Balliemeanoch Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 2: Main Report
Chapter 15: Noise and Vibration

ILI (Borders PSH) Ltd

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Quality information

Prepared by	Checked by	Verified by	Approved by
Alex Southern BSc-Hons MSc PhD MIOA	Seckin Basturk PhD MIOA	Jason Evans MSc BSc Hons MIOA	David Lee
Principal Consultant	Principal Consultant	Regional Director - Acoustics	Technical Director – Renewable Energy

Revision History

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1	July 2024	Submission	DL	David Lee	Technical Director

Distribution List

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15. Noise and Vibration

15.1 Introduction

This chapter presents the assessment of potential noise and vibration effects during the construction, operational and decommissioning phases of the Development. The assessment has been undertaken following guidelines set out in the IEMA publication "Guidelines for Environmental Impact Assessment" (IEMA Guidelines), relevant British Standards, planning policy and guidance.

The Scoping Report identified the following potential effects may result from the construction and operation of the Development:

- Noise and vibration impacts during the construction phase which could affect existing nearby noise sensitive receptors (NSRs);
- Construction phase noise impacts from changes in road traffic noise levels at NSRs in proximity to routes used by construction traffic;
- Operational airborne noise impacts from openings to underground plant or from surface plant if required at NSRs; and
- Operational ground borne noise and vibration impacts from underground plant at nearby NSRs.

This chapter is supported by the following Figures (Volume 3) and Technical Appendices, which are located in Volume 5:

- Figure 15.1: Sensitive receptors considered as part of Noise and Vibration impact assessment
- Figure 15.2: Long and Short Term Sound Monitoring Locations
- Figure 15.3: Road Traffic Noise Study Links
- Appendix 15.1: Acoustic Terminology
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- Appendix 15.3: Acoustic Model Input Data
- Appendix 15.4: Uncertainty in Modelling

15.2 Legislation and Policy

15.2.1 Relevant Legislation

The provisions of Sections 60 and 61 of the Control of Pollution Act 1974 offer protection to those living in the vicinity of construction sites.

Section 60 enables a local authority to serve a notice specifying its noise control requirements which may include:

- Plant or machinery that is or is not to be used;
- Hours of working; and
- Levels of noise or vibration that can be emitted.

Section 61 relates to prior consent and is for situations where a contractor or developer takes the initiative and approaches the local authority before work starts, to obtain prior approval for the methods to be used and any noise and vibration control techniques that may be required.

The term 'Best Practicable Means' (BPM) is defined in Section 72 of the Control of Pollution Act 1974, where 'practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications.

15.2.2 National Planning Policy

15.2.2.1 National Planning Framework 4 (NPF4)

NPF4 is Scotland's national spatial strategy. It outlines spatial principles, regional priorities, national developments, and planning policies. NPF4 replaces NPF3 and Scottish Planning Policy. This comprehensive framework aims to create sustainable, liveable, and productive places, aligning with the United Nations Sustainable Development Goals and Scotland's national outcomes.

NPF4 Policy 11 states that:

> *"a) Development proposals for all forms of renewable, low-carbon and zero emissions technologies will be supported. These include:*
>
> *i. wind farms including repowering, extending, expanding and extending the life of existing wind farms;*
> *ii. enabling works, such as grid transmission and distribution infrastructure;*
> *iii. energy storage, such as battery storage and pumped storage hydro;*
> *iv. small scale renewable energy generation technology;*
> *v. solar arrays;*
> *vi. proposals associated with negative emissions technologies and carbon capture; and*
> *vii. proposals including co-location of these technologies.";*

It later states:

> "*e)* In addition, project design and mitigation will demonstrate how the following impacts are addressed:
>
> *i. impacts on communities and individual dwellings, including, residential amenity, visual impact, noise and shadow flicker;"*

15.2.2.2 Planning Advice Note 1/ 2011 Planning and Noise

Current national guidance on noise is contained in Planning Advice Note (PAN) 1/2011 Planning and Noise (The Scottish Government, 2011). In para 2 PAN 1/2011 states that it "*promotes the principles of good acoustic design and a sensitive approach to the location of new development. It promotes the appropriate location of new potentially noisy development, and a pragmatic approach to the location of new development within the vicinity of existing noise generating uses, to ensure that quality of life is not unreasonably affected and that new development continues to support sustainable economic growth."*

Part 3 of PAN 1/2011 states *"The Environmental Noise (Scotland) Regulations 2006 transposed the European Directive 2002/49/EC (the Environmental Noise Directive) into Scottish law. This requires Scottish Ministers and airport authorities to manage noise through a process of strategic noise mapping and noise action plans. In the areas affected by the Regulations, planning authorities have a role in helping to prevent and limit the adverse effects of environmental noise."*

There are no Noise Action Plans in proximity to the Development site.

A Technical Advice Note (TAN 2011) (The Scottish Government, 2011) accompanies PAN 1/2011 and provides technical guidance on noise assessment.

15.2.3 Local Planning Policy

The Argyll and Bute Council (ABC) Local Development Plan 2 (LDP2) was adopted on 28 February 2024, and replaces the Argyll and Bute Local Development Plan 2015 and its associated Supplementary Guidance (March 2016), and Supplementary Guidance 2 (December 2016). LDP2 is divided into the written statement and proposals maps. The written statement provides the general policy context against which planning applications for new development proposals should be assessed.

With respect to noise, LDP2 section 4.33 states:

> *"4.33 Uses that can result in negative impact upon neighbouring amenity are sometimes referred to as "bad neighbour uses". Such uses can include pubs or clubs, waste water treatment plants, scrap yards and various industrial processes. Their impact can be wide ranging with issues, including:*
>
> - *Noise disturbance from industrial or mechanical processes*
> - *Noise from high turnover of customers at unsocial hours*
> - *Odour pollution from cooking smells*

• Light pollution from outdoor lighting or flicker from moving apparatus

4.34 Proposals that would have an unacceptable, detrimental impact upon neighbouring amenity will be resisted.

4.35 The Council will operate a precautionary principle and it will be for the applicant to provide evidence to demonstrate that there would not be any unacceptable impacts upon neighbouring amenity. This could be provided through the commissioning of technical studies and reports which should be submitted, where relevant, with the planning application."

15.2.4 Chapter Specific Guidance

The following documents have been referred to as part of this assessment. Further details about the documents can be found in the Guidance and Standards subsection below.

- BS 5228:2009+A1:2014 Noise and Vibration Control on Construction and Open Sites Parts 1 and 2 (with amendments, 2014);
- BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting;
- BS 6472-2: 2008 Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration;
- BS 4142:2014 Methods for Rating and Assessing Industrial and Commercial Sound; and
- BS 8233: 2014 Guidance on sound insulation and noise reduction for buildings.

15.3 Consultation

The assessment scope has also been considered following review of Scoping Opinion responses for the Development *(Appendix 4.2 (Volume 5: Appendices)).* Specifically, no amendments were made to the scope or methodology proposed in the Development Scoping Report, however it is noted that Argyle and Bute Council's noise and vibration scoping report response stated that:

- *"Mitigation measures to abate noise and vibration should be deployed during the construction and operational phase of the development. Predicted noise and vibration levels should be detailed within the CEMP and EIAR.*
- *As limited information is provided on the proposed impact piling works for the Marine Facility* [referred to as the Temporary Jetty in this chapter]*, the applicant/contractor is requested to submit a Noise Method Statement for the construction and operation that outlines timing, duration and expected noise levels* [as part of the CEMP]*. The Noise Method Statement should detail potential Likely Significant Effects (LSEs) and be agreed by the Planning Authority and NatureScot respectively prior to works being commenced."*

Further to this a private stakeholder at Loch Fyne has highlighted the potential for piling at the Temporary Jetty to affect their underwater measurements on "trial days" where noise sensitive equipment is being tested within the Loch. Avoiding piling on these days (up to 12 days per year) has been included as embedded mitigation; see *section 15.7.0*.

15.4 Study Area

The extent of the study area has been defined to include the closest NSRs/ communities in each direction from the Main Site, Temporary Jetty and Access Tracks and those that may be affected by changes in road traffic flows during the construction phase of the Development as described below:

- Construction Noise: The construction noise assessment study area is typically 300 m (based on BS 5228-1 guidance (BSI, 2014a)) from the works, however the construction noise study area has been extended to 1 km and includes the closest NSRs to the construction works from the Main Site and access various Access Tracks as a conservative approach due to the size of the working areas.
- Construction Vibration: NSRs within 100 m from the closest construction activity with the potential to generate vibration have been considered.

- Construction Traffic: The study area extent is based on the traffic links in the transport model (as discussed in Chapter 14: Traffic and Transport. See *Figure 15.3* for the links considered as part of this assessment.
- Operational Noise: The study area extends to the closest NSRs to the Main Site, in each direction.

15.5 Methods

This section discusses the specific guidance and assessment criteria, provides further detail on the scope of the assessment and outlines limitations and assumptions made in undertaking the assessment.

15.5.1 Assessment Scope

The assessment considers the effects during multiple phases of the Development lifespan as identified in *Chapter 2: Project and Site Description*. The phases include construction, operation and decommissioning.

The scope of this assessment is to identify the significance of the potential effects identified within the study area defined in 15.3. Based on this a structure for the assessment methodology for the Development is presented as follows:

- Construction Phase Impacts at NSRs from:
  – Airborne and ground borne noise and vibration from activities within the site boundary.
  – Changes in airborne traffic noise levels from the surrounding road network.
- Operational Phase Impacts at NSRs from:
  – Airborne and ground borne noise and ground borne vibration from activities within the site boundary.
- Decommissioning Phase Impacts at NSRs from:
  – Activities within the site boundary.
  – Changes in airborne traffic noise levels from the surrounding road network.

Changes in road traffic flows on surrounding roads during the operational phase of the Development are not included in the scope of this assessment as the number of vehicles would be negligible compared to existing flows on the surrounding road network; see paragraph 14.39 in *Chapter 14: Access, Traffic and Transport*. In addition, low frequency noise during operation has been scoped out, due to the large intervening distance between potential sources of low frequency noise and NSRs, and due to potential audible tonal components at NSRs on the surface being designed out during detailed design as required.

Decommissioning, if required, would involve the drainage of water from the Headpond, the removal of equipment, blocking of Waterways and tunnel entrances and the removal of above ground structures, as described in *Chapter 2: Project and Site Description*. No blasting, tunnelling or crushing will be required and it is considered that the effects will be negligible.

The temporal scope of this assessment therefore includes consideration of the construction and operational phases of the Development.

The spatial scope of the assessment is described in *Section 15.4.*

Potential airborne noise impacts on ecological receptors are considered within *Chapter 6: Terrestrial Ecology* and *Chapter 9: Ornithology*. Potential underwater noise and vibration impacts on ecological receptors are considered within *Chapter 7: Aquatic Ecology*.

15.5.2 Guidance and Standards

15.5.2.1 Construction Phase

BS 5228-1: 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 1: Noise (with 2014 amendment)

Advice is provided by British Standard BS 5228-1:2009 ‘Code of Practice for Noise and Vibration Control on Construction and Open Sites’ with respect to noise assessment and mitigation (BS5228).

BS 5228 contains a noise emission database for individual construction plant, their associated activities, and methods of working. Unless noise level data is available from manufacturers, the BS 5228 database is used when predicting noise levels associated with various construction activities.

With regard to acceptable noise levels, BS 5228 provides guidance within Annex E including the 'ABC Method', which enables the identification of potentially significant effects at dwellings. This proposes Threshold Values, in terms of the $L_{Aeq,T}$, as a function of baseline sound levels at the receptors, as shown in *Table 15.1* below.

Table 15.1 Example Threshold of Potential Significant Effect at Dwellings

Assessment Category and Threshold Value Period	**Threshold Value $L_{Aeq,T}$ dB(A) façade**		
	Category A (a)	**Category B (b)**	**Category C (c)**
Night-time (23:00 – 07:00)	45	50	55
Evenings and Weekends (d)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ 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 $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.
NOTE 3: Applies to residential receptors only.
(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
(b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.
(c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.
(d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

For the appropriate period (night, evening / weekend, day), the baseline ambient sound level is determined at each NSR and rounded to the nearest 5 dB. The appropriate Threshold Value is then determined. The total construction noise level is then compared with this Threshold Value. If the total noise level exceeds the Threshold Value, then a potentially significant effect is deemed to occur.

Planning Advice Note PAN 50 'Controlling the Environmental Effects of Surface Mineral Workings'

Annex D: Control of Blasting at Surface Mineral Workings

PAN 50 includes Annex D relating specifically to the control of Blasting Surface Mineral Workings. The annex provides a framework for the consideration of blasting at surface mineral development proposals and for the monitoring and control of operations. Noise, vibration and air overpressure are amongst the considerations.

Annex D identifies that:

- airborne sound pressure levels in the audible range are not a concern and compares peak levels from blasting as being comparable to that experienced from a passing vehicle but of shorter duration.
- ground vibration levels at receptors from blasting should be specified in peak particle velocity (PPV) measured in millimetres per second. It states that vibration limit values, *"should be compatible with current guidance on this matter given within the relevant British Standards publications, namely, BS 6472, 1992 concerning perception and BS 7385, Part 2: 1993 concerning the likelihood of damage."*
- due to the unpredictable and uncontrollable effects of prevalent atmospheric conditions, the location at which the maximum air overpressure is expected cannot be determined with any degree of accuracy. Hence, demonstration of compliance with any specific air overpressure limit is not a practical possibility. Instead, annex D states, *"A scheme which details the intended methods to be employed in minimising air overpressure from blasting operations is recommended in preference to limit values"*. It also states that, *"Prior to the commencement of*

blasting operations details of the methods employed to minimise air overpressure from blasting operations shall be submitted to the planning authority for written approval."

Annex D references the guidance in BS 5228-2, BS 6272 and BS 7385 in relation to human perception and damage to buildings from blasting.

BS 5228 2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 2: Vibration (with 2014 amendments)

BS 5228-2:2009 addresses the need for the protection against vibration for persons living in the vicinity of construction sites and recommends procedures for vibration control. BS 5228-2:2009 recommends that:'.... *it is considered more appropriate to provide guidance in terms of the PPV (Peak Particle Velocity), since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage'*.

BS 5228-2:2009 provides empirical formulae relating resultant PPV for vibratory compaction, percussive and vibratory piling, dynamic compaction, the vibration of stone columns and tunnel boring operations.

Table 15.2 (adapted from Table B.1, BS 5228-2:2009) details PPV levels and their potential effect on humans, and provides a semantic scale for description of vibration impacts on human receptors.

Table 15.2 Guidance on Effects of Vibration Levels

Vibration Level (PPV mm/s)	Effect
0.14 to 0.3	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.
0.3 to < 1	Vibration might be just perceptible in residential environments.
1.0 to <10	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
>= to 10	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

BS 5228-2:2009 provides the following criteria which are the maximum vibration levels to which underground services should be subjected:

- Maximum PPV for intermittent or transient vibrations 30 mm/s;
- Maximum PPV for continuous vibrations 15 mm/s.

It goes on to state that "*even a PPV of 30 mm/s gives rise to a dynamic stress which is equivalent to approximately 5 % only of the allowable working stress in typical concrete and even less in iron or steel.*"

BS 6472-1: 2008. Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting

BS 6472-1: 2008 provides guidance on the effects of human exposure to whole body vibration inside buildings, from internal sources such as footsteps or machinery, or external sources such as road traffic or railways. It specifically excluded consideration of blasting which is covered in BS 6472-2:2008. This Standard provides guidance on the levels of vibration that are likely to give rise to varying degrees of 'adverse comment'.

The vibration criteria are given in terms of the vibration dose value (VDV) indicator. The VDV is given by the fourth root of the time integral of the fourth power of the acceleration after it has been frequency-weighted. BS 6472-1:2008 states that the VDV is the best indicator to use when assessing human response to whole body vibration inside buildings.

The criteria contained within BS 6472-1:2008 are provided in *Table 15.3*.

Table 15.3 VDV Criteria from BS 6472 1:2008

Place and time	Low probability of adverse comment $m/s^{1.75}$	Adverse comment possible $m/s^{1.75}$	Adverse comment probable $m/s^{1.75}$
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 h day.

