planning Advice Note: Planning and noise (PAN 1/2011, The Scottish Government, 2011

3 British Standard 5228: Code of practice for noise and vibration control on construction and open sites (BS 5228), BSI, 2009, amended 2014

Design Manual for Roads and Bridges LA 111 Noise and Vibration[4]

The Design Manual for Roads and Bridges (DMRB) LA 111 Noise and Vibration document provides guidelines for the assessment and management of noise and vibration impacts associated with road projects. The guidance sets out the requirements for assessing noise and vibration impacts from road schemes, ensuring that these impacts are identified, quantified, and managed appropriately.

During any time period, the significance of the effect is defined by the lowest observable adverse effect level (LOAEL) and significant observable adverse effect level (SOAEL).

Operational Noise

The assessment of operational noise will comply with the following standards and guidance.

British Standard 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound (BS 4142) [5]

British Standard 4142 describes methods for rating and assessing the following:

- Sound from industrial and manufacturing processes;
- sound from fixed installations which comprise mechanical and electrical plant and equipment,
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises,
- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train movements on or around an industrial and/or commercial site.

The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

In accordance with the assessment methodology, the specific sound level (LAeq,T) of the noise source being assessed is corrected, by the application corrections for acoustic features. These include tonal qualities and/or distinct impulses to give a "rating level" (LAr,Tr). The British Standard effectively compares and rates the difference between the rating level and the typical background sound level (LA90,T) in the absence of the noise source being assessed.

BS 4142 advises that the time interval ('T') of the background sound measurement should be sufficient to obtain a representative or typical value of the background sound level at the time(s) when the noise source in question is likely to operate or is proposed to operate in the future.

Comparing the rating level with the background sound level, BS 4142 states:

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

BS4142 places a strong emphasis on context when considering any assessment outcome. Section 11 states the following for low noise conditions (which this proposed development applies):

- “For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

4 Design Manual for Roads and Bridges (DMRB), LA 111 Noise and Vibration, Transport Scotland, 2019
5 British Standard 4142: Methods for rating and assessing industrial and commercial sound (BS 4142), BSI, 2014, Amended 2019

- Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

The second statement will be relevant when background noise levels are very low, which is likely to be appropriate for the assessment of this site. Absolute levels, which is the sum of the background sound level and the specific sound source of the Proposed Development, will be assessed as the more relevant metric if background levels are deemed very low.

The standard does not specify thresholds below which background sound and rating levels should be considered low. However, the Association of Noise Consultants guidelines for the use of BS4142 state:

"BS4142 does not define 'low' in the context of background sound levels nor rating levels. The note to the Scope of the 1997 version of BS4142 defined very low background sound levels as being less than about 30 dB LA90, and low rating levels as being less than about 35 dB(A)."

Noise Rating Curves[6] and BS8233:2014[7]

British Standard 8233:2014: Guidance on sound insulation and noise reduction for buildings provides guidance for the control of noise in and around buildings. The guidance provided within BS 8233:2014 is applicable to the design of new buildings, or refurbished buildings undergoing a change of use, but does not provide guidance on assessing the effects of changes in the external noise levels to occupants of an existing building.

British Standard 8233:2014 includes appropriate internal and external noise level criteria which are applicable to dwellings exposed to steady-state external noise sources. It is stated in BS 8233:2014 that it is desirable for internal ambient noise level not to exceed the criteria set out in **Table 13-1: Summary of Internal Ambient Noise Level Criteria for Dwellings from BS 8233:2014.**

Table 13.1: Summary of Internal Ambient Noise Level Criteria for Dwellings from BS 8233:2014

Activity	Location	07:00 to 23:00 Hours, i.e. Daytime	23:00 to 07:00 Hours, i.e. Night time
Resting	Living Room	35 dB LAeq,16 hour	n/a
Dining	Dining Room/Area	40 dB LAeq,16 hour	n/a
Sleeping (daytime resting)	Bedroom	35 dB LAeq,16 hour	30 dB LAeq,8 hour

Noise Rating (NR) curves were developed by the International Organization for Standardization (ISO) to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance. The primary standards that reference NR curves include; ISO 1996-1:2016, ISO 717-1:2013, and BS 8233:2014.

The noise rating curves for different sound pressure levels are plotted as acceptable sound pressure levels at different frequencies. Acceptable sound pressure level varies with the room and the use of it. Different curves are obtained for each type of use. Each curve is referenced by a NR number as set out in **Table 13-2: Noise Rating Descriptions**.

Table 13.2: Noise Rating Descriptions

Noise Rating	Application
NR 20	Quiet rural area for protection of amenity
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theatres and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops

6 ISO 1996-2:2017: Acoustics — Description, measurement and assessment of environmental noise, (ISO 1996), ISO, 2017

7 British Standard 8233: Guidance on sound insulation and noise reduction for buildings (BS 8233), BSI, 2014

NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

The NR curve NR 20 equates to a similar total noise level of 30 dB(A), and therefore is an appropriate consideration in respect to indoor noise levels as specified in BS 8233:2014.

NANR116 – Open/closed window research: sound Insulation Through ventilated Domestic Windows

The insulation of an open window has been generally accepted as being 10-15 dBA although its precision and effect on opening style, open area and window size, are not readily available. A programme of laboratory measurements has been undertaken by the Building Performance Centre at Napier University on behalf of the Department for Environment, Food and Rural Affairs, in order to quantify the sound insulation provided by a variety of window types, opening styles, areas of opening and ventilator devices.

Extent of the Study Area

The Study Area is the area approximately 3.8 km southeast of Halkirk, near the settlements of Banniskirk and Spittal. The Study Area encompasses the area over which all desk-based and field data were gathered to inform the assessment presented in this chapter, in an area around 500 m immediately surrounding the Proposed Development. Within the study Area, a total of six nearby NSRs have been identified in proximity to the Proposed Development. These NSRs range from 10 m to 550 m from the red line boundary. These NSRs are deemed to be representative of nearby residences in the surrounding area. If the noise criteria can be met at the closest NSRs, then any property at a greater distance will also meet the criteria.

Consultation Undertaken To Date

Table 13.3: Consultation to Date

Body/ organisation	Type of consultation/ date	Response	How response has been considered
The Highland Council – Environmental Health	Scoping Response 23/05829/SCOP 06/02/2024	**Construction Noise** Further to the scoping report, Environmental Health have no comments to make regarding noise/dust emissions and mitigations during the construction phase. It may be necessary to impose time restricted conditions (construction time shall be restricted to 0800 hours and 1900 hours Monday to Friday; and 0800 hours and 1300 hours on Saturdays with no audible work on Sundays or Public Holidays), with a caveat that works outside these hours is programmed and approved prior to being undertaken.	BS 5228 will be used as the standard of methodology for assessing construction noise. Construction noise will be assessed against Category A requirements of BS 5228 and the 55 dB noise limit as construction activities are expected to take place seven days per week.
		Operational Noise As stated in the Scoping Report, further discussion will take place once the assessment of operational noise has been carried out. The proposed methodology is satisfactory to Environmental Health but the mitigations implemented will need to consider the affect of potential creeping back ground when designed based on the predicted sound level at each noise sensitive property. It is likely that Highland Council will require that sound levels experienced do not exceed background, but this can be discussed further at a future date once all the data has been produced/calculated.	BS4142 will be used to assess the operational noise. The substation operational noise will be assessed against a 0 dB excess above background noise in a BS4142 assessment (including relevant penalties). If excess is significantly above background, then engineering detailed design and procurement must take place to reduce the noise emissions to acceptable levels.

Method of Baseline Data Collation

Noise monitoring has been conducted in the vicinity of the Proposed Development to determine the existing prevailing noise environment. Free-field long term monitoring equipment was installed on 4 July 2023 and decommissioned on 19th July 2023.

Measurements were conducted using a 01dB DUO and Rion NL-52 sound level meters which were spot calibrated with a Rion NC-74 calibrator, before, during and after the measurement campaign. These meters were housed in environmental cases and used to conduct long-term measurements. Calibration certificates can be found in **Volume 4, Technical Appendix 13.2 Calibration Certificates**.

