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Glen Earrach Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 2: Main Report
Chapter 14: Noise & Vibration

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Quality information

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Issue History

Issue	Issue date	Details	Authorized	Name	Position
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14 Noise & Vibration

14.1 Introduction

14.1.1 This chapter presents the assessment of potential noise and vibration effects during the Pre-Construction and Enabling, Construction and Operational Phases of the Proposed Development. Assessment of the decommissioning phase has been scoped out on the basis that noise and vibration impacts during decommissioning would be no greater than those during the Construction Phase. Given the approximated operational lifetime of Pumped Storage Hydro (PSH) is in the region of 125 years, a decision would be made in the future whether to refurbish the PSH or to decommission the Proposed Development. The refurbishment plan or if the latter, a detailed decommissioning plan, would be prepared as required as this may be subject to a separate planning application at the time. 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.

14.1.2 The Scoping Report identified that effects may result during the Pre-Construction and Enabling, Construction, Operational Phases of the Proposed Development, from the following potential impacts:

- Noise and vibration impacts from activities within the Proposed Development Site during the Pre-Construction and Enabling and Construction Phases, which could affect existing nearby noise sensitive receptors (NSRs);
- Pre-Construction and Enabling works and Construction Phase noise impacts from changes in road traffic noise levels at NSRs in proximity to public highways used by Construction traffic;
- Operational airborne sound impacts at NSRs, from openings to underground plant or from surface plant, if required; and
- Operational groundborne noise and vibration impacts at nearby NSRs from underground plant.

14.1.3 This chapter is supported by the following **Figures (Volume 3)** and **Appendices (Volume 5)**:

- **Figure 14.1: Sensitive receptors considered as part of Noise and Vibration impact Assessment;**
- **Figure 14.2: Long and Short Term Sound Monitoring Locations;**
- **Figure 14.3: Road Traffic Noise Study Links;**
- **Appendix 14.1: Acoustic Terminology;**
- **Appendix 14.2: Baseline Sound Monitoring Details;** and
- **Appendix 14.3: Acoustic Model Input Data.**

14.1.4 **Appendix 14.1: Acoustic Terminology** provides information on acoustic terms and concepts used throughout this chapter.

14.1.5 Potential airborne noise impacts on ecological receptors are considered within **Chapter 7: Terrestrial Ecology and Chapter 8: Ornithology (Volume 2: Main Report)**. Potential underwater noise and vibration impacts on ecological receptors are considered within **Chapter 9: Aquatic and Marine Ecology (Volume 2: Main Report)**.

14.1.6 As described within **Chapter 2 Project and Site Description** and summarised within **Chapter 3 Evolution of Design and Alternatives (Volume 2: Main Report)**, the Proposed Development presents two options, Option A and Option B. The differences between these options involve the location of the below ground works and the associated positioning of the Upper Control Works within the Headpond footprint. This assessment has considered both Options A and B; regardless of which option is taken forward, the conclusions of the Noise and Vibration assessment remain the same for both.

14.2 Legislation and Policy

Legislation

14.2.1 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.

14.2.2 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.

14.2.3 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.

14.2.4 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.

National Planning Policy

14.2.5 National Planning Framework 4 (NPF4) was formally adopted by Scottish Ministers on 13 February 2023. NPF4 sets out Scotland's long-term spatial strategy and provides a framework for addressing national planning priorities, including sustainability, health, and environmental protection.

14.2.6 NPF4 Policy 11 (e) requires energy developments to demonstrate how impacts on communities and individual dwellings, including noise are addressed. Policy 23: Health and Safety, NPF4 requires new developments to consider noise and vibration on sensitive receptors as part of the planning process. Developers are expected to undertake noise impact assessments and implement appropriate mitigation measures where necessary to minimise adverse effects on surrounding communities.

14.2.7 The integration of NPF4 into the planning system means that decisions are aligned with national objectives, balancing economic, social, and environmental factors. Local planning authorities are required to reflect the principles of NPF4 when assessing development proposals.

14.2.8 Planning Advice Note (PAN) 1/2011 'Planning and Noise' is the current advice note dealing with noise in the Scottish planning system. For technical information regarding noise assessments, this document refers to the accompanying Technical Advice Note (TAN) 1/2011. TAN 1/2011 includes a methodology which could be used in the assessment of Operational noise impacts; however, most Scottish Local Authorities request an Operational noise assessment to be undertaken using BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound.

Local Planning Policy

14.2.9 The adopted Highland-wide Local Development Plan (HwLDP) Policy 67 '*Renewable Energy Developments'* states:

14.2.10 "the Council will support proposals where it is satisfied that they are located, sited and designed such that they will not be significantly detrimental overall, either individually or cumulatively with other developments, having regard in particular to any significant effects on the following: The safety and amenity of any regularly occupied buildings and the grounds that they occupy- having regard to visual intrusion or the likely effect of noise generation".