Vibration dose values below the ranges in *Table 15.3* are rated as 'adverse comment not expected' and vibration above the ranges in *Table 15.3* are rated as 'adverse comment very likely'.

These criteria apply to both the vertical and horizontal axes of vibration, although the two directions use different frequency weighting in the calculation of the VDV. The vertical direction uses the W_b weighting, while the horizontal axes use the W_d weighting. The definitions of the frequency weightings are given in BS 6472-1:2008.

The Standard also states that if the direction of the vibration is dominated by a single axis, it is only necessary to assess the vibration response in respect to the dominant axis.

BS 6472-2: 2008. Guide to evaluation of human exposure to vibration in buildings. Part 2: Blast-induced vibration

BS 6472-2:2008 provides guidance on human exposure in buildings to blast-induced vibration and air overpressures. Like PAN 50 Annex D, it is primarily applicable to blasting associated with mineral extraction but can also be applicable to explosives used within civil engineering and demolition.

BS 6472-2:2008 advises that to predict the likely vibration magnitude from a controlled blast, a series of measurements at several locations should be taken from one or more trial blasts. Using the formula provided in BS 6472-2:2008 and extrapolation of the trial blast results, the likely vibration magnitudes at a given distance (for a given maximum instantaneous charge) can be predicted to a given confidence level.

The standard suggests that accredited blasting contractors will appropriately design blasts to minimise effects at Noise (and vibration) Sensitive Receptors (NSRs).

For blast vibration occurring up to three times per day the standard states that for residential premises the probability of adverse comment is low if the peak particle velocity (PPV) is below 6.0 to 10.0 mm/s during the day. At night this reduces to 2.0 mm/s. It goes on to state that "*Doubling the suggested vibration magnitudes could result in adverse comment and this will increase significantly if the magnitudes are quadrupled.*"

The standard acknowledges that "*blast-induced vibration is highly variable*" and it qualifies that the above limits "*should not be exceeded by more than 10% of the blasts*" and that no blast should result in vibration that exceeds the limit by more than 50%. It goes on to state that "*working to a 90% confidence limit value means, in practice, that blasts need to be designed to ensure that the average level of vibration is approximately half of the specified limit. For example, if the satisfactory limit is required to be 6.0 mm/s at 90% confidence then blasts will be designed to produce vibration levels of approximately 3.0 mm/s, and in practice most will be below this level*".

Should more than three blasts be required per day, BS 6472-2:2008 provides information on the acceptable vibration limits.

BS 6472-2:2008 states that "*Accurate prediction of air overpressure (from blasting) is almost impossible due to the variable effects of the prevailing weather conditions and the large distances often involved*."

Whilst not providing specific air overpressure limits, BS 6472-2:2008 provides the following information on acceptable overpressure levels: "*Windows are generally the weakest parts of a structure exposed to air overpressure. Research by the United States Bureau of Mines has shown that a poorly mounted window that is pre-stressed can crack at around 150 dB(lin), with most windows cracking at around 170 dB(lin). Structural damage would not be expected at air overpressure levels below 180 dB(lin).*"

The air overpressure levels measured at properties near quarries in the United Kingdom are generally around 120 dB(lin), which is 30 dB(lin) below, the limit for cracking pre-stressed poorly mounted windows (150 dB(lin)).

BS 7385: Part 2: 1993 Evaluation and measurement for vibration in buildings. Part 2 Guide to damage levels from groundborne vibration

BS 7385-2:1993 provides guidance on the levels of groundborne vibration above which building structures could be damaged. For the purposes of BS 7385-2:1993, damage is classified as cosmetic (formation of hairline cracks), minor (formation of large cracks) or major (damage to structural elements). Guide values given in BS 7385-2:1993 are associated with the threshold of cosmetic damage only, usually in wall and / or ceiling lining materials.

BS 7385-2:1993 provides a frequency-based vibration criterion for transient vibration induced cosmetic damage, which is reproduced in *Table 15.4*.

Table 15.4 Transient vibration guide values for cosmetic damage

Type of Structure	Peak Component Particle Velocity in Frequency Range of Predominant Pulse[1 and 2]	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz3	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

1 Peak Component Particle Velocity is defined as the maximum value of any one of three orthogonal component particle velocities measured during a given time interval
2 - Values referred to are at the base of the building.
3 - At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

When considering continuous vibrations, even taking the precautionary approach of halving the guideline vibration values for transient vibration induced minor cosmetic damage to buildings (from BS 7385-2:1993), the resulting guidelines are still orders of magnitude above the threshold of perception and substantially higher than equivalent values likely to provoke complaint.

The guidance on acceptable vibration levels in structures provided in BS 5228-2:2009 recommends adopting the building damage vibration guidelines from BS 7385-2:1993.

Design Manual for Roads and Bridges LA111 Noise and Vibration (Revision 2), Transport Scotland, 2020 & Calculation of Road Traffic Noise (CRTN), Dept. for Transport, Welsh Office, 1998 & Noise Advisory Council (NAC), A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}

The Development will affect traffic flows on existing roads in the area within and surrounding the Development Site during construction - refer to *Chapter 14: Traffic and Transport*. This preliminary assessment focuses on the impact at existing residential properties located alongside the existing local road network.

Construction traffic noise has been assessed by considering the increase in traffic flows during the construction works, following the guidance of CRTN (DfT/ Welsh Office, 1998) and DMRB (Transport Scotland, 2020).

18-hour (06:00 - 24:00) Annual Average Weekday Traffic (AAWT) data have been provided for the construction years, indicating totals 'with' and 'without' construction traffic, on a monthly basis. Basic Noise Level (BNL) calculations have been undertaken to predict the change in noise level between the 'with' and 'without' scenarios where flows are greater than 1000, in order to determine if any existing roads are predicted to be subject to a potentially significant change in 18-hour traffic flows.

The Noise Advisory Council (NAC) prediction method detailed in the document *'A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}'* is applicable for prediction of noise level from low traffic flows. i.e. < 1000 vehicles per 18-hour where CRTN is not valid. This has been used as necessary to supplement the CRTN calculations.

15.5.2.2 Operational Phase

BS 4142:2014 'Methods for Rating and Assessing Industrial and Commercial Sound'

BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The method compares the *rating level* of the sound source under consideration with the *background sound level* in the vicinity of residential locations. The relevant parameters are as follows:

- *ambient sound level*, L_a, $L_{Aeq,T}$ dB – defined in the standard as the 'equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far, at the assessment location over a given time interval, T. The *ambient sound* comprises the residual sound and the *specific sound* when present";
- *residual sound level*, L_r, $L_{Aeq,T}$ dB – defined in the standard as the 'equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T', where the residual sound is the '*ambient sound* remaining at the assessment location when the *specific sound source* is suppressed to such a degree that it does not contribute to the am*bient sound*";

- *background sound level* – $L_{A90,T}$ – defined in the Standard as the "A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels";
- *specific sound level* – *L*s ($L_{Aeq,Tr}$) – the "equivalent continuous A-weighted sound pressure level produced by the *specific sound source* at the assessment location over a given reference time interval, Tr"; and
- *rating level* – $L_{Ar,Tr}$ – the "*specific sound level* plus any adjustment made for the characteristic features of the sound", as follows:
  - Up to 6 dB for tonal characteristics, Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.
  - Up to 9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.
  - If intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.
  - Where the specific sound features characteristics that are neither tonal nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

When comparing the background and the rating sound levels, the standard states that:

a) "*Typically, the greater the difference, the greater the magnitude of impact.*

b) *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending upon the context.*

c) *A difference of around +5 dB is likely to be an indication of an adverse impact, depending upon the context.*

d) *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 upon the context.*"

Importantly, as indicated above, BS 4142 requires that the *rating level* of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact. The standard suggests that in assessing the context, all pertinent factors should be taken into consideration, including the following:

- "The absolute level of sound;
- The character and level of the residual sound compared to the character and level of the specific sound; and
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions."

BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings'

BS 8233:2014 provides guidance for the control of noise in and around buildings. It provides design guidance for noise generated inside or outside the building including noise level criteria and control measures, and a methodology for calculating internal noise levels depending on the performance of the building fabric.

Of relevance to this assessment, for "steady external noise sources" it provides guideline values for internal ambient noise levels within dwellings. These are reproduced in *Table 15.5*.

Table 15.5 Indoor Ambient Noise Levels for Dwellings

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining Room	40 dB $L_{Aeq,16hr}$	-

Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

15.5.3 Criteria for Sensitivity of Receptors

The adopted assessment of noise and vibration effects is based on the sensitivity of the receptor and the magnitude of the exceedance of the relevant noise and vibration criteria.

In accordance with TAN 1/2011 and the IEMA Guidelines, the sensitivity of receptors to noise or vibration is based on their usage as defined in *Table 15.6*. This classification deviates from that defined in *Chapter 4 Approach to EIA*. According to the criteria in Chapter 4, individual residential properties would be classified as of medium sensitivity to noise impacts which would make this assessment less stringent and would not be in accordance with the relevant guidance. Therefore, the below classification has been applied.

Table 15.6 Receptor Sensitivity

Sensitivity of Receptor	Description
Very high	Concert halls / theatres, specialist vibration sensitive equipment
High	Residential properties, educational buildings, medical facilities, care homes
Medium	Places of worship, community facilities, offices
Low	Other commercial / retail premises

The above criteria do not apply to underground services such as water mains or electricity cables, which are classified as sensitive to vibration but not noise. It is not considered necessary or appropriate to determine a specific sensitivity for this type of receptor.

15.5.4 Criteria for Impacts

15.5.4.1 Construction Noise

The magnitude of the impact of the construction noise is based on the difference between the likely construction noise level at the and the Threshold Value for potentially significant effects derived using the methodology in BS 5228-1:2009 in *Table 15.1*, as shown in *Table 15.7*.

Table 15.7 Construction noise magnitude of impact

Construction and Demolition Sound Level above Threshold Value (dB)	Magnitude of Impact
Exceedance of ABC Threshold Value by ≥ +5 dB	Major
Exceedance of ABC Threshold Value by up to +5 dB	Moderate
Equal to or below the ABC Threshold Value by up to -5dB	Minor
Below the ABC Threshold Value by ≥ -5dB	Negligible

15.5.4.2 Construction Noise Off-Site - Public Roads

The magnitude of the impact resulting from the construction traffic on public roads is based on the difference between predicted road noise levels in the peak construction period ‘with’ and ‘without’ construction traffic included. The mapping of the predicted level differences to a magnitude of impact descriptor for traffic noise changes arising from construction works have been taken from Table 3.17 of DMRB and are provided in *Table 15.8*.

Table 15.8 Construction Traffic Noise Criteria

Change in Traffic Noise Level, $L_{A10,18hr}$ dB	Magnitude of Impact
≥ 5	Major
≥3 to <5	Moderate
≥1 to <3	Minor
<1	Negligible

An increase in road traffic flows of 25% (where the traffic speed and composition remain consistent) equates to an approximate increase in road traffic noise of 1 dB L_A. A doubling of traffic flow would be required for an approximate increase in 3 dB L_A.

It is generally accepted that changes in noise levels of 1 dB L_A or less are imperceptible, and changes of 1 to 3 dB L_A are not widely perceptible. Consequently, at the selected road traffic noise receptors the magnitude of the predicted change in noise levels uses the scale shown in *Table 15.8* with respect to construction traffic. The criteria are based on the current guidance on short-term changes in traffic noise levels in DMRB.

15.5.4.3 Construction Vibration

For all activities except blasting, construction vibration impact criteria at the nearest NSRs have been taken from BS 5228-2:2009 for this assessment as shown in *Table 15.9*.

Table 15.9 Magnitude of impact for construction vibration (excluding blasting)

Magnitude of Impact	Vibration Level (PPV mm/s)	Effect
Negligible	0.14 to 0.3	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.
Minor	0.3 to < 1	Vibration might be just perceptible in residential environments.
Moderate	1.0 to <10	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
Major	>= to 10	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

For blasting activities the guidance in BS 6472-2:2008 has been used. Daytime PPVs of up to 6 mm/s are classified as minor impact, between 6 and 10 mm/s are classified as moderate, and exceedances of 10 mm/s are a major impact. Night-time PPVs below 2 mm/s are classified as minor impacts, between 2 and 4 mm/s are classified as moderate, and exceedances of 4 mm/s are a major impact. As per the requirements of BS 6472-2:2008 these limits should not be exceeded by more than 10% of blasts, and no blast should exceed them by more than 50%.

To avoid the potential for damage to occur to underground services, the criteria stated in BS 5228-2:2009 should not be exceeded. For continuous vibration the limit to the PPV is 15 mm/s and for transient vibration it is 30 mm/s.

15.5.4.4 Groundborne Noise

The proposed tunnelling and the operation of the turbines have the potential to generate groundborne noise at nearby receptors. There are no UK legislative standards or criteria that define when groundborne noise becomes significant. The most relevant guidance is in *'Measurement and assessment of groundborne noise and vibration'* (Association of Noise Consultants, 2020) which described a number of published guidelines for assessing impacts of groundborne noise. This includes the guidelines published by the American Public Transit Association which suggest criteria for acceptable maximum levels of groundborne noise affecting various building types, including a criterion of 35 dB L_{Amax} for groundborne noise affecting residential properties, during the day or night. This criterion is increasingly being adopted (as 35 dB L_{ASmax}) by Local Authorities in the UK when defining acceptable groundborne noise levels for new developments. These criteria are typically applied to permanent groundborne noise sources, such as new underground railway lines, however in the absence of suitable alternative criteria these have also been applied to the assessment of groundborne noise during construction. The criteria are detailed in *Table 15.10*.

Table 15.10 Magnitude of impact for groundborne noise

Magnitude of Impact	Groundborne noise (dB L_{ASmax})
Negligible	30
Minor	35
Moderate	40
Major	45

15.5.4.5 Operational Industrial Noise

With regard to operational airborne noise, the classification of magnitude of impacts is presented in *Table 15.11* which is based upon the advice of BS 4142:2014 (levels during the operational phase and then subtracting the measured *background sound level* from the *rating level*).

Table 15.11 Magnitude of impact for operational sound

Magnitude of Impact	BS4142 Descriptor	Difference Between Rating and Background Levels
Negligible (Very Low)	Indication of a low effect, depending upon context	≤ 0
Minor (Low)	Indication of a adverse impact, depending upon context	+5 dB approx.
Moderate (Medium)	Indication of a significant adverse impact, depending upon context	+10 dB approx.
Major (High)	No BS 4142 descriptor for this magnitude level	> +15

The above criteria do not include consideration of the context, which is a requirement of BS 4142:2014.

15.5.4.6 Operation – Groundborne Vibration

With regard to operational groundborne vibration, the classification of magnitude of impacts is presented in *Table 15.12* which is based upon the advice of BS 6472-1:2008 for the avoidance of adverse comment. Groundborne vibration is assessed separately for construction and operation because the source is effectively permanent and therefore has the potential to result in greater effects. The guidance in BS 6472-1:2008 relates to permanent sound sources as opposed to temporary sources which are covered in BS 5228:2009.

Table 15.12 Groundborne vibration magnitude of impact

Internal Vibration Level (VDV, $ms^{-1.75}$)		Magnitude of Impact
Day	Night	
< 0.2	< 0.1	Negligible
0.2 – 0.4	0.1 – 0.2	Minor
0.4 – 0.8	0.2 – 0.4	Moderate
> 0.8	>0.4	Major

The Power Cavern Complex is around 450 m below ground level. At this distance the vibration from the operation of the turbines will not exceed the limit of 15 mm/s at which damage to underground services may occur. Therefore the potential for damage to underground services by the operation of the Development is negligible and this has been excluded from the scope of the assessment.

15.5.4.7 Significance of Effects

Based on the derived magnitude of impact and the sensitivity of the receptor to noise and / or vibration, the significance of effects are as shown in *Table 15.13*.