The parameters measured during the background noise (BGN) monitoring campaign include the following:

- LAeq (15 minutes)
- LAeq (15 minutes) one-third octave band spectrum
- LA90 (15 minutes)
- LA90 (15 minutes) one-third octave band spectrum

As the survey is based on long-term unattended measurements, a meteorological station (Vantage Vue) was also set up in the area to monitor for appropriate weather conditions. Meteorological conditions such as wind and rain will affect background noise conditions and have possible effects on noise propagation. Measurements were conducted every 15 minutes to coincide with the measured noise data as per the requirements of BS4142.

AddressBase data, detailed maps, and aerial photographs of the area surrounding the Proposed Development were examined and nearby NSRs were identified. Representative measurement positions were found and are detailed in **Table 13-4** and **Plate 13-1**.

Table 13.4: Measurement Location Coordinates

Location	Easting	Northing	Measurement Period
BGN 1 – Mossgiel	315579	956433	04/07/2023 to 19/07/2023
BGN 2 – Revelstone	315489	957181	
BGN 3 – Banniskirk House	316070	957458	
BGN 4 – Banniskirk Mains	316911	957362	

Plate 13-1: Map of Measurement Locations

Assessment Modelling

Construction Noise

A desk-based construction noise appraisal has been prepared for the purpose of assessing the effects of the land levelling works on any nearby residents. This appraisal has been produced in line with British Standard 5228-1:2009 +A1:2014 (BS5228), Code of Practice for Noise and Vibration Control on Construction and Open Sites.

The construction schedule has been supplied by the Applicant and is outlined in **Table 13-5**, with likely construction equipment identified in Annex C of BS 5228-1. The activity is analysed to determine the percentage of the construction time each piece of equipment is being used and how many are in use. Using this information, a total equivalent noise level is calculated. The dispersion of this total noise level is then modelled, accounting for distance and ground absorption.

Table 13.5: Construction Schedule

Contract Works	Proposed Working Hours
Access, Enabling Works and Platform Creation	(March to September) Every day 07:00 to 19:00 (October to February) Every day 07:30 to 18:00
Building Civils / Structures	
Transformer Installation	
Balance of Plant	

Table 13-6 shows an approximate outline of the project timeline for each phase. At the time of writing, it is not known the exact start and end date of each individual project within the Proposed Development therefore the month of the project schedule is detailed.

Table 13.6: Indicative Project Schedule

Phase	Start	End
Platform Delivery	Month 1	Month 17
Building Construction including Transformer Installation and Balance of Plant	Month 11	Month 53
Stage 2 Commissioning	Month 30 (AC) Month 54 (HVDC)	Month 37 (AC) Month 65 (HVDC)
Mounds, Landscaping and Removal of Temporary Laydown and Welfare	Month 35 (AC) Month 58 (HVDC)	Month 38 (AC) Month 62 (HVDC)

Construction Vibration

A desk-based construction vibration appraisal has been prepared for the purpose of assessing the effects of the land levelling works on any nearby residents. This appraisal has been produced in line with British Standard 5228-2:2009 +A1:2014 (BS5228), Code of Practice for Noise and Vibration Control on Construction and Open Sites.

BS5228-2 provides recommended limits for vibration from construction sites. The construction vibration impact assessment (CVIA) will be carried out against the guidance on effects of vibration levels specified in Table B.1 of BS5228-2. The level of vibration ranging from 0.14 mm.s-1 to 10 mm.s-1 indicates where vibration may be perceptible however acceptable, or intolerable.

Construction activities that induce vibration are likely to be limited to potential piling activities and blasting for platform works. The formulae for the prediction of groundborne vibration due to piling is taken from Table E.1 in BS5228-2.

Potential of heavy goods vehicle (HGV) vibration on receptors along haul roads will be predicted using the procedures in Transport and Road Research Laboratory (TRL) Research Report 246 – Traffic Induced Vibrations in Buildings.

Operational Noise

A detailed model of the Site and surrounding area has been constructed in SoundPLAN 9, considering geometric spreading, topography, screening, meteorological conditions and detailed information regarding the sources of noise, allowing for analysis of the predicted impact of the site for NSRs. All modelling assumptions are conservative and expected to result in slightly higher levels than those that would be measured.

Elevation data to a resolution of 50 m has been used to create a digital ground model, this is appropriate due to the distances from source to receiver and there being no major topography features in the surrounding area. Resolution of the digital ground model for the bunding surrounding the site is highly detailed, with data provided by the Applicant. Detailed plans for the Proposed Development layout have been provided by SSEN Transmission and used to model the site. Satellite imagery and Ordnance Survey maps have been used to aid the modelling of the surrounding area.

All modelling events are for worst-case scenarios, and therefore modelling results are considered conservative worst-case results. These conservative estimates come inherently with the model parameters and environmental conditions assumed, the use of non-acoustically optimised input data where specifics are not available at this stage of the project, and the use of maximum utilisation load levels for specific items such as cooling system (where in-situ these items would operate at lower loading levels).

Propagation was modelled using ISO 9613-2[8], with the following parameters:

- Ground absorption: 0.0 on paved surfaces, 0.6 elsewhere.
- Receiver height: 1.5 m above ground / floor
- Temperature: 10°C
- Relative humidity: 70 %

Noise data for the proposed equipment have been based on design information and data from Hitachi. All noise from the units has been assumed to operate at a similar spectra to equipment of the same type, according to Hitachi. The equipment information supplied by Hitachi is non-acoustically optimised, therefore, relatively conservative at this stage of the assessment. A slight deviation has been applied to noise from the valve coolers in the converter stations to reflect the utilisation of similar coolers at Blackhillock Substation and Spittal Substation. Additionally, some air handling units, chillers, and climate systems have been housed internally rather than externally.

Additional input information has been provided by Siemens specification for a Synchronous Condenser units, which is not acoustically optimised.

These levels are presented in **Volume 4, Technical Appendix 13.3 Source Noise Levels**.

In the modelling phase, the buildings that enclose the noise sources have been assumed to be treated for good acoustic reduction. The specific material sound reduction data sheet has been provided giving an overall sound reduction index (Rw) of 36 dB(A). Louvres and chimneys are included on the building facades and roofs as noise breakout areas. The chimneys are also assumed to be acoustically treated, providing a Rw of 14 dB(A).

Determining Magnitude of Change and Sensitivity of Receptors

The sensitivity of the NSR is estimated in its current state prior to any change implied by the Proposed Development. The level of sensitivity is determined according to existing regulations and guidance, societal value, and vulnerability for the change. By the combination of the assessed value of these three components, the NSRs' sensitivity can be classified as Low, Medium or High, as recommended by TAN 2011.

Table 13.7: Evaluation of Receptor Sensitivity

Level of Sensitivity	Definition
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.

8 ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, ISO, 15 December 1996.

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).
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.

All NSRs considered in this assessment are residential in nature, with a very quiet baseline noise environment. Therefore, the sensitivity is **High**.

Magnitude of Impact

The magnitude of an impact at a given receptor can be interpreted as the degree of alteration that is undergone by the receptor as a consequence of the impact. Magnitude criteria can be quantitative using specified standards. As reported in the table below, the impact magnitude is worked out on a case-by-case basis for each NSR and classified as Negligible, Low, Medium, or High.

Construction

The criteria provided for the ABC method detailed in BS 5228-1 are shown in **Table 13.8**.

Table 13.8: Construction Noise Impact Assessment Criteria

Assessment category and threshold value period	Threshold value, LAeq (dB)		
	Category A	Category B	Category C
Night-time	45	50	55
Evenings and weekends	55	60	65
Daytime and Saturdays	65	70	75

Night-time is defined to be between 23:00 and 07:00. Evenings and weekends are defined to be 19:00 – 23:00 on weekdays, 13:00 – 23:00 on Saturdays and 07:00 – 23:00 on Sundays. Daytime is defined to be 07:00 – 19:00 on weekdays and 07:00 – 13:00 on Saturdays.

The NSR is defined as Category A if the ambient noise levels (rounded to the nearest 5 dB) are less than those stated for Category A. This is true for the Study Area, and therefore the Proposed Development will be assessed to Category A thresholds.

From the outlined construction schedule, it is expected that majority of construction works will occur during daytime. Daytime work is subject to the 65 dB limit. However, as indicated by the construction working extends into evening and weekend periods, therefore the 55 dB limit has been adopted in this case to ensure a conservative assessment takes place. The guidance has been applied to The World Health Organisation (WHO) concepts of lowest observable adverse effect level (LOAEL), this is the level above which adverse effects on health and quality of life can be detected, and the significant observable adverse effect level (SOAEL). This is the level above which significant adverse effects on health and quality of life occur. The LOAEL is relative to background noise, the SOAEL threshold level has been determined from Category A. The magnitude of impact at receptors can be determined from **Table 13.9**.