14.2.11 Policy 72 'Pollution' of the HwLDP states that:

14.2.12 "Proposals that may result in significant pollution such as noise (including aircraft noise), air, water and light will only be approved where a detailed assessment report on the levels, character and transmission and receiving

environment of the potential pollution is provided by the applicant to show how the pollution can be appropriately avoided and if necessary mitigated."

14.3 Consultation

14.3.1 The following table provides an overview of consultation comments received relevant to the noise and vibration chapter. The key issues and actions taken to address these points have been set out within the table. The sub paragraphs below provide some further details.

Table 14-1 Summary of Consultation

Consultee	Key Issue	Summary of Response
The Highland Council (Environmental Health)	The response outlined that planning conditions are not normally used to control construction noise however, given the size and duration of the construction for the Proposed Development, incorporating noise limits (detailed at 14.3.1) may be advisable. The following will also be required/recommended: • A detailed construction environmental management plan (CEMP) to include details of the proposals for noise and vibration mitigation and monitoring and the route of communication of any complaints. • A liaison group be established between the developer/contractor and the local community. Pre-construction survey of any properties where vibration might be perceptible was suggested. It was noted that this suggestion was made based on previous experience of the public's reaction to large construction projects, and that structural damage is not something that Environmental Health can investigate.	THC noise and vibration limits have been accepted and are embedded mitigation as detailed in **Section 14.7 Embedded Mitigation**. The preparation of a CEMP is also identified as embedded mitigation. An outline CEMP can be found within **Appendix 3.1: Outline Construction Environmental Management Plan (Volume 5: Appendices).** The benefits of liaison with the community are recognised, and the establishment of a community liaison group has been identified as mitigation in **Chapter 16: Socio-Economics, Recreation and Tourism.**
The Highland Council (Environmental Health)	In correspondence with the Environmental Health Officer, subsequent to the scoping stage, it was identified that airborne operational noise could be scoped out due to the distance and nature of the only above ground operational noise being more than 2 km away from the nearest receptor. This was on the basis that an indicative predicted airborne broadband A-weighted and 100 Hz linear sound levels be provided. Monitoring locations were also discussed and agreed, prior to the surveys being completed.	Despite this, the airborne Operational noise assessment has still been considered in alignment with scoping opinion report and BS4142 methodology along with 100 Hz linear sound levels that have been calculated. The predicted worst-case broadband noise level at the nearest NSR is -4 (minus four) dB $L_{Aeq,T}$ (i.e. 4 dB below threshold of human hearing 0 dB). Furthermore, using a typical transformer spectrum (with prominent peaks at (100 Hz, 200 Hz and 400 Hz) to meet 80 $L_{Aeq,1hr}$ dB at 1 metre, the predicted unweighted level at 100 Hz is 9 dB. This is 21 dB below 30 dB limit set out by the Environmental Health Officer below in **Section 14.3.2 - 14.3.4 The Highland Council.**

The Highland Council

14.3.2 The following construction noise and vibration limits were recommended by the Environmental Health Officer (EHO) at The Highland Council (THC):

Construction Noise

- *Monday to Friday; 8am to 6pm 55 dB $L_{Aeq\ 1\ hour}$*
- *Saturdays; 8am to 1pm 55 dB $L_{Aeq\ 1\ hour}$*
- *Saturdays; 1pm to 6pm 45 dB $L_{Aeq\ 1\ hour}$*
- *Out-with the above times, noise from construction related activities shall not exceed 35dB $L_{Aeq\ 1\ hour}$*

Construction Vibration

- *Monday to Friday; 8am to 6pm The peak particle velocity shall not exceed 5 $mm{\cdot}s^{-1}$*
- *Saturdays; 8am to 1pm The peak particle velocity shall not exceed 5 $mm{\cdot}s^{-1}$*
- *Out-with the above times, the peak particle velocity shall not exceed 0.3 $mm{\cdot}s^{-1}$*

- *The above limits apply to all construction activities other than blasting. For blasting, the applicant will be required to submit a scheme demonstrating that the best practicable means will be employed to minimise the impact of noise and vibration.*

Construction Groundborne Noise

- *Monday to Friday; 8am to 6pm 35 dB L_{ASmax}*
- *Saturdays; 8am to 6pm 35 dB L_{ASmax}*
- *Out-with the above times, groundborne noise from construction related activities shall not exceed 30dB L_{ASmax}*

Operational Noise

14.3.3 The following limit was recommended for the proposed substation/switching station:

Noise arising from within the operational land of the sub-station, when measured and/or calculated as an $L_{Zeq, 5min}$, in the 100Hz one third octave frequency band must not exceed 30 dB, at noise sensitive premises.