Table 15.13 Significance Criteria

	Magnitude of Impact			
Sensitivity of Receptor	Major	Moderate	Minor	Negligible
Very High	Major	Major	Moderate	Minor
High	Major	Moderate	Minor	Negligible
Medium	Moderate	Minor	Negligible	Negligible
Low	Minor	Negligible	Negligible	Negligible

Table 15.14 puts the levels of the magnitude of adverse impacts and effect significance in context. This is based on the IEMA Guidelines for Environmental Noise Impact Assessment and the UK Government's Planning Practice Guidance (PPG) web-based resource.

Table 15.14 Magnitude of Impact and Significance of Effect

Magnitude of Impact	Effect	Significance
Major	Disruptive, causes a material change in behaviour and / or attitude. Potential for sleep disturbance. Quality of life diminished due to change in character of the area.	More likely to be significant
Moderate	Intrusive, noise can be heard and causes small changes in behaviour and / or attitude. Potential for non-awakening sleep disturbance. Affects the character of an area such that there is a perceived change in the quality of life.	↕

Minor	Non-intrusive, can be heard but does not cause any change in behaviour or attitude. Can slightly affect the character of an area but not such that there is a perceived change in the quality of life.	Less likely to be significant
Negligible	No discernible effect on the receptor.	Not Significant

The above significance derivation does not apply to the assessment of potential for damage to underground services. BS 5228-2:2009 does not provide significance of effect criteria for assessing vibration impacts on building services in the context of Environmental Impact Assessment (EIA). The significance of effect is therefore applied based upon whether the predicted vibration levels meet the BS 5228-2:2009 limits. Where the limits are not exceeded, this has been classified as being Not Significant. Where they are exceeded, they are considered Significant.

15.5.5 Assessment Methodology Summary

The previous subsections have detailed the various methods and criteria relevant to the assessment of noise and vibration. *Table 15.15* summarises the assessment methodology relevant to each of the identified sources of noise and vibration impacts.

Table 15.15 Summary of Assessment Methodology and Criteria for Impacts

Phase	Potential Impact Origin	Assessment Method Reference	Criteria for Impacts Reference	Scope In/Out
Construction	Site Activity – Equipment Noise (Airborne)	BS 5228-1:2009	Table 15.7	Scoped In
	Site Activity – Equipment Vibration	BS 5228-2:2009	Table 15.9	Scoped In
	Site Activity – Equipment Noise (Groundborne)	Para. 15.4.4 Ground Bourne Noise Section	Table 15.10	Scoped In
	Site Activity – Blasting (Vibration & Air Overpressure)	BS 6472-2:2008	Para 15.4.4 Construction Vibration Section	Scoped In
	Site Activity – Haul Roads	BS 5228-1:2009	Table 15.7	Scoped In
	Off-Site Activity – Public Roads	DMRB & CRTN & NAC	Table 15.8	Scoped In
Operation	Site Activity – Equipment Noise	BS 4142:2014	Table 15.11	Scoped In
	Site Activity – Equipment Vibration	BS 6472-1:2008	Table 15.12	Scoped Out
	Site Activity – Low Frequency Noise	-	-	Scoped Out
	Off-Site Activity – Public Roads	-	-	Scoped Out

Note activities during the decommissioning phase are expected to be less intensive than activities during the construction phase as there will be no requirements for tunnelling, blasting and large scale earthworks. Impacts from the decommissioning will therefore be no worse than those predicted during the construction phase and consequently the construction phase is decommissioning phase has not been assessed further in this chapter.

15.5.6 Limitations And Assumptions

In order to ensure a robust assessment of the likely significance of the environmental effects of the Development, the assessment has been undertaken adopting reasonable worst-case assumptions, where necessary.

The following are the robust but reasonable worst-case scenario assumptions (maximum/minimum) parameters for the purposes of the noise assessment with regard to construction/operation of the Development:

- The quantitative assessment has been undertaken at the worst case NSRs, it is assumed that predicted noise levels at more distant NSRs would be less due to the additional propagation distance.
- Construction and operational noise level predictions in the assessment are based on a "flat ground" assumption as a worst case assumption. It is considered worst case on the basis that land topology will likely provide greater screening than that modelled for some NSRs.
- The upgrade of existing and construction of new Access Tracks has been assessed by assuming all construction plant associated with those activities would be located at the closest approach along the track to the receptor for the duration of the activity. In practice they will move passed the closest point over time.

- The assessment of construction road traffic on public roads is based on the assumption that all links will carry all development construction traffic. In practice this would not occur.
- The operational plant and equipment at the Upper Reservoir would be designed to not exceed more than 70 dBA at 5 m.
- Operation noise assessment has been undertaken on the basis that noise emissions from operational sound sources would be 24/7 in nature.

15.6 Baseline Environment

Existing sound levels in the vicinity of the Development are dominated by forestry activities within the area and road traffic on local roads. The existing sound climate is therefore typical of a rural area in the Scottish Highlands.

15.6.1 Noise Sensitive Receptors

The NSRs likely to be most exposed to the sound emissions from the Development have been identified, as shown in *Figure 15.1: Sensitive receptors considered as part of Noise and Vibration impact Assessment (Volume 3: Figures).*

The area potentially affected by noise during construction of the Development is a much larger area than that of its operation. The worst affected NSRs have therefore been identified differently for construction and operation as discussed in following subsections.

15.6.1.1 Construction Assessment NSRs

Almost 500 Ordnance Survey Data address points have been initially considered around the Development with the furthest approximately 4.7 km from related tracks or activities during construction (and 5 km from the red line boundary). Only a subset have been assessed quantitatively and were selected as follows:

The address point was less than 1 km from any construction Access Track, with the exception of receptors NSR229 NSR238, NSR244 which were retained as they represented receptors closest to the Headpond in the east and are situated between access to the north and south.

Of those that remain, many in the Inveraray area near the access closest to the jetty (known as Upper Avenue) are closely spaced and can be represented by single receptors closer to the Access Tracks along its route. The closest in this area is 17 m from the Upper Avenue Access Track (NSR278) whereas the furthest receptor is 524 m (NSR317).

The remaining subset of NSRs that have been assessed quantitatively are referred to as the *worst affected* NSRs. A figure showing the complete set of over 450 address points considered by this assessment along with those identified as worst affected NSRs highlighted is provided in *Figure 15.1: Sensitive receptors considered as part of Noise and Vibration impact Assessment (Volume 3: Figures).*

15.6.1.2 Operational Assessment NSRs

The following NSRs represent the properties closest to the Development's operational activities and will therefore be exposed to the highest noise levels of all NSRs. This means that the worst-case impacts are considered, impacts at other NSRs will be of lower magnitude than those identified at these locations.

Table 15.16 Identified Noise-Sensitive Receptors

Receptor	Description	Receptor Type	Sensitivity of Receptor	Distance to Nearest Operational Sound Source (m)
NSR059	North of Headpond and closest to substation	Residential	High	2537
NSR090	West of construction tunnel vent shaft	Residential	High	1370
NSR373	South-west of construction tunnel vent shafts	Residential	High	2470
NSR375	South-west of construction tunnel vent shafts	Residential	High	2573
NSR376	West of construction tunnel vent shaft	Residential	High	1460
NSR377	West of construction tunnel vent shaft	Residential	High	1520
NSR378	West of construction tunnel vent shaft	Residential	High	1422

15.6.2 Baseline Sound Level Monitoring

Long-term and short-term baseline sound monitoring has been completed at eight locations (L1 to L4 and S1 to S4) which were considered representative of the closest identified sensitive receptors. The monitoring locations are shown in *Figure 15.2 (Volume 3: Figures)*.

Measurements have been conducted in accordance with the principles of BS 7445-1:2003 'Description and Measurement of Environmental Noise Part 1: Guide to Quantities and Procedures' and BS 4142:2014. Details of instrumentation and meteorological conditions can be found in *Appendix 15.2* along with a plot of the time histories for the long-term survey locations and logged levels at both the long-term and short-term measurement locations.

A summary of the baseline monitoring results is provided in *Table 15.17*. All measurements are free-field. The equivalent sound levels in the Table have been derived from the logarithmic average of the measured $L_{Aeq,15min}$ values over the relevant time period. The L_{A90} levels are presented for both the mode and arithmetic mean of all L_{A90} measurements made during the time period referenced.

Table 15.17 Summary of Sound Monitoring Data (Short and Long-Term)

S1 (11:00 – 03/08/2023 : 10:45 – 04/08/2023)

Period	Start	End	L_{Aeq}	L_{AFmax}	L_{A90} Mode	L_{A90} Mean
Day	07:00	19:00	54	107	37	36
Evening	19:00	23:00	42	64	36	33
Day-Evening	07:00	23:00	54	107	37	37
Night	23:00	07:00	39	69	25	26

S2 (12:15 – 03/08/2023 : 12:00 – 04/08/2023)

Period	Start	End	L_{Aeq}	L_{AFmax}	L_{A90} Mode	L_{A90} Mean
Day	07:00	19:00	42	71	35	35
Evening	19:00	23:00	39	71	33	36
Day-Evening	07:00	23:00	42	71	33	33
Night	23:00	07:00	33	58	28	29

S3 (12:45 – 03/08/2023 : 12:30 – 04/08/2023)

Period	Start	End	L_{Aeq}	L_{AFmax}	L_{A90} Mode	L_{A90} Mean
Day	07:00	19:00	50	95	41	40
Evening	19:00	23:00	44	71	39	39
Day-Evening	07:00	23:00	50	95	42	41
Night	23:00	07:00	40	56	35	37

S4 (15:00 – 03/08/2023 : 16:00 – 03/08/2023)

Period	Start	End	L_{Aeq}	L_{AFmax}	L_{A90} Mode	L_{A90} Mean
Day	15:00	15:05	57	75	55	55
Day	15:15	15:20	56	69	55	55

Day	15:30	15:35	58	75	55	55
Day	15:45	16:50	56	70	55	55

L1 (19:00 – 27/07/2023 : 07:00 – 03/08/2023)

					L_{A90}	L_{A90}
Period	Start	End	L_{Aeq}	L_{AFmax}	Mode	Mean
Day	07:00	19:00	55	87	40	40
Evening	19:00	23:00	56	98	35	36
Day-Evening	07:00	23:00	55	98	41	39
Night	23:00	07:00	49	84	34	35

L2 (19:00 – 27/07/2023 : 07:00 – 03/07/2023)

					L_{A90}	L_{A90}
Period	Start	End	L_{Aeq}	L_{AFmax}	Mode	Mean
Day	07:00	19:00	65	104	36	36
Evening	19:00	23:00	60	99	38	38
Day-Evening	07:00	23:00	64	104	37	35
Night	23:00	07:00	55	89	39	39

L3 (19:00 – 27/07/2023 : 07:00 – 03/082023)

					L_{A90}	L_{A90}
Period	Start	End	L_{Aeq}	L_{AFmax}	Mode	Mean
Day	07:00	19:00	45	85	38	38
Evening	19:00	23:00	43	79	43	43
Day-Evening	07:00	23:00	44	85	38	38
Night	23:00	07:00	44	85	42	43

L4 (19:00 – 27/07/2023 : 07:00 – 03/08/2023)

					L_{A90}	L_{A90}
Period	Start	End	L_{Aeq}	L_{AFmax}	Mode	Mean
Day	07:00	19:00	44	75	39	39
Evening	19:00	23:00	43	68	44	44
Day-Evening	07:00	23:00	44	75	38	39
Night	23:00	07:00	42	65	42	42

Each measurement location is used to represent the prevailing baseline sound levels at one or more NSRs. The $L_{Aeq,T}$ is below 60 dB at all monitoring location with the exception L2 where is it 65 dB $L_{Aeq,12hr}$ and 64 dB $L_{Aeq,18hr}$.

15.6.3 Underground Services

These are not sensitive to noise but are sensitive to vibration due to the potential for damage to occur during construction of the Development.

15.6.4 Existing Vibration Levels

There are currently no known significant sources of vibration in the area. Consequently, ambient vibration monitoring has not been undertaken. It should be noted that annoyance due to vibration is not related to the comparison of pre and post-development vibration levels, and pre-development vibration levels are not usually necessary to assess the likelihood of vibration damage or annoyance from any new vibration sources likely to be introduced into the area. Therefore, consideration of existing vibration levels is excluded from the assessment.

15.7 Assessment of Effects

This section presents the findings of the assessment for the construction and operational phases. The assessments consider the potential causes of impacts quantitatively, the sensitivity of NSRs (and infrastructure) that could be affected, and the magnitude of impacts, in order to derive the classification of effects.

15.7.1 Construction Phase

Construction work of any type that involves heavy plant activity will generate noise, which may result in complaints if appropriate scheduling and control of works is not exercised. Noise levels generated by construction activities and experienced by NSRs, depends upon a number of variables, the most significant of which are:

- The level of noise generated by plant or equipment used on-site, generally expressed as the sound power level;
- The periods of operation of the plant on the Development Site, known as its ‘on-time’;
- The distance between the noise source and the NSR; and,
- The attenuation of sound due to ground absorption, air absorption and barrier effects.

To evaluate noise effects during the construction phases it is necessary to have knowledge of the variables listed above. Construction Contractors may use different working methods and plant to achieve the same ends. An accurate construction noise and vibration effect assessment is not possible until after the appointment of an approved Construction Contractor with knowledge of the exact working routine and plant schedule to be implemented.

Nevertheless, in order to present a quantitative assessment, assumptions regarding the plant required for different activities have been made. The assessment has adopted a worst-case approach by assuming all plant will operate simultaneously. In practice the actual levels at receptors are likely to be lower than calculated. It must be emphasised that the information used within the assessment is unlikely to be adopted exactly by any contractor and therefore the outcomes of the construction assessment should be viewed in this context.

The use of construction plant and the likely noise effect from its use is determined using the guidance detailed in BS 5228. Where necessary, mitigation methods may be required to attenuate noise to acceptable levels at NSRs. Should complaints be received from local residents, ABC would determine whether BPM is being applied. Should this not be the case, action under the Control of Pollution Act 1974 may be taken.

The anticipated activities with the potential to generate significant levels of noise at receptors are as follows:

- Enabling Works:
  - Existing access improvements.
- Mobilisation, including the following activities:
  - Construction of new Access Tracks to borrow pits;
  - Construction Compound setup (temporary and permanent); and
  - Test audit and confirmatory site investigation.

- Headpond construction, including the following activities:
  - Form access including bridges / culverts, site clearance;
  - Preparatory works: construction diversion, foundation improvements and stabilisation works;
  - Borrow pit opening and operation including Embankment works; and
  - Concrete works: core cutoff, inlet / outlet gate shafts and concrete spillway.
- Tailpond construction, including the following activities:
  - Temporary works in Loch Awe;
  - Temporary B840 realignment;
  - Site clearance;
  - Concrete works: inlet / outlet shaft and gate shaft construction;
  - Rock excavation in Loch Awe and Installation of rock armour; and
  - Disassembly of temporary works.
- Tunnelling works, including the following activities:
  - Form access to portal sites; and
  - Construction of tunnel portals.
- Switchyard activities;
  - Site clearance;
  - Superstructure; and
  - AIS Switchyard construction
- Temporary Marine Facility with jetty construction activities:
  - Form access;
  - Site clearance and compound setup;
  - Jetty piling;
  - Lifting and placing of jetty deck; and
  - Removal of jetty deck post AIL delivery.

Sections 15.6.0 to *15.6.6* together present an assessment of all significant noise and vibration generating activities required to be undertaken as listed above.

15.7.1.1 Construction Noise – Surface Plant All Works

Predictions have only included equipment anticipated to be located above ground or within a tunnel portal. The airborne sound of equipment working within the tunnels should not generate noise levels at NSRs to the same level.

The following activities listed in *Table 15.18* have been identified from the Construction Programme (*Insert 2.1* in *Chapter 2: Project and Site Description*) and the duration of each activity is also provided.

Construction activities have been grouped into phases though phases are not strictly chronological (i.e. an activity in Phase 3 can start before an activity in Phase 2). Predictions have been performed of the sound emissions from the different construction activities at the identified worst case NSRs on a monthly basis using the start and end dates provided. Activities that start or end mid-month have received an on-time correction applied for that month based on the number of daytime construction hours available in the month and the amount potentially utilised. Predicted noise levels for each month represent the worst-case day for that month.