Table 13.9: Construction Noise - Magnitude of Change at Receptors

Magnitude of Change	Descriptor
Negligible	Below LOAEL (<BGN)
Low	Above or equal to LOAEL and below SOAEL (BGN-55 dB(A))
Medium	Above or equal to SOAEL and below SOAEL + 5dB (55-60 dB(A))
High	Above or equal to SOAEL + 5dB (>60 dB(A))

In accordance with the EIA Regulations construction noise shall be defined as a significant effect where it is determined that a **High** or **Medium** magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; and/or
- a total number of days exceeding 40 in any 6 consecutive months.

Construction Vibration

Vibration levels that are felt and perceived as annoying or uncomfortable generally fall below levels that cause structural damage but can still impact human comfort and perception. Criteria for received vibration are taken from Table B.1 in BS5228-2 and shown in **Table 13.10: Construction Vibration Impact Assessment Criteria**. Vibration is measured as peak particle velocity (PPV).

Table 13.10: Construction Vibration Impact Assessment Criteria

Impact Magnitude	Vibration Level, Peak Particle Velocity (PPV)	Effect
Negligible	<0.3 $mm \cdot s^{-1}$	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
Low	>0.3 $mm \cdot s^{-1}$	Vibration might be just perceptible in residential environments.
Medium	>1.0 $mm \cdot s^{-1}$	It is likely that vibration of this level in residential environments will cause complaints but can be tolerated if prior warning and explanation have been given to residents.
High	>10 $mm \cdot s^{-1}$	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

Levels that could potentially cause structural damage are significantly higher. For example, according to the British Standards (BS7385-2:1993) and other guidelines, structural damage could become a concern at vibration levels above 10 mm/s PPV, depending on the type of structure and its condition.

Operational

Information from the rating level, the background sound level, and the stated impacts from a BS4142 assessment have been converted into representative impact magnitudes, detailed in **Table 13.11**.

Table 13.11: BS4142 Impact Magnitude

Impact Magnitude	Definition
Negligible	Impact to the receptor is immeasurable, undetectable or within the range of normal natural background variation.
Low	The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.
Medium	A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
High	A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

The assessment within BS4142 is context-based (i.e. informed by the baseline level of background noise during the relevant part of the day, as well as considering what equipment is less likely to be operational at various parts of the day), as is stated in the definitions of determining impact. There is no theoretical limit to how the context can or should influence the impact assessment, but any alteration of the conclusions of an assessment due to the context should be sufficiently explained and justified for the specific circumstances in question. Section 11 of BS4142: *"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."* The assessor will include additional consideration for internal noise levels during nighttime periods, where it is less likely that the external amenity is in use, and the preservation of internal conditions and the reduction of potential sleep disturbance is of more concern. For nighttime conditions, operational noise shall constitute a significant effect where:

- a high magnitude of impact is determined at the external amenity;
- a medium impact is determined at the external amenity and the internal noise limits of 30 dB(A) are exceeded as set out in BS8233, or the noise exceeds NR20 criteria.

This is due to the context of the assessment, during nighttime conditions it is more appropriate to consider internal noise and the potential for sleep disturbance, rather than the external amenity which is likely not in use during these times.

Significance of Effect

After assessing the sensitivity of the NSR in its baseline state, and then the impact magnitude of the noise likely to affect the NSR, an estimate of the effect significance can be derived by applying a calculation matrix (**Table 13.12**).

The measure of significance is the key output of the impact assessment process and drives the requirement for mitigation measures to be applied during operation to offset or reduce potential project generated effects.

The evaluation of effect significance shall be through the recommendations in TAN 2011 and based on professional judgement, considering both sensitivity and magnitude of change as detailed below.

Table 13.12: Evaluation of the Effect Significance

Significance		Level of Significance Relative to Sensitivity of Receptor		
		Low	**Medium**	**High**
Impact Magnitude	High	Minor/Moderate	Moderate/Major	Major
	Medium	Minor	Moderate	Moderate/Major
	Low	Negligible/Minor	Minor	Minor/Moderate
	Negligible	Neutral/Slight	Neutral/Minor	Minor
	No change	Neutral	Neutral	Neutral

The level of significance and its relevance to the decision making process is explained as follows:

- Major: These effects are likely to be important considerations but where mitigation may be effectively employed such that resultant adverse effects are likely to have a Moderate or Slight significance.
- Moderate: These effects, if adverse, while important, are not likely to be key decision making issues.
- Minor: These effects may be raised but are unlikely to be of importance in the decision making process.
- Neutral: No effect, not significant, noise need not be considered as a determining factor in the decision making process.

The evaluation of effect significance shall be performed by following professional judgment, considering where context and a conservative approach to methodology has been applied, where worst-case results are reported, and to account for potential uncertainties affecting baseline data. Resulting effects of **Moderate** and **Major** impacts are considered significant.

Limitations and Assumptions

Construction

Estimated noise emissions from the Proposed Development's construction noise activities and plant items have been based on previous projects of a similar nature. This assessment considers conservative assumptions with the aim to produce a worst-case assessment. This ensures that in practicality, noise levels would be expected to be lower than the assessment details, and uncertainty is reduced to as minimal as possible.

Operational

Modelled sound sources represent candidate plant only. The noise output of individual items of plant may vary from what is presented in this chapter after final plant specification. The assessment assumes all sound sources are operating continuously, simultaneously and at maximum noise output. In reality, not all sources will be operating at maximum noise level all of the time and operational noise levels may be lower than are presented in this chapter.

The sound level output of any auxiliary infrastructure is considered insignificant in comparison to the primary sound sources detailed in this chapter. Accordingly, no other items of plant have been considered within the assessment.

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

In practice, there is no "single" background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment in this chapter is a representative average and therefore is representative of the period being assessed.

There is always a degree of uncertainty when conducting assessments on developments in the planning stage. These uncertainties occur in calculation, rounding, and baseline levels used. This assessment considers conservative assumptions with the aim to produce a worst-case assessment. This ensures that in practicality, noise levels would be expected to be lower than the assessment details, and uncertainty is reduced to as minimal as possible.

The assessments are based on information available at the time of publications, any changes to design or specification of the Proposed Development will require reassessment. The Applicant accepts that a suitably worded condition may be applied to any future consent.

Whilst some information gaps have been identified, it is considered that there is sufficient information to enable an informed decision to be taken in relation to the identification and assessment of likely significant environmental effects on noise and vibration.

13.3 Sensitive Receptors

In addition to the four background noise measurement locations, two residential properties that are geographically closest to the two BGN locations and share the same acoustic environment, have been chosen as two more representative NSRs.

Table 13.13: Receptor Locations

Receptor	Address	Easting	Northing	Distance from the Nearest Site Boundary (m)
NSR 1 – Mossgiel	A9, Spittal, Caithness, Scotland, KW1 5XR, United Kingdom	315579	956433	20
NSR 2 – Achalone	A9, Spittal, Caithness, Scotland, KW1 5XR, United Kingdom	315525	956568	10
NSR 3 – Revelstone	A9, Spittal, Caithness, Scotland, KW1 5XR, United Kingdom	315489	957181	6
NSR 4 – Achalone Croft	A9, Spittal, Caithness, Scotland, KW1 5XR, United Kingdom	315478	957370	10
NSR 5 – Banniskirk House	Banniskirk, Caithness, Scotland, KW12 6XA, United Kingdom	316070	957458	170
NSR 6 – Banniskirk Mains	Banniskirk Road, Banniskirk, Caithness, Scotland, KW12 6XA, United Kingdom	316911	957362	550

Plate 13-2: Map of the Sensitive Receptors

13.4 Baseline Conditions

The measurements were made within free-field conditions, i.e. at least 3.5 m from any acoustically reflective surfaces other than the ground. These measurement positions were deemed to represent the background noise conditions for external amenity for the surrounding NSRs.

Noise measurements were filtered for daytime and night-time conditions (night-time defined as between 23:00 and 07:00) where noise is shown to be at its lowest.