Operational Vibration

14.3.4 The following limits were recommended: -

Unless otherwise authorised in writing by the Planning Authority the vibration dose value generated by this development shall not exceed 0.1 $m \cdot s^{-1.75}$ as measured or calculated in accordance with BS 6472-2-2008 Part 1 Vibration sources other than blasting. Unless there is a clear difference between night time and day time operational activities, this standard shall apply to both periods.

For operational groundborne noise the recommended limit would be 30 dB L_{ASmax}.

Public Consultation

14.3.5 At the pre-application consultation events attendees expressed concerns about the impact of noise generated during Construction and Operational Phases on residents and guests staying in visitor accommodation, including on accommodation located on the east side of Loch Ness (the Tailpond). Concerns about impacts at the accommodation on the east-side of Loch Ness were based on the openness (i.e. lack of substantial visual/acoustic screening from land topography) and potential direct line-of-sight to the Lower Control Works area, which could result in noise levels that, the stakeholders believe, disturb visitors.

14.3.6 Baseline monitoring locations were selected to focus on the closest receptors as these are generally expected to represent well the most affected. The monitoring locations presented later in this chapter were discussed and finalised with THC prior to the survey being undertaken. Baseline sound level monitoring was also undertaken at two locations on the east shore at the Holiday Park and Foyers Lodge.

14.3.7 As discussed in **Table 14-1 Summary of Consultation**, airborne Operational noise levels have been scoped out on the basis that predicted noise levels are well below the existing baseline at NSRs due to the large distance to the NSRs. This is especially the case for residents and accommodation located on the east shore of Loch Ness.

14.4 Study Area

Definition

14.4.1 With reference to **Figure 14.1: Sensitive receptors considered as part of Noise and Vibration impact Assessment (Volume 3: Figures),** the extent of the construction noise Study Area had been defined initially as an area that is 300 m from the Proposed Development Site boundary, based on the guidance provided in BS 5228-1. However, the construction noise Study Area has been extended to include the key representative NSRs at locations beyond 300 m that were discussed with THC EHO prior to undertaking baseline noise monitoring. This includes two locations on the eastern shore of the Tailpond as a precautionary assessment approach.

14.4.2 The construction vibration Study Area extent is considered to include NSRs within 100 m from the closest construction activity with the potential to generate vibration.

14.4.3 The construction traffic Study Area extent is based on the traffic links in the transport model (as discussed in **Chapter 13: Access, Traffic and Transport (Volume 2: Main Report)**). See **Figure 14.3: Road Traffic Noise Study Links (Volume 3: Figures)** for the links considered as part of this assessment.

Sensitive Receptors

14.4.4 The NSRs likely to be most exposed to the noise emissions from the Proposed Development have been identified, as shown in **Table 14-2 Identified key sensitive receptors**.

14.4.5 Ordnance Survey address point data have been initially considered around the Proposed Development Site boundary up to 1 km. Only a subset of the address points has been assessed quantitatively as defined in **Section 14.4.1 - 14.4.3**.

14.4.6 Of the subset of the address points that have been assessed quantitatively, 10 have been identified as key NSRs that represent those potentially most affected by the Proposed Development. These are listed in **Table 14-2** Identified key sensitive receptors below, see **Figure 14.2: Long and Short Term Sound Monitoring Locations (Volume 3: Figures)** for map showing their location.

Table 14-2 Identified key sensitive receptors

NSR #	Name	X	Y	Type
NSR1	Balmacaan Estate	248322.0	823362.0	Residential
NSR2	Annie's Lodge	249238.0	824081.0	Residential
NSR3	Loch Ness Shores Campsite	249167.0	821001.3	Residential / Visitor Accommodation
NSR4	Primrose Bay	247085.0	820545.0	Residential
NSR5	Balnain Old Post Office	245081.4	829717.4	Residential
NSR6	Achindaul House	249718.0	828185.0	Residential
NSR7	Foyers Lodge	250367.0	821593.0	Residential / Visitor Accommodation
NSR8	Ancarraig House	248860.0	827522.0	Residential
NSR9	Divach Farmstead	249354.0	825195.0	Residential
NSR10	Lochside Hostel	245675.0	819095.0	Residential

14.5 Methodology

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

Assessment Scope

14.5.2 The scope of this assessment is to identify the significance of the potential effects identified within the Study Area defined in **Section 14.4 Study Area.**

14.5.3 The assessment considers the effects during the three phases of the Proposed Development lifespan as identified in **Chapter 2: Project and Site Description (Volume 2: Main Report)**. The phases include: Pre-Construction and Enabling, Construction and Operational.

14.5.4 The spatial extent of the assessment has been defined in **Section 14.4 Study Area**.

14.5.5 The temporal extent of the assessment covers the civil works of the Pre-Construction and Enabling, and Construction Phases.