Table 15.18. Construction noise activity programme

Construction Areas	Task ID	Major Construction Activities	Start Date	End Date
		Phase 1		
Enabling works	P1-A1-T1	Existing access improvements	19/01/2027	05/07/2027
		Phase 2		
General Mobilisation	P2-A1-T1	Construction of new Access Tracks – road construction	06/07/2027	13/03/2028
	P2-A1-T2	Construction Compound setup (temporary and permanent)	06/07/2027	20/12/2027
	P2-A1-T3	Temporary jetty construction	06/07/2027	05/06/2028
	P2-A1-T4	General HGV movements within RLB	14/03/2028	30/12/2031
Headpond	P2-A2-T1	Construction of access including bridges and culverts	06/07/2027	13/03/2028
	P2-A2-T2	Site clearance	14/03/2028	08/05/2028
	P2-A2-T3	Construction diversion	14/03/2028	08/05/2028
	P2-A2-T4	Stabilisation works	09/05/2028	28/08/2028
Tailpond	P2-A3-T1	Temporary B840 Realignment Works	06/07/2027	10/04/2028
	P2-A3-T2	Inlet / outlet area	11/04/2028	31/07/2028
	P2-A3-T3	Site clearance	11/04/2028	08/05/2028
	P2-A3-T4	Trench construction for gatehouse and tailrace	09/05/2028	15/01/2029
Tunnelling works	P2-A4-T1	Form access to portal sites	06/07/2027	30/08/2027
	P2-A4-T2	Tunnel portal – construction	31/08/2027	20/12/2027
	P2-A4-T3	Tunnel portal – PT	06/07/2027	25/10/2027
	P2-A4-T4	Tunnel excavation material transport	20/12/2027	30/10/2029
Switchyard	P2-A5-T1	Groundworks	06/07/2027	20/12/2027
	P2-A5-T2	Superstructure construction	21/12/2027	20/11/2028
		Phase 3		
Headpond	P3-A1-T2	Opening and operation of borrow pit	06/07/2027	13/03/2028
	P3-A1-T3	Construction of Embankments	10/04/2029	10/02/2031
	P3-A1-T4	Construction of spillway	22/10/2028	28/06/2029
	P3-A1-T5	Construction of inlet / outlet and gate shafts	14/03/2028	30/07/2029
Tailpond	P3-A2-T1	Temporary works in Loch Awe	06/07/2027	05/06/2028
	P3-A2-T2	Construction of inlet / outlet and gate shafts	16/01/2029	03/06/2030
	P3-A2-T3	Construction of inlet / outlet structure	16/01/2029	03/06/2030
Switchyard	P3-A3-T1	Superstructure construction	21/12/2027	20/11/2028
	P3-A3-T2	AIS Switchyard	21/11/2028	22/10/2029
		Phase 4		
Lower Reservoir	P4-A1-T1	Rock excavation in front of inlet and armouring works	04/06/2030	26/08/2030

Note that this table is the construction noise activity programme. Some of the activities are part of more than one phase, but are not a second noise activity and so only appear above under a single phase, these are:

- Upper Reservoir – Site clearance which is also Phase 3
- Lower Reservoir – Trench construction for gatehouse and bifurcation which is also Phase 3
- Upper Reservoir – Opening and operation of borrow pit which is also Phase 4
- Upper Reservoir – Embankment construction Works which is also Phase 4
- Lower Reservoir – Construction of inlet and gate shafts which is also Phase 4
- Lower Reservoir – Construction of inlet/outlet structure which is also Phase 4
- Switch room building and HV Switchyard – AIS Switchyard which is also Phase 4

Whilst the actual phasing of the works may change depending on final construction proposals, it is considered unlikely that more activities will be undertaken. Therefore, the modelling considers a worst-case scenario.

The ground heights at the Headpond will change as the works progress and the excavation deepens, which will introduce barrier effects to receptors. Flat ground height has been used in the modelling of different phases, which is a worst-case assumption.

Sound power levels for each item of equipment for each construction activity have been sourced from BS 5228-1, which gives measured noise levels for various items of construction plant. The source data input into the noise model are given in *Appendix 15.3 (Volume 5: Appendices)*.

The inherent uncertainty in the modelling procedures and the processes implemented to minimise the uncertainty are discussed in *Appendix 15.4 (Volume 5: Appendices)*.

Where the construction equipment required for an activity will be located within a specific area, the sound power levels of the equipment have been summed and the overall level has been assigned to an area source. Where significant mobile plant movements are required to transport spoil between tunnel portal and other areas for moving spoil, these have been modelled as moving point sources at a maximum speed of 20 km/h. However, it is worth noting that the speed entirely depends on the design speed of the construction track that and could be less than 20 km/h.

In addition, following the completion of the construction Access Tracks we have assumed that all tracks will observe average of 3.25 HGV movements per hour at 20 km/h (based on 59 movements in a 12 hour day) relating to general site logistics.

Construction noise levels have been predicted using the noise modelling software package CadnaA 2023, which implements the standard noise prediction methodology given in BS 5228-1+A1:2014. The model includes the assumes a flat ground topography of the Development Site and surrounding area as a worst case assumption, as well as soft ground absorption properties. The modelling approach assumes that all receptors are downwind of all contributing noise sources.

During construction, it is expected that the noisiest activities will be the drilling and, blasting during the construction works for the Headpond and tunnelling. The noise from blasting has been assessed separately below.

At close proximity to the tunnel excavation, airborne noise from this equipment is likely to be high. However, for the majority of this tunnelling activity (i.e. the excavation by drill and blast methods) will be underground and will therefore be further screened from NSRs.

The measured baseline sound levels at all monitoring locations, rounded to the nearest 5 dB, are 5 dB or more below the Category A Threshold Values within BS 5228-1 shown in *Table 16.1* with the exception of L2, which is 65 dB $L_{Aeq,12hr}$. L2 is located at a property less than 5 metres from the A819, it is located 200 m from the nearest Access Track and is potentially affected by only HGV movements on the A819 rather than construction site work noise. Construction traffic noise affecting noise sensitive receptors along public roads is not assessed against BS5228-1, therefore on this basis the applicable Threshold Values for the construction noise assessment at all NSRs are from Category A; 65 dBA, 55 dBA and 45 dBA during the day, evening and night-time respectively. This is the most stringent assessment category.

Construction noise levels have been predicted at the receptors identified as the worst affected NSRs using a 12 hour construction working day, based on 07:00 – 19:00. For assessment purposes, it is assumed that all the equipment listed in *Appendix 15.3 (Volume 5: Appendices)* for each construction activities listed in Table 15.18 would be operating simultaneously throughout the months they are scheduled for. Therefore, they are based upon the proposed working hours and the monthly schedule in *Table 15.18*, the $L_{Aeq,1h}$ noise levels have been predicted for a theoretical ‘worst-case day’.

Construction noise levels have been predicted “without” and “with” contribution from tasks relating to the upgrade or preparation of new Access Tracks, namely Task ID’s:

- P1-A1-T1 – Existing access improvements
- P2-A1-T1 – Construction of new Access Tracks – road construction; and
- P2-A3-T1 – Temporary B840 Realignment works

When determining the construction noise levels “with” the contribution from these tasks, the tasks have been assumed to be located at the closest approach to an NSR from the nearest Access Track. Each NSR is only considered to receive the noise contribution from tasks being undertaken at the closest point to the closest Access Track. The tasks are assumed to be located at these locations for the full duration of the task as stated in *Table 15.18*. This is a conservative approach as in practice the Access Track tasks are linear in nature and will therefore only be at their worst location as they pass the NSR, furthermore the assumption that all equipment required for the task compounds the worst-case assumption. The “without” contribution from the Access Track construction scenario allows the typical levels experienced by receptors during a typical day in a given a month to provide context of what the significance the Access Track might have when works are at their closest point to the NSRs.

These conservative assumptions have been used when establishing the predicted levels from the construction activities as it is too early to identify the precise timing of each task, i.e. where crews will be along each Access Track on a given day.

Table 15.19 and *Table 15.20* show the predicted free-field construction noise levels at each receptor for each month of the construction programme *without* contribution from the Access Track construction activities for the first and second 30-month periods. The results are without the benefit of embedded mitigation discussed in *Section 15.7.*

Table 15.21 and *Table 15.22* show the predicted free-field construction noise levels at each receptor for each month of the construction programme *with* contribution from the Access Track construction activities for the first and second 30 month periods. The results are without the benefit of embedded mitigation discussed in *Section 15.7.*

The following paragraphs discuss the worst affected NSRs in some detail to provide context to the levels presented in the result tables.

NSR090 – This receptor is located approximately 43 m from the planned Temporary B840 Realignment road and it can be seen that a potential exceedance of 8 dB over the threshold value 65 dB $L_{Aeq,T}$ is only predicted during the period corresponding to the construction of the new road between Jul-27 to Apr-28, see task P2-A3-T1. Therefore, while activity will be noticeable during this time it will not be occurring at a distance of 43 m for the total duration as has been assessed and will gradually move over time, meaning adverse effects will be reduced.

NSR220, NSR424 & NSR216 – The Access Track near Inveraray castle may require upgrades in some places to accommodate the construction traffic as part of task P1-A1-T1. These receptors are located approximately 45 m, 83 m and 106 m from the existing Access Track at Inveraray castle respectively. It is predicted that exceedances at these receptors only occur during track upgrade task Jan-27 to Jul-27, the exceedances at NSR220, NSR424 & NSR216 are 11 dB, 3 dB and 1 dB respectively. As above these works will move gradually in practice and will not be located at the closest approach for the duration of the task as assessed here.

NSR278 – As this receptor is located 17 m from the existing Access Track (Upper Avenue) near the jetty designated for upgrade an exceedance of 20 dB over the 65 dB $L_{Aeq,T}$ threshold value is predicted over most of Jan-27 to Jul-27. It is important to note that in practice the upgrade of the Access Track will be localised and undertaken where needed and will be in the vicinity of NSR for a much shorter duration than that assumed for the quantitative predictions.

The calculations for the receptors above have assumed that the Access Track/road work will be undertaken by all equipment at the same time for the total duration of the relevant task. In practice the equipment will only be in the vicinity of the NSR for a much shorter duration than that assumed for the quantitative predictions. Therefore, due to the relative short duration of the Access Track / road works it is expected that the potential adverse effects can be managed by minimising the amount of time in proximity to the receptor, observing the good practices to reduce noise as well as communicating plans/progress and changes with residents. The application of these general mitigation measures are also referenced in *Section 15.8 Mitigation and Monitoring*.

NSR376 – This receptor is located approximately 35 m from the boundary of the northernmost temporary compound at the Lower Reservoir (Loch Awe). Predicted levels exceed the 65 dB $L_{Aeq,T}$ threshold value by no more the 3 dB during the period the compound will be established Apr-27 to Dec-27. The predicted levels have assumed the setup task will occur throughout this period however there are more than 15 compounds (temporary or permanent) that require setup over this period. Therefore, actual levels are likely to be lower than the threshold value, and in addition the application of good practice to reduce construction noise levels will also support this.

NSR378 – This receptor is located approximately 81 m from the Temporary B840 Realignment, therefore for explanation of these exceedances from Jul-27 to Apr-28 see NSR090 above. In addition, the exceedances are also contributed by task P2-A1-T2 during the setup of the main Tailpond temporary Construction Compound which may occur until Dec-27. This task relates to all permanent and temporary compounds and therefore a single compound will not likely require the entire Jun-27 to Dec-27 duration to complete. The receptor is approximately 40 m from the main temporary compound and is typically closest to activities listed under Lower Reservoir, see *Appendix 15.3 (Volume 5: Appendices)*. Exceedances beyond Apr-28 when the Temporary B840 Realignment work is complete is due to any task labelled under Lower Reservoir. The predicted exceedances are no more than 7 dB over the 65 dB $L_{Aeq,T}$ threshold value. It is worth noting that for each task at the Tailpond (and everywhere else) we have assumed that all equipment is in use simultaneously whereas in practice its use will be staggered and potentially used less than the on-times used in this assessment suggest.

NSR041 & NSR440 – These receptors are approximately 120 and 260 m from the closest part of the temporary jetty respectively. During task P2-A1-T3 (the temporary jetty construction), the piling is assumed in continuous operation over 60% of the reference period (i.e. 12 hour weekday) and it is the dominating noise source for that task under this assumption as it is at least 20 dB higher than any other piece of equipment used in the task (see *Appendix 15.3 (Volume 5: Appendices)*). The associated sound power level has been selected based on historic data provided in BS5228-1 Table D.4, namely Ref 21 and 62 both are diesel piling hammer types applied to tubular casings (as opposed to sheet piles) and both have associated sound power level of 132 dB(A). These have been selected as the basis for the piling noise predictions from the temporary jetty construction because they match the expected piling method and represent the most conservative option for the assessment i.e. Table D.4 Ref 62 is identical to Ref 61 which is 10 dB $L_{Aeq,T}$ lower as it has a lower power rating. Furthermore, the closest approach of the temporary jetty to the closest receptor (NSR440) is 120 m – the receptor is also adjacent to the red line boundary. At NSR440 it can be seen that for 11 of the 12 months it is potentially operational it exceeds the lower Category A weekday daytime and Saturday AM limit of 65 dB $L_{Aeq,T}$ by 10 dB at most, at NSR041 this is 3 dB exceedance at most.

Further to this it can also be observed that when contribution of track access works is included the exceedance at NSR440 increase to 11 dB $L_{Aeq,T}$ from 10 dB $L_{Aeq,T}$ at worst. Suggesting that staggering the track access preparation with the piling activities would help to reduce overall noise levels across a given day/week/month.

As piling is the dominating noise source any noise reduction strategy would need to address the piling first. Piling noise reduction mitigation is considered for this task later in the chapter.

Table 15.19 Predicted Construction Noise Levels Jan-27 to Jun-29 (without Access Track Construction contributions and without Embedded Mitigation benefit), dB $L_{Aeq,T}$

	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28
NSR023							40	41	41	41	41	41	40	40	41	42	42	38
NSR027							39	40	40	40	40	40	39	39	40	41	41	37
NSR030							41	41	41	41	41	41	40	40	41	42	42	39
NSR040							62	63	63	63	63	63	62	62	62	62	62	54
NSR041							67	68	68	68	68	68	68	68	68	68	68	59
NSR057							57	57	57	57	57	57	57	57	57	57	57	49
NSR059							46	47	47	47	46	46	45	45	42	36	36	36
NSR060							45	46	46	46	46	46	44	44	45	46	46	42
NSR066							57	57	57	57	57	57	57	57	57	57	57	49
NSR087							56	56	56	56	56	56	56	56	56	56	56	48
NSR090							63	63	63	63	63	62	57	57	55	57	59	58
NSR127							26	27	27	27	27	25			43	46	46	46
NSR147							26	27	27	27	27	25			48	50	50	50
NSR207							43	44	44	44	44	43	43	43	46	47	47	46
NSR209							43	44	44	44	44	43	43	43	46	48	48	46
NSR210							43	44	44	44	44	43	43	43	45	47	47	45
NSR211							43	44	44	44	44	43	43	43	46	47	47	45
NSR216							39	40	40	40	40	40	39	39	43	45	45	44
NSR220							44	44	44	44	44	44	43	43	49	51	51	51
NSR221							43	44	44	44	44	43	43	43	46	47	47	45
NSR225							43	44	44	44	44	43	43	43	44	45	45	42
NSR229							43	44	44	44	44	43	43	43	40	30	30	30
NSR247							36	37	37	37	37	37	37	37	39	40	40	40
NSR273							29	29	29	29	29	27			33	36	36	36
NSR278							51	52	52	52	52	51	47	47	53	55	55	54
NSR298							40	41	41	41	41	41	40	40	41	42	42	38
NSR301							54	55	55	55	55	54	52	52	53	53	53	46
NSR317							59	60	60	60	60	60	59	59	59	59	59	51
NSR348							51	52	52	52	52	50	48	48	49	49	49	44
NSR366							26	27	27	27	27	25			43	46	46	46
NSR373							53	54	54	54	54	53	52	52	49	44	45	44
NSR375							53	54	54	54	54	53	52	52	49	44	45	44
NSR376							67	68	68	68	68	66	54	54	52	52	54	52
NSR377							63	63	63	63	63	61	53	53	51	52	53	52
NSR378							62	62	62	62	62	62	61	61	60	64	67	66
NSR381															35	37	37	37
NSR382							41	42	42	42	42	41	40	40	42	42	42	39
NSR395							28	29	29	29	29	27			40	42	42	42
NSR397							28	29	29	29	29	27			40	42	42	42
NSR398							26	27	27	27	27	25			43	45	45	45
NSR399							41	42	42	42	42	41	41	41	42	43	43	40
NSR424							41	41	41	41	41	41	41	41	47	49	49	48
NSR440							74	75	75	75	75	74	73	73	73	73	73	65
NSR457							47	47	47	47	47	47	45	45	46	46	46	42
NSR466							55	55	55	55	55	55	54	54	54	54	54	47
NSR476							54	55	55	55	55	54	53	53	53	54	54	47