Periods of rain or windspeeds of 5 m/s or above are removed from the analysis as per BS 4142:2014. Meteorological data is shown in **Volume 4, Technical Appendix 13.4 Meteorological Data.**

Statistical analysis of noise levels was conducted of the histogram distribution of L_{A90} (15 minute) levels. The histograms of noise levels for all five measurement locations are presented in **Volume 4, Technical Appendix 13.5 Histograms of Sound Level Meter Data LAEQ.**

This statistical analysis was conducted for all four long term measured BGN locations to define a representative BGN level at each BGN location. NSR 2 Achalone has assumed the same background noise level as measured at BGN 1 Mossgiel. NSR 4 Achalone Croft has assumed the same background noise as measured at BGN 3 Revelstone. These locations are geographically closest to the BGN location and share the same acoustic environment, therefore this is considered representative.

In practice, there is no “single” background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment is a representative average and therefore should be representative of the period being assessed.

The modal value has been considered alongside the skew of the data set to select the appropriate representative level. **Table 13.14** provides the night-time and daytime representative L_{A90} results of the baseline noise survey.

Table 13.14: Representative Background Noise Levels

Location	Easting	Northing	L_{A90} (dB(A)) (Night-time)	L_{A90} (dB(A)) (Daytime)
NSR 1 – Mossgiel	315579	956433	32	33
NSR 2 – Achalone	315525	956568	32	33
NSR 3 – Revelstone	315489	957181	27	31
NSR 4 – Achalone Croft	315478	957370	27	31
NSR 5 – Banniskirk House	316070	957458	21	27
NSR 6 – Banniskirk Mains	316911	957362	18	31

The representative LZ90 spectra for both daytime and night for each location are presented in **Volume 4, Technical Appendix 13.6 LZEQ Spectra.**

The results of baseline noise survey show that NSRs in vicinity of the Proposed Development have a noise environment quantified between 18 – 32 dB LA90 during night periods and 27 – 33 dB during the day. Given the rural area, the acoustic environment is generally quiet. At NSRs 1, 2, 3, and 4, the proximity to the A9 results in similar levels during the day and night. Noise at NSRs 5 and 6 are particularly low compared to the other NSRs due to lack of road traffic impact from the A9. There is an elevation in broadband noise centred around the 1000 Hz one third active during daytime. This is due to increased traffic on the A9. There is a slight elevation in noise centred around the 4000 Hz one third active during night-time. This is due to the beginning of the dawn chorus around 4 am each day.

It is not expected that there will be a significant change to future baseline noise levels than those measured in this study.

13.5 Issues Scoped Out

Noise from Operational Maintenance

Any operational maintenance works required will be short-term and intermittent and are not expected to give rise to significant effects relating to noise and vibration. Therefore, this topic is scoped out of the EIA.

Vibration

There are no known vibrational noise issues associated with the operation of the Proposed Development at nearby NSRs. Therefore, vibration due to operation is scoped out of the assessment.

13.6 Assessment of Effects, Mitigation and Residual Effects

Potential significant effects that may result from the construction and operational phases (including cumulative) of the Proposed Development include:

- effects of construction noise on the surrounding area and on NSRs. Including effects of static and quasi-static construction noise from construction plant, such as excavators, dump trucks and cranes
- operational effects of noise from the Proposed Development on NSRs. Including noise from cooling equipment and ventilation and transformer noise on NSRs.

Mitigation by Design

The highest noise producing equipment, such as transformers and reactors, are housed within buildings or specifically designed acoustic enclosures. It is assumed that the building properties have a satisfactory acoustic absorption, and sound reduction index (particularly at low frequencies and fundamentally 100 Hz) in the facades and roofs. The specific material used and its properties are defined in **Volume 4, Technical Appendix 13.3**.

The manufacturer quoted a sound power level for the synchronous condensers of 97 dB(A). As an embedded mitigation measure, the synchronous condensers are modelled at a sound power level of 89 dB(A) which is the Applicant's maximum procurement level (89 dB(A)).

Bunding surrounding the site has been implemented and included in the noise model of the site. Mounds provide both visual and acoustic attenuation and is most effective when either close to the source or receiver.

Where noise sources cannot be housed inside (such as valve coolers), the design has made use of natural screening of the converter station buildings to reduce the direct propagation of sound between source and receiver.

Construction Phase

It is expected that construction works are likely to occur during evening and weekends periods as shown in **Table 13.5**. Therefore, the 55 dB limit has been adopted in this case to ensure a conservative assessment takes place.

At the time of writing, a list of the construction equipment expected to be used has been supplied but is subject to change. Construction phases are assumed to take place sequentially.

To calculate the potential construction noise levels from the Proposed Development, information about the proposed construction activities is needed. The Principal Contractors will be responsible for developing the detailed construction methodology and associated plant requirements following contract award, however, **Volume 4, Technical Appendix 13.7 Construction Activities** shows plant activities, plant items, their quantities, their utilisation, and associated noise levels at a distance of 10 m, based on worst-case construction activities at a similar construction site. By combining the items' noise levels ($L_{A,eq}$ at 10 m (dB)) with the amount of time each will be running (utilisation) and their quantity, the total equivalent noise can be calculated for each row. These are then logarithmically summed to give a total value for the construction noise at 10 m. To ensure a worst-case assessment, it has been assumed that all works within the phases will take place simultaneously.

The total equivalent noise level at 10 m for each activity can be used in a propagation calculation to find the specific noise at each receptor.

Due to the proximity of the NSRs to the boundary, the distance is considered to be from the noise sensitive receptor to the geometric centre. Assessing to the boundary would lead to overly conservative results, as construction works are unlikely to take place at the boundary for extended time periods.

This attenuation has been calculated over mixed hard and soft ground to the F.2.3.2 method in BS 5228. Given the dominance of soft ground in the area surrounding the Proposed Development, this is slightly conservative. The effects of barriers or topographical screening have not been considered.

The Construction Noise Assessment **(Volume 4, Technical Appendix 13.8 Construction Noise Assessment**) predicts that construction noise would be above the 55 dB limit at NSRs 1 to 5 for platform creation works, civil works, and transformer installation. This exceeds is above 5 dB for the closest NSRs.

With **High** sensitivity and **High** impact, the worst-case construction noise is assessed as **Major** and therefore **significant**. To meet BS5228 criteria, a detailed construction schedule must be developed by the Principal Contractor and appropriate mitigation must be implemented. It has been identified that some construction may need to be limited to daytime periods, such as the platform creation works, civil works, and transformer installation. These works do not meet the 55 dB evening and weekend limit. If assessed to the 65 dB daytime noise limit, all NSRs are assessed to meet the limit in all phases. This is under the assumption that the

construction activities are spread out over the area of the site. The CNMP will need to consider activities that take place closer to the NSRs.

Construction activities associated with vibration are largely unknown at time of writing, therefore, the worst case parameters will be assumed for vibration. The vibration due to piling taking place at the site has been assessed for impact on the closest receptor (NSR 3 at 6 metres from the nearest point on the RLB). Vibration is not likely to take place at the RLB, therefore, the minimum distance is found where impact is classed as **low** (67 metres). If the assessment passes at the closest receptor, it will pass at all others. The parameters that affect resultant vibration from piling, v_{res}, are shown in **Table 13.15**. Airborne vibration is predicted to be negligible compared to groundborne vibration.

Table 13.15: Groundborne Vibration Parameters from Mechanised Construction Works

Vibration Parameter	Range
Maximum amplitude of drum vibration, in millimetres (mm),	Between 0.4 and 1.72 mm
Pile toe depth, in metres (m),	Between 1 and 27 m
Vibrating roller drum width, in metres (m)	Between 0.75 and 2.2 m
Number of vibrating drums	1 or 2
Slope distance from the pile toe or tunnel crown, in metres (m)	Depends on distance between source and receiver and pile toe depth
Nominal hammer energy, in joules (J)	Between 1.5 and 85 kJ
Potential energy of a raised tamper, in joules (J)	Between 1 and 12 MJ
Distance measured along the ground surface, in m	67 metres for closest NSR (minimum distance for impact to be low)

Table 13.16 shows the worst-case results of the groundborne vibration due to piling. Vibratory compaction, percussive piling, and dynamic compaction have been calculated in the case these activities will take place.