14.5.6 Based on the above, a structure for the assessment methodology for the Proposed Development is presented as follows:

- Pre-Construction and Enabling and Construction Phase impacts at NSRs from:
  - Airborne and groundborne noise and vibration from activities within the Proposed Development Site.
  - Changes in airborne road traffic noise levels due to construction traffic using the surrounding public highways.
- Operational Phase impacts at NSRs from:
  - Operational noise from activities within the Proposed Development Site.
  - Ground borne vibration from activities within the Proposed Development Site.

14.5.7 Changes in road traffic flows on surrounding roads during the Operational Phase of the Proposed 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, as detailed in **Chapter 13: Access, Traffic and Transport Chapter (Volume 2: Main Report)**.

14.5.8 Note that the assessment of effects and residual effects has been undertaken with respect to the guidance and standards set out below. Where the THC EHO criteria (see **Section 14.3**) is more stringent the assessment has also compared the Proposed Development and against the THC criteria and commented. Overall residual effects are shown to meet with the THC EHO.

Guidance and Standards

14.5.9 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 subsections below.

- BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Parts 1 and 2 (with amendments, 2014)[1,2];
- BS 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting[3];
- BS 6472-2: 2008 Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration[4];
- BS 7385: Part 2: 1993 Evaluation and measurement for vibration in buildings. Part 2 Guide to damage levels from groundborne vibration[5;]
- BS 7445-1:2003 'Description and Measurement of Environmental Noise Part 1: Guide to Quantities and Procedures'[6;]
- Design Manual for Roads and Bridges LA111 Noise and Vibration (Revision 2), Transport Scotland, 20207;
- Calculation of Road Traffic Noise (CRTN), Dept. for Transport, Welsh Office, 1988[8];
- Noise Advisory Council (NAC), A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level Leq[9];
- Guidelines for Environmental Impact Assessment, Institute of Environmental Management & Assessment (IEMA) November 2014[10]; and
- BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'[11]

Pre-Construction and Enabling & Construction Phases

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)[1] (BS 5228-1)

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

[1] British Standard 5228-1: 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 1: Noise (with 2014 amendments)
[2] British Standard 5228 2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 2: Vibration (with 2014 amendments)
[3] British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting.
[4] British Standard 6472-2: 2008 Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration
[5] British Standard 7385: Part 2: 1993 Evaluation and measurement for vibration in buildings. Part 2 Guide to damage levels from groundborne vibration
[6] British Standard 7445-1:2003 'Description and Measurement of Environmental Noise Part 1: Guide to Quantities and Procedures'
[7] Design Manual for Roads and Bridges LA111 Noise and Vibration (Revision 2), Transport Scotland, 2020
[8] Calculation of Road Traffic Noise (CRTN), Dept. for Transport, Welsh Office, 1988
[9] Noise Advisory Council (NAC), A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level Leq
[10] Guidelines for Environmental Impact Assessment, Institute of Environmental Management & Assessment (IEMA) November 2014
[11] British Standard 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

14.5.11 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 Phase activities.

14.5.12 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 ambient noise levels at the receptors, as shown in **Table 14-3 Example threshold of potential significant effect at dwellings** below.

Table 14-3 Example threshold of potential significant effect at dwellings

Assessment Category and Threshold Value Period	Threshold Value $L_{Aeq,T}$ dB 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 Proposed Development 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 Proposed Development 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.

14.5.13 For the appropriate period (night, evening / weekend, day), the baseline ambient noise 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.

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)[2] (BS 5228-2)

14.5.14 BS 5228-2 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 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*'.

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

14.5.16 **Table 14-4 Guidance on effects of vibration levels** (adapted from Table B.1, BS 5228) details PPV levels and their potential effect on humans, and provides a semantic scale for description of vibration impacts on human receptors.

Table 14-4 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.

Vibration Level (PPV mm/s)	Effect
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.

14.5.17 BS 5228-2 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; and
- Maximum PPV for continuous vibrations 15 mm/s.

14.5.18 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 7385: Part 2: 1993 Evaluation and measurement for vibration in buildings. Part 2 Guide to damage levels from groundborne vibration (BS 7385-2)

14.5.19 BS 7385-2 provides guidance on the levels of groundborne vibration above which building structures could be damaged. For the purposes of BS 7385-2, 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 are associated with the threshold of cosmetic damage only, usually in wall and / or ceiling lining materials.

14.5.20 BS 7385-2 provides a frequency-based vibration criterion for transient vibration induced cosmetic damage, which is reproduced in **Table 14-5 Transient vibration guide values for cosmetic damage.**

Table 14-5 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.

14.5.21 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), the resulting guidelines are still orders of magnitude above the threshold of perception and substantially higher than equivalent values likely to provoke complaint.