	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29
NSR023	37	37	37	37	37	37	37	37	37	37	37	37
NSR027	35	35	35	35	35	35	35	35	35	35	35	35
NSR030	38	38	38	38	38	38	38	38	38	38	38	38
NSR040	38	38	38	38	38	38	38	38	38	38	38	38
NSR041	42	42	42	42	42	42	42	42	42	42	42	42
NSR057	34	34	34	34	34	34	34	34	34	34	34	34
NSR059	36	36	36	36	36	35	35	35	35	39	40	40
NSR060	41	41	41	41	41	41	41	41	41	41	41	41
NSR066	33	33	33	33	33	33	33	33	33	33	33	33
NSR087	41	41	41	41	41	41	41	41	41	41	41	41
NSR090	57	55	55	55	55	55	58	60	60	60	60	60
NSR127	46	46	46	46	46	46	46	46	46	46	46	46
NSR147	50	50	50	50	50	50	50	50	50	50	50	50
NSR207	45	45	45	45	45	45	45	45	45	45	45	45
NSR209	46	46	46	46	46	46	46	46	46	46	46	46
NSR210	45	45	45	45	45	45	45	45	45	45	45	45
NSR211	45	45	45	45	45	45	45	45	45	45	45	45
NSR216	44	44	44	44	44	44	44	44	44	44	44	44
NSR220	50	50	50	50	50	50	50	50	50	50	50	50
NSR221	45	45	45	45	45	45	45	45	45	45	45	45
NSR225	41	41	41	41	41	41	41	41	41	41	41	41
NSR229	30	30	30	30	30	30	30	30	30	30	30	30
NSR247	40	40	40	40	40	40	40	40	40	40	40	40
NSR273	36	36	36	36	36	36	36	36	36	36	36	36
NSR278	54	54	54	54	54	54	54	54	54	54	54	54
NSR298	37	37	37	37	37	37	37	37	37	37	37	37
NSR301	42	42	42	42	42	42	42	42	42	42	42	42
NSR317	40	40	40	40	40	40	40	40	40	40	40	40
NSR348	43	43	43	43	43	43	43	43	43	43	43	43
NSR366	46	46	46	46	46	46	46	46	46	46	46	46
NSR373	44	42	42	42	42	42	45	46	46	46	46	46
NSR375	44	42	42	42	42	42	44	46	46	46	46	46
NSR376	52	49	49	49	49	49	53	55	55	55	55	55
NSR377	51	48	48	48	48	48	52	54	54	54	54	54
NSR378	66	65	65	65	65	65	68	69	69	69	69	69
NSR381	37	37	37	37	37	37	37	37	37	37	37	37
NSR382	37	37	37	37	37	37	37	37	37	37	37	37
NSR395	42	42	42	42	42	42	42	42	42	42	42	42
NSR397	42	42	42	42	42	42	42	42	42	42	42	42
NSR398	45	45	45	45	45	45	45	45	45	45	45	45
NSR399	39	39	39	39	39	39	39	39	39	39	39	39
NSR424	48	48	48	48	48	48	48	48	48	48	48	48
NSR440	43	43	43	43	43	43	43	43	43	43	43	43
NSR457	41	41	41	41	41	41	41	41	41	41	41	41
NSR466	41	41	41	41	41	41	41	41	41	41	41	41
NSR476	41	41	41	41	41	41	41	41	41	41	41	41

Table 15.20 Predicted Construction Noise Levels Jul-29 to Dec-31 (without Access Track Construction contributions and without Embedded Mitigation benefit) dB $L_{Aeq,T}$

	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31
NSR023	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR027	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSR030	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
NSR040	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
NSR041	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR057	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	33
NSR059	40	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	36	33	33	33	33	33	33	33	33	33	33
NSR060	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR066	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
NSR087	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR090	60	60	60	60	60	60	60	60	60	60	60	55	54	53	41	41	41	41	41	39	38	38	38	38	38	38	38	38	38	38
NSR127	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	45
NSR147	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NSR207	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR209	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
NSR210	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	44
NSR211	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR216	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
NSR220	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NSR221	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR225	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR229	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NSR247	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NSR273	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	35
NSR278	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
NSR298	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR301	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41
NSR317	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NSR348	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42
NSR366	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	45
NSR373	46	46	46	46	46	46	46	46	46	46	46	42	42	41	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37
NSR375	46	46	46	46	46	46	46	46	46	46	46	42	42	41	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37
NSR376	55	55	55	55	55	55	55	55	55	55	55	50	49	49	40	40	40	40	40	38	37	37	37	37	37	37	37	37	37	37
NSR377	54	54	54	54	54	54	54	54	54	54	54	49	49	48	40	40	40	40	40	38	37	37	37	37	37	37	37	37	37	37
NSR378	69	69	69	69	69	69	69	69	69	69	69	62	61	60	41	41	41	41	41	40	39	39	39	39	39	39	39	39	39	39
NSR381	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR382	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR395	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR397	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR398	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR399	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
NSR424	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
NSR440	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42
NSR457	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR466	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR476	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41

Table 15.21 Predicted Construction Noise Levels Jan-27 to Jun-29 (with Access Track Construction contributions and without Embedded Mitigation benefit) dB $L_{Aeq,T}$

	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29
NSR023	39	43	43	43	43	43	41	41	41	41	41	41	40	40	41	42	42	38	37	37	37	37	37	37	37	37	37	37	37	37
NSR027	43	46	46	46	46	46	42	40	40	40	40	40	39	39	40	41	41	37	35	35	35	35	35	35	35	35	35	35	35	35
NSR030	43	46	46	46	46	46	42	41	41	41	41	41	40	40	41	42	42	39	38	38	38	38	38	38	38	38	38	38	38	38
NSR040							63	64	64	64	64	64	64	64	63	62	62	54	38	38	38	38	38	38	38	38	38	38	38	38
NSR041							68	69	69	69	69	69	69	69	68	68	68	59	42	42	42	42	42	42	42	42	42	42	42	42
NSR057							58	58	58	58	58	58	58	58	58	57	57	49	34	34	34	34	34	34	34	34	34	34	34	34
NSR059							47	47	47	47	47	47	46	46	43	36	36	36	36	36	36	36	36	35	35	35	35	39	40	40
NSR060	47	51	51	51	51	51	47	46	46	46	46	46	44	44	45	46	46	42	41	41	41	41	41	41	41	41	41	41	41	41
NSR066							57	58	58	58	58	58	58	58	57	57	57	49	33	33	33	33	33	33	33	33	33	33	33	33
NSR087	47	51	51	51	51	51	56	56	56	56	56	56	56	56	56	56	56	48	41	41	41	41	41	41	41	41	41	41	41	41
NSR090							72	73	73	73	73	73	72	72	72	68	59	58	57	55	55	55	55	55	58	60	60	60	60	60
NSR127							26	27	27	27	27	25			43	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
NSR147							26	27	27	27	27	25			48	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NSR207	57	61	61	61	61	61	53	44	44	44	44	43	43	43	46	47	47	46	45	45	45	45	45	45	45	45	45	45	45	45
NSR209	60	64	64	64	64	64	56	44	44	44	44	43	43	43	46	48	48	46	46	46	46	46	46	46	46	46	46	46	46	46
NSR210	57	60	60	60	60	60	53	44	44	44	44	43	43	43	45	47	47	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR211	57	60	60	60	60	60	52	44	44	44	44	43	43	43	46	47	47	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR216	62	66	66	66	66	66	58	40	40	40	40	40	39	39	43	45	45	44	44	44	44	44	44	44	44	44	44	44	44	44
NSR220	72	76	76	76	76	76	67	44	44	44	44	44	43	43	49	51	51	51	50	50	50	50	50	50	50	50	50	50	50	50
NSR221	56	60	60	60	60	60	52	44	44	44	44	43	43	43	46	47	47	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR225	56	60	60	60	60	60	52	44	44	44	44	43	43	43	44	45	45	42	41	41	41	41	41	41	41	41	41	41	41	41
NSR229							43	44	44	44	44	44	44	44	40	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NSR247							36	37	37	37	37	37	37	37	39	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NSR273	45	49	49	49	49	49	40	29	29	29	29	27			33	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
NSR278	81	85	85	85	85	85	77	52	52	52	52	51	47	47	53	55	55	54	54	54	54	54	54	54	54	54	54	54	54	54
NSR298	39	43	43	43	43	43	41	41	41	41	41	41	40	40	41	42	42	38	37	37	37	37	37	37	37	37	37	37	37	37
NSR301	48	52	52	52	52	52	54	55	55	55	55	54	52	52	53	53	53	46	42	42	42	42	42	42	42	42	42	42	42	42
NSR317	45	49	49	49	49	49	59	60	60	60	60	60	59	59	59	59	59	51	40	40	40	40	40	40	40	40	40	40	40	40
NSR348	54	58	58	58	58	58	53	52	52	52	52	50	48	48	49	49	49	44	43	43	43	43	43	43	43	43	43	43	43	43
NSR366							26	27	27	27	27	25			43	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
NSR373							54	54	54	54	54	54	53	53	51	46	45	44	44	42	42	42	42	42	45	46	46	46	46	46
NSR375							54	54	54	54	54	54	53	53	50	45	45	44	44	42	42	42	42	42	44	46	46	46	46	46
NSR376							67	68	68	68	68	66	58	58	58	55	54	52	52	49	49	49	49	49	53	55	55	55	55	55
NSR377							63	64	64	64	64	62	56	56	55	53	53	52	51	48	48	48	48	48	52	54	54	54	54	54
NSR378							67	67	67	67	67	67	67	67	66	66	67	66	66	65	65	65	65	65	68	69	69	69	69	69
NSR381															35	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR382	41	45	45	45	45	45	42	42	42	42	42	41	40	40	42	42	42	39	37	37	37	37	37	37	37	37	37	37	37	37
NSR395							28	29	29	29	29	27			40	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR397							28	29	29	29	29	27			40	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR398							26	27	27	27	27	25			43	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR399	46	50	50	50	50	50	44	42	42	42	42	41	41	41	42	43	43	40	39	39	39	39	39	39	39	39	39	39	39	39
NSR424	65	69	69	69	69	69	60	41	41	41	41	41	41	41	47	49	49	48	48	48	48	48	48	48	48	48	48	48	48	48
NSR440							75	76	76	76	76	75	75	75	74	73	73	65	43	43	43	43	43	43	43	43	43	43	43	43
NSR457	47	51	51	51	51	51	48	47	47	47	47	47	45	45	46	46	46	42	41	41	41	41	41	41	41	41	41	41	41	41
NSR466	47	51	51	51	51	51	55	55	55	55	55	55	54	54	54	54	54	47	41	41	41	41	41	41	41	41	41	41	41	41
NSR476	48	52	52	52	52	52	55	55	55	55	55	54	53	53	53	54	54	47	41	41	41	41	41	41	41	41	41	41	41	41

Table 15.22 Predicted Construction Noise Levels Jul-29 to Dec-31 (with Access Track Construction contributions and without Embedded Mitigation benefit) dB $L_{Aeq,T}$

	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31
NSR023	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR027	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSR030	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
NSR040	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
NSR041	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR057	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	33
NSR059	40	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	36	33	33	33	33	33	33	33	33	33	33
NSR060	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR066	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
NSR087	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR090	60	60	60	60	60	60	60	60	60	60	60	55	54	53	41	41	41	41	41	39	38	38	38	38	38	38	38	38	38	38
NSR127	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	45
NSR147	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NSR207	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR209	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
NSR210	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	44
NSR211	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR216	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
NSR220	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
NSR221	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR225	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR229	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
NSR247	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NSR273	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	35
NSR278	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
NSR298	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR301	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41
NSR317	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NSR348	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42
NSR366	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	45
NSR373	46	46	46	46	46	46	46	46	46	46	46	42	42	41	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37
NSR375	46	46	46	46	46	46	46	46	46	46	46	42	42	41	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37
NSR376	55	55	55	55	55	55	55	55	55	55	55	50	49	49	40	40	40	40	40	38	37	37	37	37	37	37	37	37	37	37
NSR377	54	54	54	54	54	54	54	54	54	54	54	49	49	48	40	40	40	40	40	38	37	37	37	37	37	37	37	37	37	37
NSR378	69	69	69	69	69	69	69	69	69	69	69	62	61	60	41	41	41	41	41	40	39	39	39	39	39	39	39	39	39	39
NSR381	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR382	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
NSR395	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR397	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
NSR398	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NSR399	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
NSR424	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
NSR440	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42
NSR457	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR466	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
NSR476	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41

The worst-case noise impacts and resultant effects are summarised in *Table 15.23* both without and with the Access Track construction activities P1-A1-T1, P2-A1-T1 and P2-A3-T1 and without and with the benefit of embedded mitigation and based on comparison with the Threshold Value (65 dB $L_{Aeq,1h}$), the magnitude of impact scale in *Table 15.7* and significance of effect matrix in *Table 15.13*. The receptor sensitivity of all NSRs has been classified as high.

The construction noise level reduction provided by embedded mitigation is discussed later in *Section 15.7.0*.

Table 15.23 Predicted worst-case construction noise effects

Receptor	Area	Without Access Track Construction		With Access Track Construction	
		Magnitude of Impact	**Significance of Effect**	**Magnitude of Impact**	**Significance of Effect**
(a) <u>Without</u> Embedded Mitigation (and Without other Specific Mitigation)					
NSR090	Lower Reservoir	Minor	Minor	Major	Major
NSR220	Inveraray Castle	Negligible	Negligible	Major	Major
NSR424	Inveraray Castle	Negligible	Negligible	Moderate	Moderate
NSR216	Inveraary Castle	Negligible	Negligible	Moderate	Moderate
NSR278	Upper Avenue/A819	Negligible	Negligible	Major	Major
NSR376	Lower Reservoir	Moderate	Moderate	Moderate	Moderate
NSR378	Lower Reservoir	Moderate	Moderate	Major	Major
NSR041	Temporary Jetty	Moderate	Moderate	Moderate	Moderate
NSR440	Temporary Jetty	Major	Major	Major	Major
(b) **<u>With</u> Embedded Mitigation (but Without other Specific Mitigation)**					
NSR090	Lower Reservoir	Minor	Minor	Moderate	Moderate
NSR220	Inveraray Castle	Negligible	Negligible	Moderate	Moderate
NSR424	Inveraray Castle	Negligible	Negligible	Minor	Minor
NSR216	Inveraray Castle	Negligible	Negligible	Minor	Minor
NSR278	Upper Avenue/A819	Negligible	Negligible	Moderate	Moderate
NSR376	Lower Reservoir	Minor	Minor	Minor	Minor
NSR378	Lower Reservoir	Minor	Minor	Moderate	Moderate
NSR041	Temporary Jetty	Moderate	Moderate	Moderate	Moderate
NSR440	Temporary Jetty	Major	Major	Major	Major

At all other NSRs in *Figure 15.1*, the significance of effects is predicted to be temporary and either negligible or minor adverse at worst, and therefore Not Significant.