Table 13.16: Groundborne Vibration Results from Foundation Works at NSR 1

Vibration Operation	Resultant PPV (mms^{-1})	Magnitude of Impact
Vibratory Compaction (Steady State)	0.43	Low
Vibratory Compaction (Start Up and Run Down)	1.00	Low
Percussive Piling	0.19	Low
Vibratory Piling	0.17	Low
Dynamic Compaction	n/a	Low

Vibration due to blasting is expected to take place over a small area. With appropriate mitigation in place, the impacts are predicted to be **Low.**

All impacts for potential vibration works have been assessed as **negligible**. In the worst case, all operations are imperceptible, therefore, the effect for construction vibration is **not significant**.

Vibration due to traffic on access routes has been assessed. Vehicle movements are not known at time of writing. Therefore, it assumed one heavy goods vehicle is passing by the NSRs per hour. Groundborne vibration arises primarily from the interaction of vehicle tires with irregularities in the road surface, such as potholes, cracks, or bumps. In this case, the road defect is a 5 mm depression, which could amplify groundborne vibrations. However, it is important to consider the condition of the road surface, ground conditions, and vehicle characteristics when evaluating the magnitude of impact.

In this case, with a vehicle traveling at an assumed maximum 60 km/h over a 5 mm road defect, at a distance of 5 metres from NSR 1, it is expected that the resultant PPV at NSR 1 is 0.4 $mm.s^{-1}$ would fall within the **minor** impact range. This would likely result in a **minor/moderate** significance of effect. It is unlikely that the road defect would be 5 m from the property, and therefore this impact is considered minor and not significant.

Mitigation during Construction

The platform works for the Proposed Development are predicted to cause the most construction noise of all phases. As shown in **Volume 4, Technical Appendix 13.7 Construction Activities**, the tracked semi-mobile crusher is a dominant source of noise during the platform works. The construction noise assessment prior to mitigation assumed all equipment would be operating at each individual subsite. In addition to platform works being prioritised in the daytime hours, if the crushing activity were to move further from the critical receptors during construction of the relevant subsites, this will further reduce noise impacts at NSRs.

It is best practice that construction noise should continue to be controlled by a Construction Noise Management Plan (CNMP), in accordance with the guidance and procedures outlined in BS 5228-1. The CNMP is expected to be embedded within the Construction Environmental Management Plan (CEMP). Procedures will include:

- minimising the noise as much as is reasonably practicable at source;
- attenuation of noise propagation;
- carrying out identified high noise level activities at a time when they are least likely to cause a nuisance to residents; and
- providing advance notice of unavoidable periods of high noise levels to residents

In order to maintain low impact on the noise environment, consideration will be given to attenuation of construction noise at source by means of the following:

- giving due consideration to the effect of noise, in selection of construction methods;
- avoidance of vehicles waiting or queuing, particularly on public highways or in residential areas with their engines running;
- scheduling of deliveries to arrive during daytime hours only. Care should be taken to minimise noise while unloading delivery vehicles. Delivery vehicles should follow routes that minimise use of residential roads;
- ensure plant and equipment are regularly and properly maintained. All plant should be situated to sufficiently minimise noise impact at nearby properties;
- fit and maintain silencers to plant, machinery, and vehicles where appropriate and necessary;
- operate plant and equipment in modes of operation that minimise noise, and power down plant when not in use;
- use electrically powered plant rather than diesel or petrol driven, where this is practicable; and
- work typically not to take place outside of hours defined in the construction schedule.

Consideration will be given to the attenuation of construction noise in the transmission path by means of the following:

- locate plant and equipment liable to create noise as far from noise sensitive receptors as is reasonably practicable or use natural land topography to reduce line of sight noise transmission;
- noise screens, hoardings and barriers should be erected where appropriate and necessary to shield high-noise level activities; and

- provide lined acoustic enclosures for equipment such as static generators and when applicable portable generators, compressors and pumps.

If blasting should take place, then groundborne vibration as a result of the operations shall not exceed a peak particle velocity of [6 mm/sec][10 mm/sec] in 95% of all blasts measured over any period of [6 months] and no individual blast shall exceed a peak particle velocity of [12 mm/sec] as measured at vibration sensitive buildings. The result will be the maximum of three measurements taken in a perpendicular direction to the ground surface.

Practical measures, including good blast design, that have been found to reduce air overpressure and/or vibration are:

- taking particular care with the development of faces and with trial blasts as anomalous vibration levels
- might be produced when there is no free face to relieve the energy produced;
- ensuring appropriate burden to avoid over or under confinement of the charge;
- accurate setting out and drilling;
- appropriate charging
- appropriate stemming with appropriate material such as sized gravel or stone chippings;
- using delay detonation to ensure smaller maximum instantaneous charges (MICs);
- using decked charges and in-hole delays
- blast monitoring to enable adjustment of subsequent charges;
- designing each blast to maximize its efficiency and reduce the transmission of vibration; and
- avoiding the use of exposed detonating cord on the surface in order to minimise air overpressure.

Therefore, with appropriate blasting practices in place, any impact is likely to be low, resulting in a **minor** effect that is **not significant**.

Residual Construction Noise Effects

It is essential that the construction schedule is defined in detail by the Principal Contractor and a robust CNMP and best practice mitigation is implemented. Where necessary, work will be limited to daytime hours. Subject to these mitigations, the residual construction effects will fall below the construction noise limits of 65 dB during daytime conditions and 55 dB during evening and weekend conditions. No night-time working is scheduled, and any requirements for night-time working would be discussed with the Local Planning Authority (LPA) and local community before commencing.

Meeting these limits would result in **Low** impact magnitude, with a receptor sensitivity of **High** which would have **Minor** effect and therefore **not significant**.

Operational Phase

Noise level predictions have been carried out to establish the specific noise levels at the nearest NSR to the Proposed Development. The levels predicted by the model relate to the outdoor ground floor façade of the NSR considered. A contour map of the Proposed Development is presented in **Volume 4, Technical Appendix 13.9 Noise Contour Map**.

The predicted noise levels of the Proposed Development received at the NSRs where cooling is included are detailed in **Table 13.17**.

Table 13.17: Proposed Development Modelled Noise Levels at NSRs

Receptors	Total Specific Noise (dB(A)) – Excluding Cooling	Total Specific Noise (dB(A)) – Including Cooling
NSR 1 - Mossgiel	30.2	29.9
NSR 2 - Achalone	31.7	31
NSR 3 - Revelstone	28.6	30.5
NSR 4 – Achalone Croft	26.6	28.9
NSR 5 - Banniskirk House	27.6	30.9
NSR 6 - Banniskirk Mains	26.6	29.3

The highest contributing source equipment from the Proposed Development at nearby receptors are the synchronous compensator buildings, external valve cooler banks, and the AC equipment in the HVDC converter station such as capacitors and filters. Any lack of physical screening between the outdoor converter station sources and NSRs may result in increased noise impacts as it would not reduce any potential effects.

Most equipment within the HVDC design is housed indoors has been sufficiently attenuated by the buildings. This is achieved by mitigation assumed in the design, by adding earth mounds, internalising the air handling units and noise sources such as transformers and reactors, specifying acoustically treated chimneys and louvres on the buildings with noise-producing equipment is necessary to ensure minimal noise impact. Some high noise equipment remains external and unmitigated associated with the synchronous compensators.

The highest specific noise level is predicted at NSR 2 – Achalone. The total noise at this NSR is dominant from the synchronous compensators and associated transformers in the AC substation.

The predicted operational levels at NSRs due to the Proposed Development can be compared with background noise levels in a BS 4142:2014 assessment.

The assessments conducted are based on modelled results of the Proposed Development operating under standard yet conservative conditions. The conservative assumptions are that all cooling systems are active and at 100% load during the daytime, whereas this would be dependent on environmental conditions and the requirement for cooling. Coolers generally operate only when there is high load and high ambient air temperatures, neither of which would typically occur during the hours of 11pm and 7 am, and therefore the worst case scenario is only assessed to daytime conditions.

BS4142 requires that, when assessing the impact of noise with a tonal component, the noise emitted from the specific sound source is subject to a rating level penalty. The received 1/3 octave spectra at NSRs are presented in **Plate 13-3**.