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

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

14.5.23 BS 6472-2 provides guidance on human exposure in buildings to blast-induced vibration and air overpressures. It is primarily applicable to blasting associated with mineral extraction but can also be applicable to explosives used within civil engineering and demolition.

14.5.24 BS 6472-2 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 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.

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

14.5.26 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.*"

14.5.27 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*".

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

14.5.29 BS 6472-2 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."

14.5.30 Whilst not providing specific air overpressure limits, BS 6472-2 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).*"

14.5.31 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)).

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

14.5.32 The Proposed Development will affect traffic flows on existing roads in the area within and surrounding the Proposed Development Site during construction - refer to **Chapter 13: Access, Traffic and Transport (Volume 2: Main Report)**. This preliminary assessment focuses on the impact at existing residential NSRs located alongside the existing local public highway network.

14.5.33 Construction traffic noise level changes at NSRs have been assessed by considering the increase in traffic flows during the construction works, following the guidance of CRTN (DfT/ Welsh Office, 1988) and DMRB (Transport Scotland, 2020). CRTN is valid where flows are greater than 1000.

14.5.34 The 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.

Operational Phase

BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BS 4142)

14.5.35 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.

14.5.36 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.*"

14.5.37 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 6472-1:2008. Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting (BS 6472-1)

14.5.38 BS 6472-1 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. This Standard provides guidance on the levels of vibration that are likely to give rise to varying degrees of 'adverse comment'.

14.5.39 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 states that the VDV is the best indicator to use when assessing human response to whole body vibration inside buildings.

14.5.40 The criteria contained within BS 6472-1 are provided in **Table 14-6 VDV Criteria from BS 6472-1**

Table 14-6 VDV Criteria from BS 6472-1

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

14.5.41 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.

14.5.42 VDVs below the ranges in **Table 14-6 VDV Criteria from BS 6472-1** are rated as 'adverse comment not expected' and vibration above the ranges in **Table 14-6 VDV Criteria from BS 6472-1** are rated as 'adverse comment very likely'.

14.5.43 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.

14.5.44 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.

Assessment Methodology

Baseline Surveys

14.5.45 Baseline noise level monitoring has been undertaken to establish the baseline acoustic environment at NSRs. Properties closer in proximity to the Proposed Development are likely to represent the most affected. The closest properties are represented by NSR1 to NSR10 in **Table 14-2 Identified key sensitive receptors**.

14.5.46 As discussed in **Section 14.3.2 - 14.3.4 The Highland Council**, consultation with the EHO was undertaken with respect to the assessment methodology and criteria and this included the selection of baseline monitoring locations and the monitoring regime to be employed in advance of completing the surveys.

14.5.47 A combination of long-term unattended and short-term attended baseline monitoring was planned. Long-term unattended monitoring was planned at the majority of receptors to include weekend and weekday times. Ideally, and subject to adequate security, a minimum five-day unmanned monitoring period was desired (Thursday – Monday suggested) but where secure locations could not be identified or possible then shortened manned monitoring regime was considered necessary.

14.5.48 Baseline survey 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'*. Instrumentation is listed in **Appendix 14.2: Baseline Sound Monitoring Details (Volume 5: Appendices)**, calibration certificates available on request.

14.5.49 It is assumed that there are no existing sources of vibration and therefore a baseline vibration survey is scoped out.

Sound Level Calculation and Prediction

Predicting Construction and Operational Noise Level at Receptors from On-site Activities

14.5.50 Construction and Operational noise levels have been predicted using the noise modelling software package CadnaA 2025, which implements the standard noise prediction methodology given in ISO 9613-2:2024 *Acoustics – Attenuation of sound during propagation outdoors* (ISO 9613). Although BS 5228 gives general methods of calculation for construction noise, the standard notes that this does not preclude the use of more precise methods, and notes that the predictions need to be treated with caution at distances greater than 300 m. On this basis it is considered that the more precise methodology of ISO 9613 is appropriate.

14.5.51 All predictions undertaken with CadnaA are free-field and have been performed using a combination of line sources and area sources, to represent internal haul routes and compounds\working areas respectively. Intervening ground as has been modelled as absorbing, whereas water (rivers and lochs) has been assumed to

be acoustically reflective. Ground heights have also been included in the model within a 2 km buffer of the Proposed Development Site boundary.

Predicting Relative Change in Noise Levels Along Public Highways due to Construction Vehicles

14.5.52 Calculation methods presented in CRTN[8] and NAC[9] have been to predicted relative change in road traffic noise level along public highways.

14.5.53 Utilising 18-hour (06:00 - 24:00) Annual Average Weekday Traffic (AAWT) data and average speeds Basic Noise Level (BNL) calculations have been undertaken to predict the change in road traffic noise level between the 'with' and 'without' scenarios.