15.7.1.2 Construction Vibration – Surface Plant Impacts

Research by the Transport and Road Research Laboratory (TRL, 1977) found that the levels of ground-borne vibration from tracked earth moving equipment (such as a bulldozer or excavator) are imperceptible to humans at a distance of approximately 20 metres, and those generated by vehicles with rubber tyres (e.g. a heavy lorry or dump truck) would be imperceptible at more than 10 metres from the haul road. Mobile plant may occasionally come within 20 metres of a sensitive receptor, such as during the track upgrade task (P1-A1-T1) at Upper Avenue; hence vibration may be perceptible but is unlikely to be of a magnitude that could cause complaint. It is concluded that the magnitude of vibration impacts for surface plant would be no worse than Minor at NSRs closer than 20 m and Negligible beyond. Accordingly, the predicted worst-case significance of effects is a localised, temporary, minor adverse for all high sensitivity NSRs, which is considered to be Not Significant.

Hydraulic hammers and breakers that are mounted on excavators will cause ground-borne vibration from their impulsive percussive action. Typical safe working distances from this type of equipment are shown in *Table 15.24.*

BS 5228-2 does not provide case history data for hydraulic hammer vibration specifically and therefore this table has been taken from the Australian document "*Construction Noise Strategy (Rail Projects)*" (NSW Transport Construction Authority) as indicative advice for safe working distance to comply with the vibration criterion levels published within BS 6472-1:2008 (relating to annoyance) and BS 7385-1:1993 (relating to damage).

Table 15.24 Recommended safe working distances for Hydraulic Hammers

Plant	Rating / Description	Safe Working Distance	
		Cosmetic Damage	Human Response
Small Hydraulic Hammer	300 kg / 5-12 t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg / 12-18 t excavator	7 m	23 m
Large Hydraulic Hammer	1,600 kg / 18-34 t excavator	22 m	73 m

Hydraulic Hammer equipment is expected to be in use at the Upper (Headpond) and Lower Reservoirs with reference to the detailed equipment list *Appendix 15.3 (Volume 5: Appendices)*. NSR378 is located approximately 45 m from a temporary compound boundary at the Lower Reservoir and is the closest receptor to this activity.

As such the values provided within *Table 15.24* demonstrate that all identified high sensitivity NSRs are unlikely to perceive the vibration from hydraulic hammer rock breaking. Accordingly, the magnitude of impact on humans is predicted to be negligible and therefore the significance of effect is negligible, which is considered to be Not Significant.

Furthermore, the distance to the nearest building is around double the distance quoted for causing cosmetic damage from the largest hydraulic hammer in *Table 15.24*. Therefore the magnitude of impact on buildings for the potential to cause cosmetic damage is predicted to be negligible resulting in significant of effects that are negligible based on a high sensitivity receptor. Overall the effect of surface plant vibration on building is Not Significant.

15.7.1.3 Construction Vibration – Piling Impacts

The planned piling activities are as follows:

- A diesel impact piling hammer would be required for the construction of the temporary jetty.
- Vibratory sheet piling would be required during the construction of the cofferdam at the Tailpond at Loch Awe and may be required at the Upper Reservoir as well for stabilising the excavated slopes.

Airborne piling noise has been included in the predictions of construction noise. Predictions of the groundborne vibration generated by the piling have been performed using the methodology in BS 5228-2:2009+A1:2014.

Temporary Jetty – Impact Piling

It is assumed that that all jetty piles will be driven to refusal and that the maximum pile driver hammer energy is likely to be approximately 200 kJ. This is greater than the stated range of hammer energy in the prediction method, which is 1 to 85 kJ. BS 5228-2:2009+A1:2014 does not state an applicable distance range for the prediction methodology, however the research on which it is based (Groundborne vibration caused by mechanised construction works, Hiller and Crabb, 2000) validated the equation with measured levels at distances of up to 120 m.

The closest NSR to the jetty hammer piling location is NSR440, which is between 130 m to 230 m from the jetty footprint. At this range the predicted PPV vibration level is 2.0 mm/s down to 1.0 mm/s, assuming the piles are driven to refusal and using an nominal hammer energy (W) of 200 kJ. While the valid range of W for the calculation method is 1.5 ≤ W ≤ 85 kJ, the method has been used in the absence of an alternative.

On this basis, the magnitude of impact at the closest NSR is predicted to be up to moderate and therefore the significance of effect is considered to be localised, temporary, moderate adverse, which is potentially Significant. It should be noted that the predicted vibration levels are at the lower end of the moderate PPV range 1.0 to < 10 mm/s and specifically *Table 15.5* states that the effect is likely to cause complaint but, "can be tolerated if prior warning and explanation has been given to residents".

Regarding potential cosmetic damage to buildings, by comparing the PPV levels at which annoyance and cosmetic damage might occur, see *Table 15.2* and *Table 15.4* it can be observed the humans are more sensitive than buildings to vibration. As PPV level from impact piling at the temporary jetty are less than 10 mm/s the magnitude of impact and the significance of effect on the building would be no worse than minor which is Not Significant.

Lower Reservoir – Cofferdam Vibratory Sheet Piling

The closest receptor to the vibratory sheet piling at the Lower/Upper Reservoir is NSR378 which is approximately 105 m from the closest place piling would take place. At this distance the predicted PPV is 0.5 mm/s.

Accordingly, the magnitude of impact is predicted to be no worse than minor and therefore the significance of effect is expected to be localised, temporary, minor adverse for all high sensitivity NSRs and buildings, which is considered to be Not Significant.

15.7.1.4 Construction Vibration – Piling Impacts on Underground Services

No underground services have been identified in the vicinity of construction equipment with potential to create significant vibration levels. Therefore, with reference to the prediction method in BS 5228-2:2009, the vibration levels at the closest underground services are likely to be below the limit of 30 mm/s for transient vibration. Hence the effect on the underground services is considered to be Not Significant.

15.7.1.5 Construction Blasting – Air Overpressure and Vibration

It is proposed to use the blast and drill method to excavate the tunnel entrances and portals, powerhouse cavern, surge shafts and construction and Access Tunnels. Areas of hard rock are anticipated to be encountered during the excavation of the Headpond which will require blasting.

Open air blasting activities (i.e. excavation of the tunnel entrances and the foundation preparation at the reservoir area would be scheduled for daytime hours of 07:00 – 19:00, Monday to Friday. However, underground blasting (at the powerhouse cavern, surge shafts and construction and Access Tunnels) may be a 24-hour operation, with 2 cycles per 24 hours. As explained in PAN 50 Annex D, blasting generates both air overpressure and vibration simultaneously. At this stage of the Development design, the detail of blasting (such as mass of charge, site location, hole spacing, detonation delay) is not determined and would be established in the detailed design phase.

PAN 50 Annex D states that, *"Variations in instantaneous charge weights at any specific site relate closely to variations in vibration magnitude. It is this parameter, together with distance from the blast, that forms the basis of vibration prediction."*

Australian Standard AS2187.2-2006 'Explosives-Storage and Use, Part 2: Use of explosives' provides guidance on calculating first estimates of potential vibration levels from blasting. Using the distances to the closest NSRs to the blasting works, a maximum instantaneous charge (MIC) can be calculated for a mean PPV limit. Indicative first estimates of the MIC are shown in *Table 15.25* on the basis of not exceeding the PPV 6 mm/s threshold and therefore remaining Not Significant.

Table 15.25 Indicative first estimates of the MIC to not exceed applicable threshold for different blasting locations

Location	Most Sensitive Period of Works	Applicable threshold from BS 6472-2 (PPV, mm/s)	Closest Receptor	Approximate Distance to Closest Receptor (m)	Indicative first estimates of the MIC to not exceed applicable threshold (kg)
Access Tunnel Portal	Daytime	6	NSR378	860	1048
Construction Tunnel Portal			NSR378	530	398
Power Tunnel Portal			NSRs	> 2000	5670
Headpond			NSR090	> 2000	5670
Powerhouse cavern and surge shafts	Night-time	2	NSR090	> 2000	1436
Access Tunnel			NSR378	860	266
Construction Tunnel			NSR378	530	101
Power Tunnel			NSRs	1500	808

Night-time blasting on the surface is not planned, however the allowable MIC information is provided for night-time to give some context to the daytime values. It is recognised that some of the quoted indicative first estimates of the MIC not to be exceeded are much greater than the size of the blast charge typically required and provided for context only.

If the Construction Contractor requires the flexibility, it is possible to identify different allowable MICs for the day and night-time periods for those works planned to be undertaken 24 hours a day. Furthermore, *Table 15.22* is a first estimate of possible maximum instantaneous charges to demonstrate that through appropriate design, blasting can achieve imposed limits. However, the above prediction method does not allow for the specific rock conditions at the Development Site and explosive packing by the Construction Contractor. BS 6472-2:2008 states *"In order to predict the likely vibration magnitude, a series of measurements at several locations should be taken from one or more trial blasts*". It also provides a method for determining likely site-specific vibration levels with a 90 % confidence limit at receptors using a scaled distance graph, based on measurements of trial blasts at that location.

Note that BS 5228-2:2009+A1:2014 provides the following guidance regarding air overpressure from blasting operations and the effects of screening and weather conditions:

- "*The attenuation effects due to the topography, either natural or manufactured, between the blast and the receiver are much greater on the audible component of the pressure wave, whereas the effects are relatively slight on the lower frequency concussive component. The energy transmitted in the audible part of the pressure wave is much smaller than that in the concussive part and therefore baffle mounds or other acoustic screening techniques do not significantly reduce the overall air overpressure intensity*."
- "*Meteorological conditions, over which an operator has no control, such as temperature, cloud cover, humidity, wind speed, turbulence and direction, all affect the intensity of air overpressure at any location and cannot be reliably predicted. These conditions vary in time and position and therefore the reduction in air overpressure values as the distance from the blast increases might be greater in some directions than others*."

As such it is very difficult to provide a quantitative prediction of absolute levels of air overpressure from blasting works. In lieu of this, it is preferential to carry out blasting operations using the BPM available to ensure that the resultant noise, vibration and air overpressure are minimised.

With appropriate design by suitably qualified blasting contractors, the worst-case magnitude of impacts due to blasting is predicted to be minor and the significance of effects is predicted to be localised, temporary and minor adverse for all high sensitivity NSRs, which is considered to be Not Significant.

15.7.1.6 Construction Traffic Noise

The potential changes in road traffic noise as a result of the Development have been considered for each road link in the Traffic and Transport Chapter defined study area. These links are shown in *Figure 15.3*.

Construction traffic data parameters have been provided by the applicant for the following parameters for each road link for the baseline and construction year (2023 and 2027 respectively):

- Annual Average Weekday Traffic (AAWT) between 06:00 – 00:00 (18hr):
- Percentage HGV; and
- Vehicle speed (kph).

The assessment has considered three different scenarios in order to contextualise predicted changes in road traffic noise levels as a result of Development construction activities, these are the 18hr weekday average in the:

A. Worst month – November 2027

B. High Intensity Period – (Oct 29 - Nov 31)

C. Average period (Jan 27 - Apr 34)

The CRTN or NAC method has been used to calculate the 'Basic Noise Level' (BNL), i.e., the traffic noise level at 10 m from the kerb, taking into account of the flow, percentage HGV and speed. The BNL is calculated for scenarios with and without the construction works and is used to determine a change in road traffic noise levels. The different methodologies predict different metrics; CRTN predictions are based on $L_{A10,18hr}$ results whereas the NAC predictions are based on $L_{Aeq,16hr}$ results. This difference is not important however, given that it is the change in traffic noise level that is relevant.

The results for each scenario A, B and C are presented in *Table 15.26*, *Table 15.27* and *Table 15.28* respectively. The magnitude of impact and significance of effect has been determined using *Table 15.8* and *Table 15.13* for high sensitivity NSRs. It is also important to note that the traffic flows quoted for each link are based on the assumption that all construction traffic will use all links at the same time as a conservative approach. The allows the sensitivity of each link to noise to be analysed, but in practice the number of construction related vehicles using a given link may be less.

Table 15.26 Predicted change in 18hr weekday average BNL for Scenario A - Worst Month

#	Link Name	Scenario A: Baseline				Scenario A: Baseline & Balliemeanoch Construction				Calc. Method	Change in BNL, dB	Magnitude of Impact & Significance of Effect
		AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)	AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)			
1	A85 Taynuilt	166	4974	3	52	656	5618	12	52	CRTN	2.6	MINOR
2	A85 West	160	4332	4	75	650	4976	13	75	CRTN	2.4	MINOR
3	A85 East	160	3790	4	70	650	4434	15	70	CRTN	2.7	MINOR
4	B840	7	358	2	38	7	358	2	38	NA	NA	NO CHANGE
5	A819 Dalmally	83	1630	5	80	573	2274	25	80	CRTN	4.9	MODERATE
6	Site Access North (Two-way)	0	0	0	0	490	644	76	32	NAC	59.1	MAJOR
7	Site Access North (Entry Only)	0	0	0	0	245	322	76	32	NAC	56.1	MAJOR
8	Site Access South (Exit Only)	0	0	0	0	245	322	76	32	NAC	56.1	MAJOR
9	A819 Site Access	85	1699	5	84	575	2343	25	84	CRTN	4.7	MODERATE
10	A819 Inveraray (N)	82	1703	5	89	572	2347	24	89	CRTN	4.6	MODERATE
11	A819 Inveraray (S)	81	1877	4	64	81	2031	4	64	CRTN	0.4	NEGLIGIBLE
12	Inveraray Bypass	0	0	0	0	490	490	100	32	NAC	59.0	MAJOR
13	A83 Aray Bridge	211	4183	5	54	701	4827	15	54	CRTN	2.7	MINOR
14	A83 Garron Bridge	197	4077	5	79	687	4721	15	79	CRTN	2.3	MINOR
15	A83 Rest and Be Thankful	296	4525	7	65	786	5169	15	65	CRTN	2.2	MINOR
16	A815 Strachur	119	2418	5	62	609	3062	20	62	CRTN	3.9	MODERATE
17	A83 Inveraray	210	4187	5	40	210	4341	5	40	CRTN	0.1	NEGLIGIBLE
18	A83 Pier	210	3477	6	74	700	4121	17	74	CRTN	2.6	MINOR
19	B840 Ford	4	186	2	41	4	186	2	41	NA	NA	NO CHANGE

Table 15.27 Predicted change in 18hr weekday average BNL for Scenario B - High Intensity Period

#	Link Name	Scenario B: Baseline				Scenario B: Baseline & Balliemeanoch Construction				Calc. Method	Change in BNL, dB	Magnitude of Impact & Significance of Effect
		AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)	AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)			
1	A85 Taynuilt	166	4974	3	52	594	5556	11	52	CRTN	2.3	MINOR
2	A85 West	160	4332	4	75	588	4914	12	75	CRTN	2.1	MINOR
3	A85 East	160	3790	4	70	588	4372	13	70	CRTN	2.4	MINOR
4	B840	7	358	2	38	7	358	2	38	NA	NA	NO CHANGE
5	A819 Dalmally	83	1630	5	80	511	2212	23	80	CRTN	4.5	MODERATE
6	Site Access North (Two-way)	0	0	0	0	428	582	74	32	NAC	58.6	MAJOR
7	Site Access North (Entry Only)	0	0	0	0	214	291	74	32	NAC	55.6	MAJOR
8	Site Access South (Exit Only)	0	0	0	0	214	291	74	32	NAC	55.6	MAJOR
9	A819 Site Access	85	1699	5	84	513	2281	22	84	CRTN	4.3	MODERATE
10	A819 Inveraray (N)	82	1703	5	89	510	2285	22	89	CRTN	4.2	MODERATE
11	A819 Inveraray (S)	81	1877	4	64	81	2031	4	64	CRTN	0.4	NEGLIGIBLE
12	Inveraray Bypass	0	0	0	0	428	428	100	32	NAC	58.4	MAJOR
13	A83 Aray Bridge	211	4183	5	54	639	4765	13	54	CRTN	2.4	MINOR
14	A83 Garron Bridge	197	4077	5	79	625	4659	13	79	CRTN	2.1	MINOR
15	A83 Rest and Be Thankful	296	4525	7	65	724	5107	14	65	CRTN	2.0	MINOR
16	A815 Strachur	119	2418	5	62	547	3000	18	62	CRTN	3.6	MODERATE
17	A83 Inveraray	210	4187	5	40	210	4341	5	40	CRTN	0.1	NEGLIGIBLE
18	A83 Pier	210	3477	6	74	638	4059	16	74	CRTN	2.4	MINOR
19	B840 Ford	4	186	2	41	4	186	2	41	NA	NA	NO CHANGE