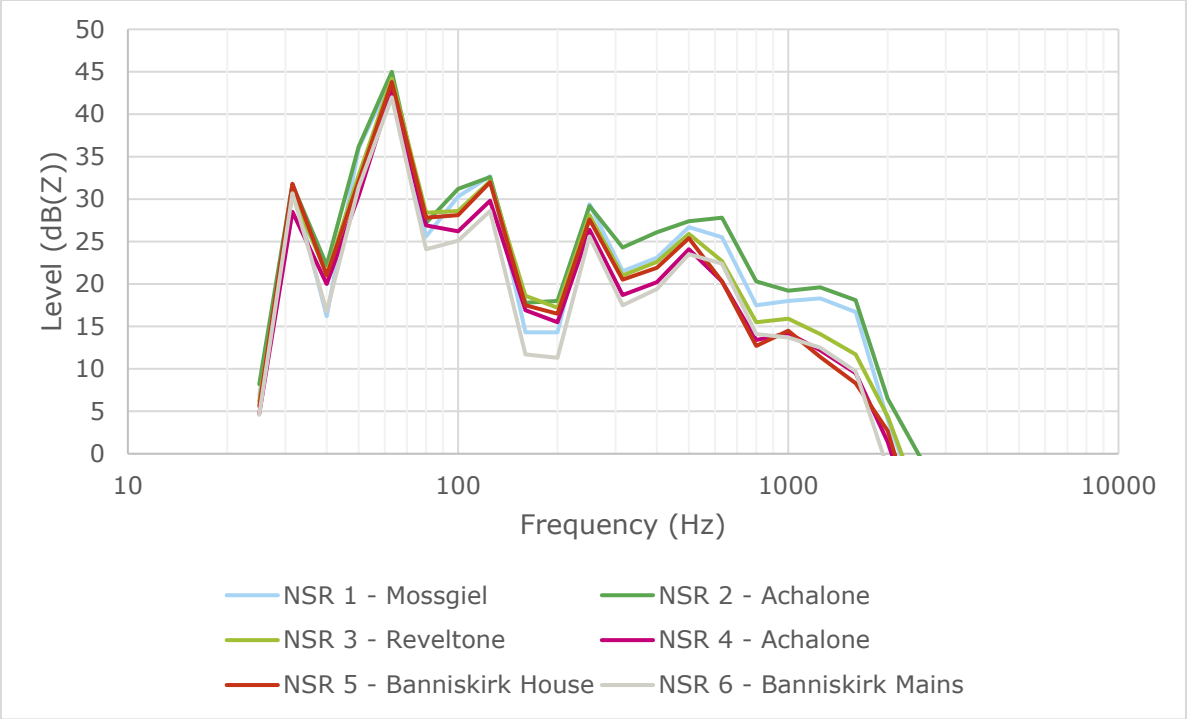

Plate 13-3: Modelled Received 1/3 Octave Spectra

The received 1/3 octave spectra at NSRs indicate that there are major tonal components according to Annex C of BS4142. This is due to the dominant noise sources being the step up transformers associated with the synchronous condensers. Outdoor cooling equipment is also included which has a high noise contribution but is mostly broadband in nature. Based on this analysis the full tonal penalty of 6 dB has been applied.

The excess noise above background at the NSRs will determine the significance of impact of the Proposed Development.

A BS 4142 assessment has been performed for the Proposed Development, and the results are detailed in **Table 13.18**. The results have separated the modelled specific noise into a daytime scenario and nighttime scenario, where cooling is only considered to be operational in the daytime.

Table 13.18 – BS4142 Assessment – Proposed Development Under Standard Conditions for Day and Night

Receptors	Night				Day			
	Specific Noise from Proposed Equipment (dB(A))	Rating Level (including +6 dB tonal penalty)	Background Noise Level, L_{A90} (dB(A))	Excess above Background Noise	Specific Noise from Proposed Equipment (dB(A))	Rating Level (including +6 dB tonal penalty)	Background Noise Level, L_{A90} (dB(A))	Excess above Background Noise
NSR 1 – Mossgiel	30.2	36	32	4	29.9	36	33	3
NSR 2 – Achalone	31.7	38	32	6	31	37	33	4
NSR 3 - Revelstone	28.6	35	27	8	30.5	37	31	6
NSR 4 – Achalone Croft	26.6	33	27	6	28.9	35	31	4
NSR 5 - Banniskirk House	27.6	34	21	13	30.9	37	27	10
NSR 6 - Banniskirk Mains	26.6	33	18	15	29.3	35	31	4

The results during daytime conditions predict excess above background at all receptors (including a conservative 6 dB tonal penalty). The maximum excess is 10 dB at NSR 5. The daytime assessment shows **High** impact magnitude, and with **High** sensitivity receptors indicates **Major** effect which is **significant** for operational noise during daytime conditions.

The results during nighttime conditions predict excess above background at all receptors (including a conservative 6 dB tonal penalty). The maximum excess is 15 dB at NSR 6. The daytime assessment shows **High** impact magnitude, and with **High** sensitivity receptors indicates **Major** effect which is **significant** for operational noise during nighttime conditions.

For additional context and due to low background noise at night, it should be discussed how the impacts affect internal levels of the NSRs.

During night-time periods, it is less likely that impacts on external levels are important, and that the preservation of internal noise levels that would not impact sleep disturbance should be contextualised.

Internal Noise Assessment

According to Table 4 of BS8233, the indoor ambient noise levels in the night-time should not exceed 30 dB $L_{Aeq,8hr}$. In addition, octave band levels should meet an NR20 rating for night-time and NR25 rating for daytime.

The external noise levels and spectra have been considered at each receptor. An external to internal noise calculation has been performed on the basis of a partially open window. The small element parameter level difference (Dn,e) has been assumed from NANR116: Sound Insulation through Ventilated Domestic Windows. The level difference values are taken from a window opening of **Table 13.19.**

Table 13.19: Level Difference Through a Partially Open Window NANR116

Opening Size	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	Dn,e
200k (mm^2)	20	14	14	16	14	17	19	16

The results of the internal noise assessment for the existing site are presented in **Table 13.21** and **Plate 13-4**.

Table 13.20: Predicted Internal Noise Levels

NSR	Level (dB(Z))							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	Total (dB(A))
NSR 1 – Mossgiel	24.9	20.7	16.2	14.1	8.7	-0.1	-28.0	14.8
NSR 2 – Achalone	25.6	21.0	16.7	15.9	10.5	1.4	-22.1	16.2
NSR 3 – Revelstone	24.6	19.8	15.2	12.8	6.0	-4.5	-29.1	13.2
NSR 4 – Achalone Croft	23.1	17.5	13.4	10.7	4.1	-6.8	-34.9	11.2
NSR 5 - Banniskirk House	24.2	19.6	14.6	11.8	3.8	-7.6	-32.9	12.2
NSR 6 - Banniskirk Mains	22.4	16.3	12.4	10.9	4.3	-7.0	-42.0	11.0