14.5.54 Where vehicles flows are greater than 1000 the CRTN BNL calculation is used and where the vehicle flows are less than 1000 NAC BNL calculation can be used. Where flows are above/below this threshold on the same link for the 'with' and 'without' scenarios, only one BNL calculation method is used.

Initial Estimation of Allowable Maximum Instantaneous Charge from Blasting Activity

14.5.55 BS 6472-2 does not provide a direct method of calculating Allowable Maximum Instantaneous Charge (MIC) in kilograms. However, the 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, MIC can be calculated for a mean PPV limit. This approach has been applied in this assessment.

Estimation of Groundborne Noise Levels from Operational activity in the Power Cavern Complex

14.5.56 There is no specific standardised method for the prediction of groundborne noise level at receptors from the proposed operation of the Power Cavern Complex. However, TRL Report 429 *Groundborne vibration caused by mechanised construction works*[12]*.* Equation 25 provides an empirically based formula for the predicting groundborne noise levels up to 100 m based on mechanised tunnelling (i.e. tunnel boring machine). This calculation method has been to provide context in this assessment.

Criteria for Sensitivity of Receptors

14.5.57 The adopted assessment of noise and vibration effects is based on the sensitivity of the receptor and the magnitude impact (i.e. the exceedance of the relevant noise and vibration criteria).

14.5.58 In accordance with TAN 2011 and the IEMA Guidelines, the sensitivity of receptors to noise or vibration is based on their usage as defined in **Table 14-7 Receptor sensitivity**. This classification deviates from that defined in **Chapter 4: Approach to EIA (Volume 2: Main Report)**. 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 14-7 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

Magnitude of Impact Classifications

Construction Noise due to On-site Activities

14.5.59 The magnitude of the impact of the construction noise is based on the difference between the likely construction noise level at the receptor and the Threshold Value for potentially significant effects derived using the methodology in BS 5228-1 as shown in **Table 14-8 Construction noise magnitude of impact.**

[12] Transport Research Laboratory Report 429 *Groundborne vibration caused by mechanised construction works* (2000)

Table 14-8 Construction noise magnitude of impact

Construction and Demolition Noise Level above Threshold Value (dB)	Magnitude of Impact
5 dB or more above the ABC threshold value	High
Up to 5 dB above the ABC threshold value	Medium
Equal to, or up to 5 dB below the ABC threshold value	Low
Below the ABC Threshold Value by 5 dB or more	Very Low

Construction Road Traffic Noise on Public Highways

14.5.60 The magnitude of the impact resulting from the construction traffic on public highways is based on the difference between predicted road traffic 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 road traffic noise level changes arising from construction works have been derived from Table 3.17 of DMRB and are provided in **Table 14-9 Construction traffic noise criteria.**

Table 14-9 Construction traffic noise criteria

Change in Traffic Noise Level, $L_{A10,18hr}$ dB	Magnitude of Impact
≥ 5.0	High
3.0 to 4.9	Medium
1.0 to 2.9	Low
<1.0	Very Low

14.5.61 The criteria are based on the current guidance on short-term changes in traffic noise levels in DMRB.

14.5.62 As a rule of thumb, 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 $L_{A10,18hr}$. A doubling of traffic flow would be required for an approximate increase in 3 dB $L_{A10,18hr}$.

Construction Vibration due to On-site Activities

14.5.63 For all activities except blasting, construction vibration impact criteria at the nearest NSRs have been taken from BS 5228-2 for this assessment as shown in **Table 14-10 Magnitude of impact for construction vibration (including and excluding blasting)**.

14.5.64 For blasting activities, the guidance in BS 6472-2 has been used and is also presented in the table below. As per the requirements of BS 6472-2 these limits should not be exceeded by more than 10% of blasts, and no blast should exceed them by more than 50%.

Table 14-10 Magnitude of impact for construction vibration (including and excluding blasting)

Vibration Level (PPV mm/s)	Effect	Magnitude of Impact
Non-Blasting Vibration		
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.	Very Low
0.3 to < 1.0	Vibration might be just perceptible in residential environments.	Low
1.0 to <10.0	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.	Medium
>= to 10.0	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High
Blasting Vibration - Daytime		
Up to 6 mm/s	-	Very Low to Low
Between 6 and 10 mm/s	-	Medium
Exceedances of 10 mm/s	-	High
Blasting Vibration – Night-time		

Vibration Level (PPV mm/s)	Effect	Magnitude of Impact
Non-Blasting Vibration		
Below 2 mm/s	-	Very Low to Low
Between 2 and 4 mm/s	-	Medium
Exceedances of 4 mm/s	-	High

14.5.65 To avoid the potential for damage to occur to underground services, the criteria stated in BS 5228-2 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.