Table 15.28 Predicted change in 18hr weekday average BNL for Scenario C - Average Period

#	Link Name	Scenario C: Baseline				Scenario C: Baseline & Balliemeanoch Construction				Calc. Method	Change in BNL, dB	Magnitude of Impact & Significance of Effect
		AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)	AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)			
1	A85 Taynuilt	166	4974	3	52	354	5556	6	52	CRTN	1.3	MINOR
2	A85 West	160	4332	4	75	348	4914	7	75	CRTN	1.3	MINOR
3	A85 East	160	3790	4	70	348	4372	8	70	CRTN	1.4	MINOR
4	B840	7	358	2	38	7	358	2	38	NA	NA	NO CHANGE
5	A819 Dalmally	83	1630	5	80	271	2212	12	80	CRTN	3.1	MODERATE
6	Site Access North (Two-way)	0	0	0	0	188	582	32	32	NAC	55.6	MAJOR
7	Site Access North (Entry Only)	0	0	0	0	94	291	32	32	NAC	52.6	MAJOR
8	Site Access South (Exit Only)	0	0	0	0	94	291	32	32	NAC	52.6	MAJOR
9	A819 Site Access	85	1699	5	84	273	2281	12	84	CRTN	2.9	MINOR
10	A819 Inveraray (N)	82	1703	5	89	270	2285	12	89	CRTN	2.9	MINOR
11	A819 Inveraray (S)	81	1877	4	64	81	2031	4	64	CRTN	0.4	NEGLIGIBLE
12	Inveraray Bypass	0	0	0	0	188	428	44	32	NAC	55.3	MAJOR
13	A83 Aray Bridge	211	4183	5	54	399	4765	8	54	CRTN	1.4	MINOR
14	A83 Garron Bridge	197	4077	5	79	385	4659	8	79	CRTN	1.2	MINOR
15	A83 Rest and Be Thankful	296	4525	7	65	484	5107	9	65	CRTN	1.1	MINOR
16	A815 Strachur	119	2418	5	62	307	3000	10	62	CRTN	2.3	MINOR
17	A83 Inveraray	210	4187	5	40	210	4341	5	40	CRTN	0.1	NEGLIGIBLE
18	A83 Pier	210	3477	6	74	398	4059	10	74	CRTN	1.4	MINOR
19	B840 Ford	4	186	2	41	4	186	2	41	NA	NA	NO CHANGE

With reference to the presented results:

- Link 6 and Link 7 represent the northern site access route utilised in different ways; as a two-way and one-way route to Site. There are no NSRs in the vicinity of the road, the closest is ~1.2 km and therefore the magnitude of impact and significance of effect is downgraded from major adverse for these links and is considered negligible at NSRs regardless of the period considered, which is considered Not Significant.
- The southern access route (one way) Link 8 is 45 m the closest and 200 m from the second closest NSR. The closest NSR is also a similar distance from the A819 (specifically Link 10) as it is at the junction of Link 8 and Link 10. Existing ambient levels at this location are represented by monitoring location L2 which was directly adjacent to the A819. The option to utilise Link 8 may not arise however, as it is dependent on it being established by the adjacent proposed Wind Farm development.
- In the worst month (Scenario A) and high intensity period (Scenario B) only, it can be seen that for Links 9, 10 and 16 are predicted to experience moderate effects at worst. Otherwise outside these periods, which is the majority of the time, they are predicted to experience minor adverse effects at worst.
- In all scenarios moderate effects are predicted at receptors in proximity to Link 5, however it should be noted that for average activity period (Scenario C) the relative change only just exceeds the boundary between minor and moderate magnitude of impact.
- Link 12 is the Inveraray Bypass Access Track through Inveraray Castle grounds, this track allows construction traffic to avoid passing through the town in order minimise adverse effects. However some dwellings, that are not close to other Links, may experience a change based on the predicted levels at 10 m from carriageway edge of 59 dB, 58 dB and 55 dB LAeq,16hr in Scenario A, B and C respectively when compared to ambient levels observed in that area at S3 of 50 dB LAeq,16hr, see *Table 15.18*. Therefore additional conservative calculations have been performed to predict the level at the potentially affected receptors using a continuous line source propagation assumption and the closest approach to Link 12.

Table 15.29 Predicted Road Traffic Noise Levels at Receptors near Link 12 (Inveraray Bypass)

NSR	Distance to Link 12 (m)	Reduction due to distance (based on line source) (dB)	Scenario A $L_{Aeq,16hr}$ dB	Scenario B $L_{Aeq,16hr}$ dB	Scenario C $L_{Aeq,16hr}$ dB
Reference	13.5	0	59.0	58.4	55.3
NSR220	45	-5	53.8	53.2	50.1
NSR209	130	-10	49.2	48.6	45.5
NSR207	178	-11	47.8	47.2	44.1
NSR210	182	-11	47.7	47.1	44.0
NSR211	184	-11	47.7	47.1	44.0
NSR221	187	-11	47.6	47.0	43.9

- At 130 m and beyond it can be seen that all NSRs are predicted to experience construction traffic noise levels from Link 12 that are comparable to or lower than the existing ambient sound levels. When summing the ambient sound level of 50 dB $L_{Aeq,16hr}$ to the highest predicted level of 49.2 dB $L_{Aeq,16hr}$ at NSR209, this would result in less than a 3 dB increase due to road traffic noise and would be classified as minor in accordance with *Table 15.8* and *Table 15.13*, and Not Significant. The exception is NSR220 (45 m from the link) is 3 dB above the measured ambient level of 50 dB $L_{Aeq,16hr}$ for Scenario A and B and equal to the ambient level of 50 dB $L_{Aeq,16hr}$ for Scenario C. On this basis effects at receptors in proximity to Link 12 are potentially Significant.
- No change is predicted on the B840 (Link 4 & 19), as the access to the site has been designed such that HGV movements to/from site will not utilise the B840 and instead use either the northern and possibly southern Access Tracks.
- On Links 1-4, Link 11, Link 13-15 and Links 17-19 the significant of effect is minor adverse, negligible or no change (Not Significant) regardless of the scenario considered.

Finally, it is important to remember that the assumptions under which the significance of effect for each scenario have been predicted in the above tables are on the basis all construction vehicles will utilise every road link simultaneously in the transportation of materials to/from site. This is a conservative approach but does allow the sensitivity of each link to be compared. In practice the magnitude of impacts will be less or at least no worse than those presented.

Mitigation measures to reduce construction road traffic noise, particularly where effects of moderate adverse or greater are predicted, are presented in the *Section 15.8 Mitigation and Monitoring*.

15.7.2 Operational Phase

Depending on the proximity of noise sensitive receptors to above ground operational infrastructure and the intrinsic sound power level of the operational activities, there is potential for adverse impacts during the operation of the Development.

The sound power levels of the turbines, generators, emergency generators and associated equipment in the powerhouse cavern are not yet known. Modern gas insulated switchgear equipment emits very low noise levels during operation. At this stage, no detailed information is available regarding the sound power level or acoustic character of sound from the proposed transformers; however, these commonly produce a strong tonality at levels of 50 and / or 100 Hz due to the frequency of mains electricity. However, given the depth of the cavern and the distance to the nearest NSRs in approximately 2.5 km, it is highly unlikely that there will be any perceivable operational noise or vibration from the below ground equipment at the surface level.

At this distance, the level at which minor adverse impacts might occur (0.1 mm/s) for night-time groundborne vibration and 35 dB L_{ASmax} for groundborne noise (see *Table 15.10* and *Table 15.12* respectively) are highly unlikely to be exceeded. As such, operational noise and vibration affecting NSRs at the surface is not considered further for the powerhouse cavern activities.

However, the following ancillary equipment and operations have been considered as potential source of operational sound on the surface:

- Upper Reservoir – Switching Station (nearest NSR > 2 km)
- Upper Reservoir – Ventilation Shafts (nearest NSR to a ventilation shaft is ~1.4 km)

Note there are no operational sound sources attributed to the Lower Reservoir area.

The equipment at the Upper Reservoir would be designed to not exceed more than 70 dBA at 5 m.

Operational sound modelling has been undertaken using the same 3D noise model used for the construction assessment which included, global soft-ground assumption and flat ground assumpotion but instead using ISO 9613-2 as the method of sound propagation prediction. The operational sound sources have been represented by hemispherical point sources for the "Switchgear Building and Switchyard" and each ventilation shaft as indicated on *Figure 1.4*. Each source has been assigned a sound power level of 92 dB L_{WA} (based on meeting 70 dBA at 5 m meters). The free-field specific sound level at NSRs has been calculated based on continuous operation, day and night, at 1.5 m and 4 m height respectively, as presented in *Table 15.30*.

Table 15.30 Predicted Operational Sound Levels

Receptor	Predicted operational specific sound Level and $L_{Aeq,15min}$, dB	
	Day $L_{Aeq,1h}$, dB	Night $L_{Aeq,15min}$, dB
NSR059	<15 dBA	<15 dBA
NSR090		
NSR373		
NSR375		
NSR376		
NSR377		
NSR378		

15.7.2.1 BS4142:2014 Assessment

The predicted free-field operational *specific sound levels* at the NSRs around the Development are presented in Table *15.30*. Assuming continual 24-hr operation, the predicted sound levels could apply to 1-hour daytime or 15-minute night-time BS 4142 assessment periods.

The daytime and night-time BS 4142 assessments are presented in *Table 15.31*. In addition, the magnitude of impact and effect classification has been included based upon the BS4142 assessment outcomes, with reference to the semantic scales in *Table 15.6*, *Table 15.11* and *Table 15.13*. As the predicted *specific sound levels* are below 15 dBA at the closest NSRs, the assessments have been grouped based on the *background sound level* used in the assessment. This results in two NSR groups, corresponding to monitoring locations L4 and S4. However as there is no night-time measured background sound level at S4 due to the presence of a flowing water in the area, making daytime levels unlikely to be different to night-time, the night-time level at L4 is used as a conservative approach at NSR373 and NSR375. This may also better represent dryer months.

Table 15.31 BS 4142 Assessment

Receptor	NSR059, NSR090, NSR376, NSR377 and NSR378		NSR373 and NSR375	
TIME PERIOD	DAYTIME	NIGHT-TIME	DAYTIME	NIGHT-TIME
Specific sound level Ls ($L_{Aeq,Tr}$), dB	15	15	15	15
Acoustic feature correction, dB	+0	+0	+0	+0

Rating level ($L_{Ar,Tr}$), dB	15	15	15	15
Representative *background sound level* ($L_{A90,T}$), dB	42 (L4)	39 (L4)	55 (S4)	39 (L4)
Excess of *rating level* over *background sound level* ($L_{Ar,Tr} – L_{A90,T}$), dB	-27	-24	-40	-24
BS 4142:2014 assessment outcome	Low impact, depending on context	Low impact, depending on context	Low impact, depending on context	Low impact, depending on context
Magnitude of impact (from **Error! Reference source not found.**11)	Very low	Very low	Very low	Very low
Receptor Sensitivity (from **Error! Reference source not found.**6)	High	High	High	High
Classification of effect (from **Error! Reference source not found.**13)	Negligible	Negligible	Negligible	Negligible

For all NSRs, the BS 4142 *rating level* is well below the *background sound level*. Predicted effects are therefore categorised as negligible (Not Significant) without the need for additional specifically designed sound mitigation to be in place.

15.8 Mitigation and Monitoring

15.8.1 Embedded Mitigation

15.8.1.1 Construction Phase

During the construction phase a commitment has been made by the Applicant to not utilise the B840 for the purpose of delivering materials to/from the Site, resulting in no change of traffic noise impact at NSRs close to the B840 in relation to the movement of Development construction vehicle on local roads.

To achieve Best Practical Means (BPM) as required by the Control of Pollution Act 1974 during the construction phase, good practice measures have been embedded into the project. These measures are particularly important during construction works being undertaken in the vicinity of the Lower Reservoir, temporary jetty and during the upgrade of existing tracks or establishment of new Access Track passing in the vicinity of NSRs, namely Upper Avenue Access Track, the Inveraray Castle Access Track and the Temporary B840 Realignment. The good practice embedded measures include:

Construction Works

- Establishing and maintaining good community relations throughout the construction process to keep residents and stakeholders informed on progress and the measures put in place to minimise noise impacts;
  - One stakeholder has highlighted the potential for the diesel impact piling at the temporary jetty to affect their underwater measurements on “trial days” where noise sensitive equipment is being tested within Loch Fyne. The trial days are understood to be up to 12 days per year and would be undertaken in blocks of 2 to 4 days at a time from 2025 onwards. diesel impact piling will therefore cease on these days, to avoid any adverse impacts.
- Adherence to standard construction working hours, i.e. 0700 hours – 1900 hours weekdays and 0800 hours – 1300 hours Saturdays, with no working on Sundays or Bank Holidays (including site deliveries) unless agreed in advance with the local planning authority.
- Selection of quiet and low vibration equipment and methodologies in accordance with the principles of BPM;
- Locating of fixed and semi-fixed ancillary plant such as generators, compressors and pumps away from NSR locations wherever possible;
- Provision of electrical power to the appointed Contractor for the construction phase which minimises the requirement for diesel generators at the Site;

- Regular maintenance of all plant used on site, paying attention to the integrity of silencers and acoustic enclosures;
- Fitting of compressors with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers;
- Shutting down of all noise generating construction plant when not in use.
- Loading and unloading of materials away from residential properties, ideally in locations which are acoustically screened from nearby NSRs;
- Handling of materials with care and placement rather than dropping where possible. Drop heights of materials from lorries and other plant shall be kept to a minimum;
- Selection of modern plant shall which complies with the latest European Commission noise emission requirements. Electrical plant items (as opposed to diesel powered plant items) shall be used wherever practicable. All major compressors shall be low noise models fitted with properly lined and sealed acoustic covers. All ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Organisation of site operations and vehicle routes to minimise the need for reversing movements, and to take advantage of any natural acoustic screening present in the surrounding topography;
- No employees, subcontractors and persons employed on the Site will cause unnecessary noise from their activities, e.g., excessive 'revving' of vehicle engines, music from radios, shouting and general behaviour etc. All staff inductions at the Site shall include information on minimising noise and reminding them to be considerate of the nearby residents; and
- As far as practicable, planning of noisier activities to take place during periods of the day which are generally considered to be less noise sensitive, i.e., not particularly early or late in the day.

Blasting Air Overpressure and Vibration

- Reduction of the air overpressure and vibration effects of blasting through good blast design, although this may come at the expense of higher drilling and detonator costs. Smaller, more frequent blasts lead to smaller but more frequent effects, and the balance between these factors will need to be discussed with ABC.
- Agreement of the methods employed to control air overpressure and vibration from blasting operations agreed with ABC prior to any blasting, as well as the frequency of blasting and a 90% confidence limit for blast PPV values at NSRs. The PPV blasting vibration limit should follow the guidance provided within BS 6472-2:2008 of between 6.0 and 10.0 mm/s during the daytime and 2.0 mm/s at night.
- Avoidance of ground blasting in the early morning, late afternoon or evening. The local community will be given advance notice prior to any blasting.
- An air overpressure limit at NSRs should follow the guidance provided within BS 6472-2:2008 (120 – 150 dB(lin)) and be agreed with ABC.
- Implementation of a blast monitoring scheme for air overpressure and vibration. Any scheme should include details on the location of monitoring points and vibration sensitive properties, and the equipment to be used. This should include a series of representative initial trial blasts at the start of the blasting to accurately identify allowable MICs to prevent exceedance of the identified limits at nearby receptors.
- Monitoring of all blasts at the Development Site and maintenance of records so that the historical peak particle velocity from blasts can be produced as required.
- Maintenance of a close working relationship between the construction / blasting operator and the local planning authority to facilitate the exchange of information regarding blasting events.
- Carrying out of all blasting using BPM where available, to ensure that the resultant noise, vibration and air overpressure are minimised in accordance with current British Standards and guidelines.
- Development of blast designs with the aid of regression lines determined from a logarithmic plot of Peak Particle Velocity against scaled distances. The regression lines should be regularly updated using the blasting monitoring information. The regression lines should be made available for inspection upon request.
- Control of fly rock requirements through Health and Safety legislation.