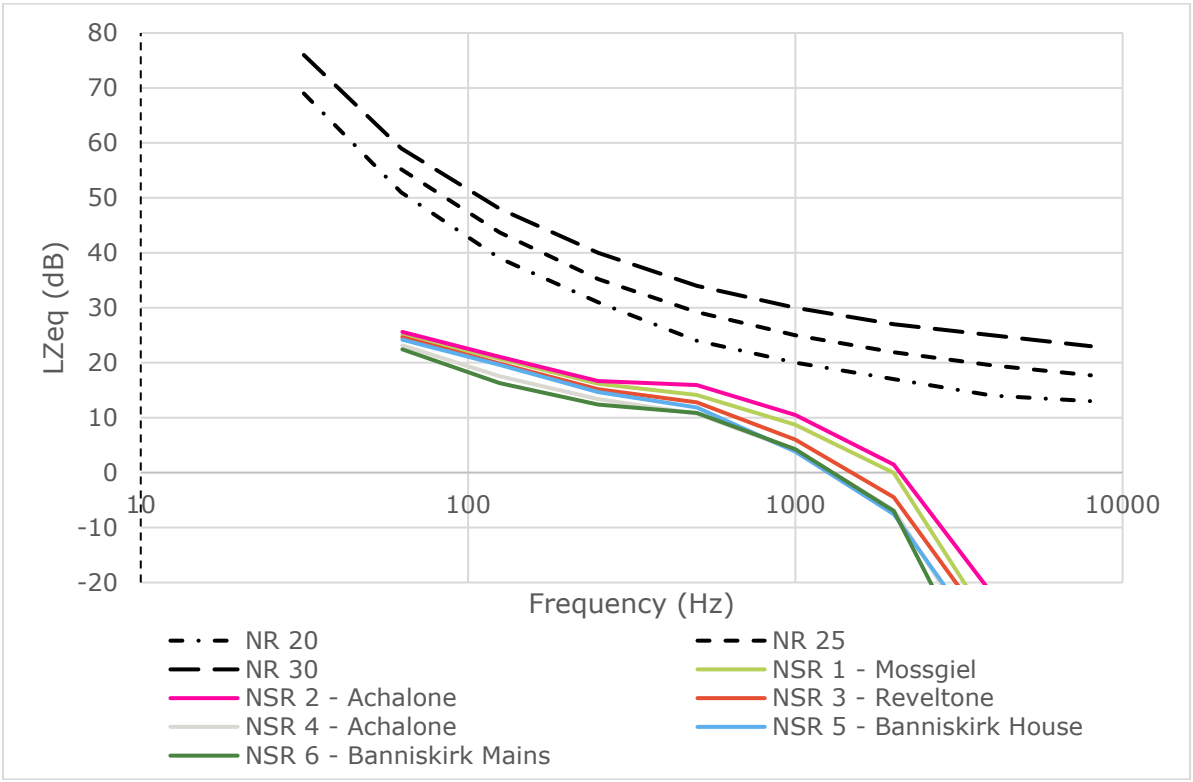

Plate 13-4: Indoor Noise Assessment

The results show that for the Proposed Development, the internal noise level at all NSRs meet the 30 dB, the NR20 limit and the NR25 limit. The maximum internal noise level is predicted to be 16.2 dB(A) at NSR 2 – Achalone.

The internal noise results indicate **Low** impact and therefore **Minor** effect, that is **not significant**.

Mitigation during Operation

A **Major** and therefore potential **significant** impact is predicted in a BS4142 assessment during both daytime and night-time conditions. Although in context, internal noise levels during this time predict **Minor** effect, which is more important during nighttime hours for preservation for sleep. This does not apply for the context of daytime hours, where there remains a **High** impact at NSR 5 – Banniskirk House and **Medium** impacts predicted for all other receptors, which is **signifcant**. The Applicant is committed to meeting the noise limits that no significant residual effects are predicted. Therefore, additional mitigation is required.

The assessment considers the likely noise level output of the Proposed Development when it is operational based on candidate plant and typical noise control options. Source noise levels of individual items of plant, however, will vary as the final plant specifications and required control measures are determined during a commercial tendering process. Accordingly, the predicted noise levels presented in this chapter, or the noise levels at source, should not be used to specify particular noise level limits. Rather, it is more appropriate to consider the noise levels received at the nearest NSRs with regards to the existing sound levels in the area (as assessed by BS 4142). This allows appropriate levels of protection to be allocated to the nearest receptors, giving comfort to residents and the Local Planning Authority (LPA), whilst providing the developer with sufficient flexibility in the design and specification of plant during the tendering process. Accordingly, the following planning conditions to control operational noise effects are proposed:

- During daytime hours, the noise Rating Level (as defined in BS 4142:2014+A1:2019) from the operation of the Proposed Development shall not exceed 5 dB above the background sound levels, as measured or calculated at the nearest occupied residential NSRs;
- during nighttime hours, internal noise levels should not exceed 30 dB(A) according to Table 4 of BS8233,
- octave band levels should meet an NR20 rating for night-time and NR25 rating for daytime.
- prior to first operation, a revised Noise Impact Assessment (NIA) shall be submitted to The Highland Council for approval. The NIA report shall include details of the specified plant to be installed and any required noise control measures to ensure that operational noise levels from the Proposed Development will meet the desired noise limits.

The noise levels presented in this assessment at the NSRs must reduce by 5 to 6 dB to decrease the excess during the daytime to below 5 dB. The same reduction is required during nighttime to ensure a excess below 10 dB above the background noise level. This reduction would result in a **low** and **medium** impact magnitude respectively. As shown in Table 13.20, the levels during the night are predicted to meet the internal noise level criteria, therefore, the resultant effect would be **not significant**.

The input noise data provided at this stage of design has not been acoustically optimised, particularly items associated with the external cooling equipment, synchronous compensations units, and the step up transformers. An acoustically optimised design will be progressed during the engineering detailed design and procurement phase of the project. There are various engineering solutions and potential mitigation strategies that could be implemented to reduce noise levels from specific equipment such as the step up transformers, coolers, and other synchronous condenser equipment. Options could include:

- specification of low noise units;
- housing any external equipment within enclosures buildings;
- noise barriers to target propagation from specific noise sources;
- use of an active fan system with variable speed drive;
- use of liquid to liquid cooling; and/or
- a system with a larger number of fans operating at lower duty.

In addition, it should be noted that the extent of the issue with the external cooling units, such as valve coolers and synchronous condenser coolers is determined by the load and requirement for cooling. A prediction for assumed HVDC link loading profile has been provided by the Applicant in **Plate 13-5**. This shows that the Proposed Development is unlikely to operate at its maximum load for a significant amount of time, and therefore

it is unlikely that the cooling systems will be required to run at its maximum capacity. While operating at lower loadings, it is less likely that the cooling systems are required to operate at maximum levels. Therefore, the extent of noise excess from the value coolers is likely to be limited to outwith normal operation. Mitigation will be sought to negate impacts while running at 100% load.

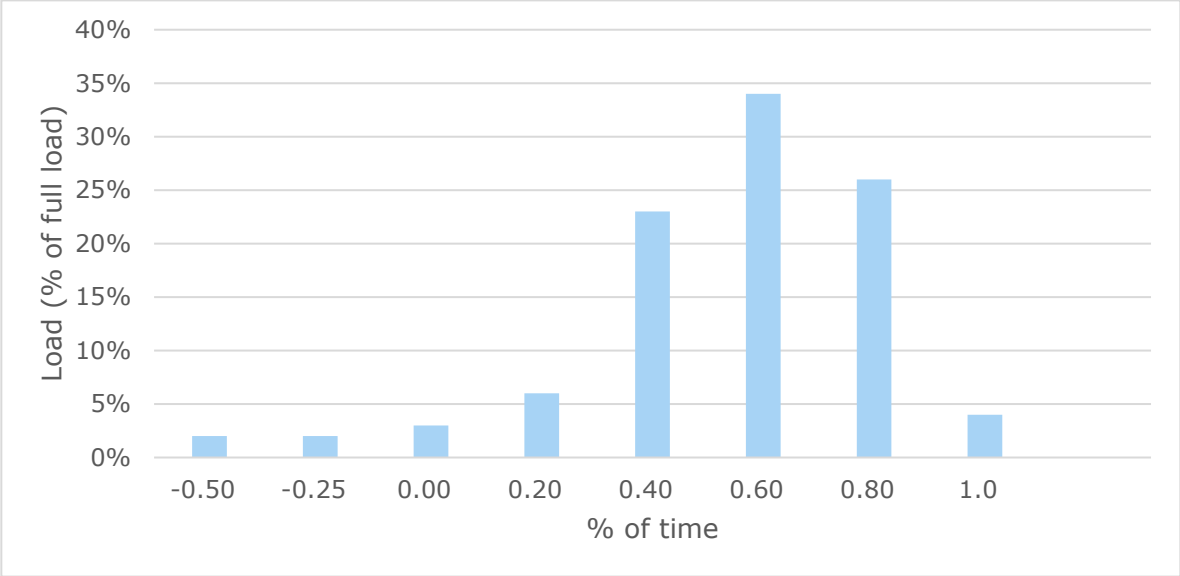

Plate 13-5: Assumed HVDC Loading Profile

In addition, the assessment includes a worst case 6 dB tonal penalty, this accounts for the majority or large portion of the overall noise excess in the BS4142 assessment. The input data for some noise sources, including dominant sources such as the synchronous condenser cooling is provided in octave bands, which is not reliable for the determination of such a penalty. Higher resolution data, such as 1/3 octave bands will be requested during detailed design. At the time of writing, this level of detail was not made available, therefore the conservative 6 dB tonal penalty remains. As the coolers are likely to mask prominent tones, the levels received at NSRs are more likely to be broadband in nature, which is likely to incur a less severe tonal penalty during the BS4142 assessment stage.