14.5.66 Note that the THC EHO criteria in **Section 14.3** for construction vibration (including and excluding blasting) is comparable though slightly more stringent than the thresholds quoted in the British Standard above.

Groundborne Noise

14.5.67 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[13] 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, see also '*Groundborne vibration caused by mechanised construction works'* (TRL, 2000)[14] for a more recent overview. This criterion is increasingly being adopted (as 35 dB L_{ASmax}) by Local Authorities in Scotland and the rest of 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.

14.5.68 The groundborne noise criteria are detailed in **Table 14-11 Magnitude of impact for groundborne noise**.

Table 14-11 Magnitude of impact for groundborne noise

Groundborne noise (dB L_{ASmax})	Magnitude of Impact
< 35	Very Low
35 < 45	Low
≥ 45	Medium
-	High

Operational – Noise

14.5.69 With regard to Operational airborne noise, the classification of magnitude of impacts is presented in Table 14-12 Magnitude of impact for Operational sound which is based upon the advice of BS 4142 (levels during the Operational Phase and then subtracting the measured background sound level from the rating level).

Table 14-12 Magnitude of impact for Operational sound

Magnitude of Impact	BS4142 Descriptor	Difference Between Rating and Background Levels
Very Low	Indication of a low effect, depending upon context	≤ 0
Low	Indication of an adverse impact, depending upon context	+5 dB approx.
Medium	Indication of a significant adverse impact, depending upon context	+10 dB approx.
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.

[13] American Public Transit Association (1981). Guidelines for design of rapid transit facilities. American Public Transit Association, Washington DC
[14] Transport Research Laboratory, Hiller, DM, Crabb, GI, Groundborne vibration caused by mechanised construction works, Published: Jan 2000, ISBN: 1-84608-428-8:

Operational – Groundborne vibration

14.5.70 With regard to Operational groundborne vibration, the classification of magnitude of impacts is presented in **Table 14-13 Groundborne vibration magnitude of impact** which is based upon the advice of BS 6472-1. Groundborne vibration is assessed separately for Construction and Operational Phases because during the Operational Phase the source is effectively permanent and therefore has the potential to result in greater effects. The guidance in BS 6472-1 relates to permanent sound sources as opposed to temporary sources which are covered in BS 5228:2009.

Table 14-13 Groundborne vibration magnitude of impact

Internal Vibration Level (VDV, $ms^{-1.75}$)		Magnitude of Impact
Day	Night	
< 0.2	< 0.1	Very Low
0.2 – 0.4	0.1 – 0.2	Low
0.4 – 0.8	0.2 – 0.4	Medium
> 0.8	>0.4	High

Significance of Effects

14.5.71 Based on the derived magnitude of impact and the sensitivity of the receptor to noise and / or vibration using the scales set out above, the significance of effect at each NSR for each impact type is determined using the matrix shown in **Table 14-14 Significance of effect** where necessary supplemented by professional judgement and contextual information regarding the existing acoustic environment.

Table 14-14 Significance of effect matrix

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

Note that Major and Moderate Significance of Effect are highlighted and are considered Significant in EIA terms.

Limitations and Assumptions

14.5.72 To ensure a robust assessment of the likely significance of the environmental effects of the Proposed Development, the predictions, modelling and assessment have been undertaken adopting reasonable worst-case assumptions where necessary.

14.5.73 The following are the robust but reasonable worst-case scenario assumptions (maximum/minimum) parameters for the purposes of the noise and vibration assessments with regard to the Pre-Construction and Enabling, Construction and Operational Phases of the Proposed Development:

- All quantitative predictions and assessment have been undertaken at the closest NSRs (those within the Proposed Development Site boundary and those within a 300 m buffer around it) as well as key properties located on the east shore of the Tailpond. All NSRs were agreed with THC EHO. It is assumed that predicted noise levels at more distant NSRs would be less due to the additional noise propagation with distance.
- All noise level predictions used in the assessment are based on 10 m resolution ground contours extending over an area up to 2 km beyond the Proposed Development Site boundary.