Appropriate noise and vibration mitigation measures will be incorporated into the template Construction Environmental Management Plan (CEMP) *(Appendix 3.1 (Volume 5: Appendices*), which will form the basis of the Contractor CEMP. The Contractor CEMP will be implemented by the E&C contractor, who is yet to be appointed.

15.8.1.2 Operational Phase

The operational embedded measures are as follows:

- Employment of the principles of best practice to minimise noise and vibration from the Development.
- Confirmation of control measures to prevent underground plant noise from exceeding appropriate operational sound limits during detailed design. These control techniques may include measures such as orientation away from NSRs, vent attenuators, acoustic lining within the vent shaft, and acoustic louvres at intake and extract terminals.
- Designing of external surface plant and buildings at the Upper Reservoir to limit sound emissions to 70dBA at 5 m as previously discussed in the operational assessment.
- Designing out of audible low frequency noise from the Development at NSRs, by design. If required, mitigation for tonal noise and groundborne noise and vibration could include vibration isolation, mufflers, attenuators, etc. and will be considered during the detailed design stage.

15.8.2 Additional Mitigation, Compensation and Enhancement

15.8.2.1 Construction Phase

Construction Noise – Surface Plant Noise

Without including noise reduction provided by embedded mitigation the potential exceedance of the 65 dB $L_{Aeq,12hr}$ threshold value from construction site noise at:

- NSR090 is no worse than 8 dB for a short duration during Access Track works.
- NSR220 is no worse than 11 dB for a short duration during Access Track works.
- NSR278 is no worse than 20 dB for a short duration during Access Track works.
- NSR376 is no worse than 3 dB during the construction of the northern most Construction Compound at the Lower Reservoir.
- NSR378 is no worse than 7 dB without including the noise reduction provided by embedded mitigation. It is affected initially by Temporary B840 Realignment works and then by surface plant noise from the Tailpond compound area.

Furthermore, predicted levels are conservative and will likely be lower in practice and the previously listed embedded mitigation will further help to reduce noise levels and minimise annoyance. Nevertheless, BS5228-1 Table B.1 provides a list of specific construction noise sources, and typical noise mitigation measures that can achieve between 5 dB to 10 dB and higher in addition to the embedded mitigation, which will be applied as appropriate to reduce levels at these NSRs to within the threshold value.

Construction Noise - Piling at Temporary Jetty

Activity P2-A1-T3 (temporary jetty construction) has been shown to have the potential to cause an exceedance of the 65 dB $L_{Aeq,12hr}$ threshold value by up to 10 dB at NSR440 and no more than 3 dB at NSR041. This activity is dominated by the Diesel Hammer Piling which has been as the most conservative assumption. With reference to BS 5228-1 it has been noted that 10 dB reduction could be achieved by selecting a quieter diesel hammer piling rig. Noise level reducing mitigation measures specific to a piling rig can also be utilised providing up to 5 to 10 dB of attenuation. These measures are outlined in BS 5228-1 Table B.1 i.e. enclosure of hammer head with acoustic screen, use a resilient pad between pile and hammer head, use of sound reduction equipment, exhausts or screens on power units and base machine where possible. Finally, the assessment has assumed that piling rig would be operational 60% of the work period on each day (Mon-Sat) for almost 12 months, this is a conservative assumption and would be less in practice.

Using one or a combination of these measures it is feasible that the activity P2-A1-T3 (temporary jetty construction) would be compliant with 65 dB $L_{Aeq,12hr}$ threshold value at NSR440 and NSR041 on the basis that following the appointment of a construction contractor a specific mitigation plan for P2-A-T3 would be implemented as part of the CEMP.

Construction Vibration - Piling at Temporary Jetty

Section 15.6 identified that the magnitude of impact associated with unmitigated impact piling at the temporary jetty is predicted to up to Moderate adverse with reference to *Table 15.9* and therefore the significance of effects is considered as a localised, temporary, moderate adverse effect for this high sensitivity NSR, which is considered Significant.

The predicted vibration levels are at the lower end of the Moderate PPV range 1.0 to < 10 mm/s and as noted in *Table 15.9* whilst such levels are likely to cause complaint they "can be tolerated if prior warning and explanation has been given to residents".

Therefore specific mitigation is included in the form of a suitable plan of communication between the contractor and the resident at NSR440.

Construction Blasting – Air Overpressure and Vibration

The assessment has identified that:

- the indicative first estimates of the allowable MIC values in the daytime to avoid significant effects during blasting at the nearest NSR; and
- the prediction method does not allow for the influence of specific rock conditions at the Development Site and explosive packing by the Construction Contractor on the vibration levels observed at receptors.

However, BS 6472-2:2008 states "In order to predict the likely vibration magnitude, a series of measurements at several locations should be taken from one or more trial blasts". It also provides a method for determining likely site-specific vibration levels with a 90 % confidence limit at receptors using a scaled distance graph, based on measurements of trial blasts at that location.

The final design of the blasting requirements will be undertaken by specialist blasting contractor to avoid vibration and air overpressure impacts that are greater than minor adverse at NSRs.

Construction Traffic Noise

NSRs in the vicinity of Link 8 southern site Access Track (NSR127, NSR366, NSR398) are predicted to potentially experience major adverse effects due to the introduction of a new road traffic noise source ~200 m at its closest point. Therefore, as the northern access has no receptors in the immediate vicinity, specific mitigation in the form of utilising the northern access (Link 6) for two-way access to the Site is proposed to avoid the use of the southern site Access Track wherever possible and therefore avoid significant construction road traffic noise impacts at these NSRs.

NSRs in the vicinity of Links 5, 9, 10 and 16 are predicted to potentially experience moderate adverse effects at worst on the basis that all links carry all construction traffic at the same time. In practice the moderate adverse impacts can be reduced to Minor, by applying specific mitigation in the form of splitting construction traffic over the north and south routes to the site entrance. This would provide a reduction of the with construction traffic noise levels on each link which would reduce the effect to minor adverse at worst.

NSRs in the vicinity of Link 12 have been determined to be far enough away from the link to experience minor adverse effects at worst, with the exception of NSR220 which is located approximately 45 m from Link 12. The 16 hour road traffic noise level from construction traffic movements was predicted at the receptor in *Table 15.29* and was shown to be just less than 4 dB over the measured ambient in the area of 50 dB $L_{Aeq,16hr.}$ Therefore a potentially effective mitigation measure would be a road side acoustic barrier with height and length determined to provide at least 5 dB attenuation at NSR220 from passing construction vehicles. With the barrier installed the increase in ambient level at the NSR would be reduced to less than 3 dB which would be classified as minor adverse effect and Not Significant. Other measures to reduce effects road traffic noise would also be valid, i.e. diverting the route. According to BS 5228-1 Table B.1 upto 10 dB can be observed generally from an acoustic screen. The location and parameters of a suitable barrier would be included in the final Contractor CEMP by the E&C contractor.

15.8.2.2 Operational Phase

No adverse effects are predicted during the operational phase and therefore no additional mitigation has been required.

15.9 Residual Effects

A summary table is presented below for construction and operational phases that indicates whether the residual effects, after the implementation of all mitigation, are significant or not significant or a given receptor or group of receptors.

Table 15.32 Summary of Effects: Construction

Receptor	Description of Effect	Effect with Embedded Mit.	Additional Mitigation	Residual Effects	Significance
NSR376/ NSR378	Surface Plant Noise	Minor/Moderate	Specific construction site activity mitigation measures to achieve the 65 dB $L_{Aeq,12hr}$ threshold, see BS 5228-1 Table B.1	Minor	Not Significant
NSR216, NSR424	Access Track Upgrade/ Construction	Minor	None	Minor at worst	Not Significant
NSR090 NSR220	Access Track Upgrade/ Construction	Moderate	Specific construction site activity mitigation measures to achieve the 65 dB $L_{Aeq,12hr}$ threshold, see BS 5228-1 Table B.1	Minor at worst	Not Significant
NSR278	Access Track Upgrade/ Construction	Moderate/Major	Specific construction site activity mitigation measures to achieve the 65 dB $L_{Aeq,12hr}$ threshold, see BS 5228-1 Table B.1	Moderate at worst for short temporary period, but Minor at worst for the majority of the time.	Not Significant
NSR041 and NSR440	Temporary Jetty Impact Piling Noise	Moderate to Major	Specific construction site activity mitigation measures to achieve the 65 dB $L_{Aeq,12hr}$ threshold, see BS 5228-1 Table B.1	Negligible to Minor	Not Significant
All NSRs	Surface Plant Vib.	Negligible	None	Negligible	Not Significant
NSR440	Temporary Jetty Impact Piling Vibration	Moderate	Communication – prior warning and explanation as per BS5228-2, see *Table 15.9*	Minor	Not Significant
All NSRs	Cofferdam Piling	Minor	None	Minor	Not Significant
All NSRs	Blasting	Minor/Moderate	Design of the blasting requirements undertaken by specialist blasting contractor.	Minor	Not Significant
NSRs near Links 1-3, 11, 13-15,17,18	Road Traffic Noise	Negligible to Minor	None	Negligible to Minor	Not Significant
NSRs near Link 4 & 19 (B840)	Road Traffic Noise	No Change	None	No Change	Not Significant
NSRs near Link 5, 9, 10 and 16	Road Traffic Noise on northern and southern routes to site	Moderate	Divide traffic over north and south routes to site.	Minor	Not Significant

Receptor	Description of Effect	Effect with Embedded Mit.	Additional Mitigation	Residual Effects	Significance
Link 6 and 7	Haul road traffic noise at northern track "two way" and "entry" respectively	Negligible (due to large distance to nearest receptor)	None	Negligible	Not Significant
NSRs near Link 8	Haul road traffic noise using southern track "exit" only	Major	Use the northern track two-way (Link 6) primarily.	Negligible to Minor	Not Significant
NSRs near Link 12 (except NSR220)	Haul road traffic noise on Link 12	Minor (reduced from Major based on NSR level comparison to ambient level)	None	Minor	Not Significant
NSR220	Haul road traffic noise on Link 12	Major	Roadside acoustic screen, location, height and length to be determined as part of CEMP preparation to provide minimum of 5 dB attenuation at 45 m.	Minor	Not Significant

Table 15.33 Summary of Effects: Operation

Receptor	Description of Effect	Effect	Additional Mitigation	Residual Effects	Significance
All NSRs	Turbine hall Groundborne Noise and Vibration	Negligible	None	Negligible	Not Significant
All NSRs	Surface plant airborne noise at Upper Reservoir	Negligible	None	Negligible	Not Significant
All NSRs	Operational road traffic noise	Negligible	None	Negligible	Not Significant

15.10 Cumulative Effects

The assessment of likely cumulative effects set out below is based on the cumulative schemes identified in Chapter 4: Approach to EIA. Cumulative schemes identified are those that are reasonably foreseeable - i.e. in the public domain e.g. at scoping stage, or have been consented but not yet under construction / constructed at the point of writing the assessment / at submission.

15.10.1 Inter-Cumulative Effects

The inter-cumulative effects have been considered for both the construction and operational phases in combination with other schemes.

15.10.1.1 Construction

The inter-cumulative effects with noise and vibration have been considered at NSRs following a high-level review of other developments. On the basis that the intervening distance to construction works is long (>2 km) and duration is short, the contribution of noise and vibration from on-site works at all other developments is considered to have a negligible effect on predicted construction noise and vibration levels at NSRs in the vicinity of the Development.

However, other developments in the wider area will potentially utilise the same public roads during construction as the Development. Therefore a cumulative assessment of construction traffic on local roads has been carried out in relation to the following developments:

- Cruachan Expansion Hydro

- Blarghour Wind Farm
- Upper Sonachan Wind Farm
- Ladyfield Wind Farm

The worst-case period (Scenario A – Worst Month, see *Section 15.6.0.5*) has been considered in the following cumulative assessment as a conservative assumption of the combined effect:

- The traffic flows on all road links (see *Figure 15.3*) including the contribution from the Development;
- The traffic flows on all road links (see *Figure 15.3*) including the contribution from the Development and the contribution from the other key developments identified.

Table 15.34 Predicted change in 18hr weekday average BNL for Scenario A - Worst Month (Nov 2027)

#	Link Name	Scenario A: Baseline				Scenario A: Baseline & Balliemeanoch Construction				Calc. Method	Change in BNL, dB	Magnitude of Impact & Significance of Effect
		AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)	AAWT	% HGV	SPEED (km/h)	Predicted Level (dBA)			
1	A85 Taynuilt	656	5618	12	52	1299	6409	20	52	CRTN	2.0	MINOR
2	A85 West	650	4976	13	75	1393	5911	24	75	CRTN	2.1	MINOR
3	A85 East	650	4434	15	70	1293	5225	25	70	CRTN	2.0	MINOR
4	B840	7	358	2	38	7	358	2	38	NO CHANGE		
5	A819 Dalmally	573	2274	25	80	1128	2957	38	80	CRTN	2.6	MINOR
6	Site Access North (Two-way)	490	644	76	32	490	644	76	32	NO CHANGE		
7	Site Access North (Entry Only)	245	322	76	32	245	322	76	32	NO CHANGE		
8	Site Access South (Exit Only)	245	322	76	32	245	322	76	32	NO CHANGE		
9	A819 Site Access	575	2343	25	84	1130	3026	37	84	CRTN	2.5	MINOR
10	A819 Inveraray (N)	572	2347	24	89	1127	3030	37	89	CRTN	2.5	MINOR
11	A819 Inveraray (S)	81	2031	4	64	636	2714	23	64	CRTN	4.9	MODERATE
12	Inveraray Bypass	490	490	100	32	490	490	100	32	NO CHANGE		
13	A83 Aray Bridge	701	4827	15	54	755	4881	15	54	CRTN	0.2	NEGLIGIBLE
14	A83 Garron Bridge	687	4721	15	79	741	4775	16	79	CRTN	0.2	NEGLIGIBLE
15	A83 Rest and Be Thankful	786	5169	15	65	840	5223	16	65	CRTN	0.2	NEGLIGIBLE
16	A815 Strachur	609	3062	20	62	609	3062	20	62	NO CHANGE		
17	A83 Inveraray	210	4341	5	40	531	4790	11	40	CRTN	2.1	MINOR
18	A83 Pier	700	4121	17	74	1021	4570	22	74	CRTN	1.1	MINOR
19	B840 Ford	4	186	2	41	4	186	2	41	NO CHANGE		

It can be observed that the combined effects at road links are no worse than minor adverse (Not Significant) with the exception of Link 11 which is moderate adverse (Significant). However, it should be noted that without the contribution of other developments the Development has Negligible effect on the Magnitude of Impact outcome at Link 11; in other words the effect of construction traffic noise associated with the other developments is moderate adverse without the contribution of Development. Therefore, the overall effect of the Development on the cumulative effect of construction road traffic on all considered road links is Negligible (Not Significant).

15.10.1.2 Operational

The predicted operational noise levels from the Development are much lower than the prevailing *background sound level* and *residual sound levels* at the NSRs. Therefore, the contribution of the Development to that of any other development in the area would be negligible and not significant and inter cumulative operational effects have been considered in no further detail.

15.10.2 Intra-Cumulative Effects

The intra-relationship effects of noise and vibration with other potential environmental effects have been considered at NSRs. Generally, the effects from the following sources have the potential to lead to significant effects when considered in combination:

- Noise and Vibration
- Visual Impact
- Dust
- Construction Traffic on Public Roads

The intra-cumulative effects are most likely to lead to significant effects when the receptor is in close proximity to the source of noise and vibration and the levels experienced are already leading to Minor or worse effects. However, it is difficult to quantify the intra-cumulative effects of noise and vibration with other potential effects. Nevertheless, given that only negligible effects of noise and vibration have been identified for the operational phase of the Development, any significant intra-cumulative effects that could occur would only be short term and temporary, during construction.

Vibration is unlikely to contribute significantly to any intra-cumulative effects at receptors considered in the chapter, due to the nature and distance of the groundborne vibration induced activities i.e. piling and blasting from the receptors.

15.11 References

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