Residual Noise – Operational

Maintaining the design to house noise producing equipment where possible in suitably designed buildings or total acoustic enclosures will ensure noise impacts remain low.

Where it has been identified that there are potential issues, this is due to non-acoustically optimised input information at this stage of the design.

An updated noise impact assessment should be conducted during engineering detailed design and procurement, following further refinement of the assessment data and the implementation of mitigation, it is expected that noise levels at NSRs can be reduced.

Therefore, with the Applicant committed to meeting the proposed noise limits, **no significant** residual effects are predicted.

Cumulative Effects

Cumulative Development Type	Assessment
SSEN Transmission Cumulative Developments	This includes SSEN Transmission developments which would connect into the Banniskirk Hub. As these developments would very likely be constructed concurrently, this assessment considers the potential for cumulative effects during both construction and operation. The SSEN Transmission developments are: • the Spittal to Peterhead HVDC underground cable

	• the Banniskirk to existing Spittal Substation underground cable • Spittal to Beauly 400 kV OHL The construction of the undergrounding of the cable for the two aforementioned underground cable projects has the potential to have a cumulative noise impact due to the equipment and increased traffic. If the construction works are coincidental, once a contractor has been appointed, a detailed construction noise management plan must be updated to include working times, activities and a schedule. There is the potential for activities that are associated with the undergrounding of a cable that take place concurrently to raise the noise above either the 65 dB daytime noise limit or the 55 dB evening and weekend limit at the Banniskirk NSRs. Therefore, it is possible for cumulative construction noise to result in **major** effect which is **significant**. Cumulative construction noise is required to be controlled through an updated assessment by the Principal Contractor, and a CNMP. In addition, as these developments are SSEN Transmission projects, there is greater potential for a coordinated noise management approach. Therefore, with the appropriate mitigation, residual effects are likely to be **minor** and **not significant**. Operational noise impacts of the underground cable projects would be **negligible,** and therefore result ***negligible*** cumulative operational effects which is ***not significant***. If the construction of the Spittal to Beauly 400 kV OHL is to coincide with the construction of the Banniskirk Hub, the Principal Contractor must update the construction noise management plan to address the working times, activities and schedule. The OHL works are likely to be short term in comparison, however, the limit may be breached while the OHL works are ongoing. If construction phases coincide, it is possible for cumulative construction noise to result in **major** effect which is **significant**. With the appropriate CNMP and coordinated approach, the residual effects are likely to be **minor** and **not significant**. The operational noise of the Spittal to Beauly 400kV OHL is yet to be assessed. However, the worst-case noise effects would arise in wet conditions, where the impact of Banniskirk Hub would be **negligible**. Therefore, cumulative operational noise with the Spittal to Beauly 400kV OHL is predicted to result in **negligible** effect and is **not significant** and can be scoped out of further assessment.
Third Party Cumulative Developments	Third party developments considered are: • West of Orkney Windfarm Grid Connection (23/05353) – Permitted. • Ayre Windfarm Grid Connection – (24/00243) Scoping Issued • Watten Windfarm If construction schedules overlap with any of the above developments, there may be the possibility for cumulative construction noise impacts. Information on the construction schedules of third-party developments is not currently known at this stage. Any possible significant impacts could be mitigated with communication with the respective developers and a combined CNMP during potential high noise activities. Operational noise of the West of Orkney Windfarm Grid Connection has been assessed as low noise subject to the implementation of a noise control strategy. No significant residual noise and vibration impacts were predicted in the EIA. There is unlikely the potential for cumulative impacts to occur with NSRs 1 and 2, which fall geographically between the Proposed Development and this 3rd party development. If mitigation is implemented in the engineering detailed design and procurement phase of the Proposed Development, noise excesses at NSRs 1 and 2 will remain low and **not significant.** The onshore substation and other infrastructure associated with the Ayre Windfarm Grid Connection will be assessed for operational noise. The study area of this development overlaps with the Proposed Development. There is therefore the potential for cumulative impacts. The operational noise impact of windfarms are assessed in different conditions to substation noise. Windfarm noise is increased in high winds, where the background noise also increases. This reduces the impact of the operational noise of the Banniskirk Hub to a negligible level, due to the increase in background noise when windfarm noise may be significant. Therefore, **no significant** cumulative effects are predicted from Watten Windfarm.

13.7 Summary

This Chapter has considered the potential noise effects that could arise due to the Proposed Development during the construction and operational phases at the closest NSRs. The assessment has taken account of applicable planning policy and current guidance.

A desk-based construction noise assessment, in line with BS 5228, has been prepared for the purpose of assessing the effects of the works on any nearby residents. NSRs in the vicinity fall under Category A, and construction noise is predicted to be above the 55 dB evening and weekend limit during the platform works, civil works, and the transformer installation, and therefore construction noise is assessed initially as **Major** significance. The implementation of a robust construction noise management plan, prioritising particularly noisy work (such as platform works) during daytime defined hours with a higher 65 dB limit, and careful consideration of the location of crushing activities will ensure the construction noise of the Proposed Development will have **Minor** (**not significant**) impact on nearby NSRs.

Information on the construction schedule has been supplied and is subject to change depending on the Principal Contractor. Any updates to the construction schedule and plant will need to be revisited and assessed, to inform a more detailed management plan.

Operational noise has been assessed to BS4142 and BS8233 standards. The results of the external BS4142 assessment predict **Major** (**significant**) effect with excess above background noise during daytime conditions at NSR 5 – Banniskirk House. Assessed against night-time background noise conditions and in the absence of further mitigation, **Major (significant)** effects are predicted for nearby NSRs 5 and 6 (Banniskirk House and Banniskirk Mains. This assessment is relatively conservative, while using inputs available for a non-acoustically optimised site and is assuming the cooling is fully active during the day. Detailed engineering design and procurement will require mitigation for step up transformers and other equipment associated with the synchronous condensers.

Considering context, an internal noise assessment was conducted for the operational noise from the Proposed Development, according to BS 8233. The internal noise assessment indicates noise meet NR20 criteria, and therefore the effects **Minor** (**not significant**).

Noise excess is also due to the operation of external cooling equipment. It has been identified that this issue will be limited to where the Proposed Development is operating at higher loadings and requirements for the cooling system are close to its maximum level. Low-noise cooling fans are also recommended to be specified for any external HVAC units. With appropriate engineering design or mitigation, it is expected that the noise impacts would be reduced to an extent where low impact is predicted.

An updated noise impact assessment should be conducted during detailed engineering design and procurement, following further refinement of the assessment data and the implementation of mitigation, it is expected that noise levels at NSR would be in line with the limits proposed by the LPA. Therefore, with the Applicant committed to meeting the noise limits, **no significant** residual effects are predicted.

Cumulative noise has been considered. If construction schedules are to overlap, then a CNMP must be produced to avoid cumulative construction noise. Subject to a CNMP, residual cumulative construction noise is assessed as **minor** and **not significant**.

Underground grid connections and substation cumulative projects are required to be controlled through an updated assessment by the Principal Contractor and a CNMP. Any possible significant cumulative construction impacts could be mitigated with communication with the respective developers and a combined CNMP during potential high noise activities. With the appropriate mitigation, residual effects are likely to be **Minor** and **not significant**.

Operational noise has the potential for cumulative significant effects with the West of Orkney Grid Connection electrical infrastructure such as the substation, which is geographically close to NSR 1 and 2. The noise control strategy will ensure that the impacts remain low. Therefore, the cumulative noise is deemed not significant.

Other noise impact assessments are unknown with respect to the remaining 3rd Party cumulative developments, therefore, the operational noise impact assessment must be updated when this is known.

The assessment concludes that nearby NSRs have the potential for **Major** effects from both construction and operational noise, which is **significant**, and therefore appropriate mitigation must be implemented. Avoiding high noise construction work during the weekends and evenings in the vicinity of the potentially impacted NSRs for the platform works and civils work phases will ensure this phase meets the 55 dB limit. In addition, the construction noise assessment must be revisited by the Principal Contractor when a full construction schedule

is known, and a detailed CNMP is to be developed. The CNMP must also include any cumulative 3rd Party Developments. With these appropriate measures, potential residual construction effects are deemed **not significant**. Operational noise effects are expected to be reduced with appropriate engineering design or procurement. It is expected that operational noise can be reduced to an extent where ***Minor*** effects are predicted and therefore residual operational effects are deemed **not significant**.