- All areas are considered to be soft ground with the exception of existing bodies of water, which are considered to be hard (acoustically reflective).
- The ground heights at various areas will change as the works progress and the excavation deepens – all noise level predictions are based on the existing land topography. However, compounds have been assumed to be flat and internal haul routes are assumed to follow the existing ground contours.
- The upgrade of existing and construction of new Access Tracks has been assessed using two approaches to determine an average monthly level at receptors but also a worst-case day level by assuming all construction plant associated with those activities would be located at the closest approach along the track to the receptor. In practice they will not be located at the same point all the time and they will gradually move past each receptor as work progresses, rather than be located at the worst location for the duration of the works.
- The programme is approximate, and the three phases (Pre-Construction and Enabling, Construction and Operational Phases) may or may not overlap in practice. Whilst the actual phasing of the works may change depending on the Construction Contractor's proposals, it is considered unlikely that more activities will be undertaken. Therefore, the construction noise modelling considers a worst-case scenario, and an overlap has been included.
- 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 14.3: Acoustic Model Input Data (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 i.e. 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 26 km/h (15 mph).
- Operational noise and vibration emissions are 24/7 in nature, however there are no Operational sources of noise at the LCW.
- Operational plant, equipment and openings above ground will be designed to not produce airborne sound pressure level exceeding more than $L_{Aeq,1hr}$ 80 dB at 1 m. It is understood that the only Operational noise source above ground is the GIS Switchyard which is more than 3 km from the nearest NSR. Airborne Operational noise assessment has been scoped out following correspondence with the EHO as discussed in **Section 14.3 Consultation**.

14.6 Baseline Environment

14.6.1 Long-term and short-term baseline noise monitoring has been completed at nine locations NSR1 to NSR9 with reference to baseline methodology in **Section 14.5.45 - 14.5.49 Assessment Methodology**

14.6.2 The monitoring locations are shown in detail in **Figure 14.2: Long and Short Term Sound Monitoring Locations (Volume 3: Figures)** and are considered representative of the closest identified NSRs. NSR5 and NSR9 were short-term attended measurements, whilst all other measurements were long-term unattended measurements from 22/10/24 – 28/10/24.

14.6.3 Details of instrumentation and meteorological conditions can be found in **Figure 14.2: Long and Short Term Sound Monitoring Locations (Volume 3: Figures)** 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.

14.6.4 A summary of the baseline monitoring results is provided in **Table 14-15 Summary of measured baseline noise levels at key NSRs**. All measurements are free-field i.e. away from significant reflecting surfaces and are not façade measurements. The equivalent continuous 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 14-15 Summary of measured baseline noise levels at key NSRs

	Period	Start	End	L_{Aeq}	L_{AFmax}	L_{A90} Mode	L_{A90} Mean
NSR1 Balmacaan Estate	Day	07:00:00	19:00:00	42	87	23	30
	Evening	19:00:00	23:00:00	38	76	27	27
	Night	23:00:00	07:00:00	39	71	24	29
NSR2 Annie's Lodge	Day	07:00:00	19:00:00	45	80	34	38
	Evening	19:00:00	23:00:00	42	79	38	36
	Night	23:00:00	07:00:00	42	62	33	37
NSR3 Loch Ness Shore	Day	07:00:00	19:00:00	46	80	39	40
	Evening	19:00:00	23:00:00	41	75	28	34
	Night	23:00:00	07:00:00	44	72	35	37
NSR4 Primrose Bay	Day	07:00:00	19:00:00	55	88	44	39
	Evening	19:00:00	23:00:00	45	83	20	30
	Night	23:00:00	07:00:00	45	73	30	35
NSR5 Balnain Old Post Office	Day	10:58	11:58	63	83	-	47
NSR6 Achindaul	Day	07:00:00	19:00:00	53	96	46	45
	Evening	19:00:00	23:00:00	50	86	48	45
	Night	23:00:00	07:00:00	46	67	42	41
NSR7 Foyers Lodge	Day	07:00:00	19:00:00	56	94	34	38
	Evening	19:00:00	23:00:00	50	82	35	33
	Night	23:00:00	07:00:00	45	80	27	33
NSR8 Ancarraig House	Day	07:00:00	19:00:00	55	107	35	32
	Evening	19:00:00	23:00:00	40	73	25	28
	Night	23:00:00	07:00:00	41	62	21	29
NSR9 Divach Farmstead	Day	16:35	17:35	43	73	-	39

Note that baseline monitoring was not undertaken at NSR10 specifically, however NSR4 is considered a robust proxy

14.6.5 All key NSRs are residential properties, however, NSR3 and NSR7 on the eastern shore of the Tailpond are also visitor accommodation. All key NSRs are classified as High Sensitivity NSRs.

14.6.6 The following developments are also within 1 km of the Proposed Development Site and are either “consented" within the planning portal, or operational and already forming part of the noise baseline in the area:

- Operational Developments:
  - Foyers Pumped Storage Hydro 300,000 kW - NH 50274 21446
  - Drumclune Farm Micro Hydro 15 kW – NH 48424 29997
  - Coiltie Hydro 1,985 kW – NH 48615 28040
- Consented Developments:
  - New 33 kV Overhead Line Spur for connection to New Communications Mast at Bunloit, Drumnadrochit, which is a Consented non-EIA development.. Estimated construction time frame for the works is 1 week. Traffic Management, traffic lights for when the poles are being delivered. The actual works are away from the main road and will not require traffic management. Proposed machinery for the works include one 8 tonne machine, one Cherry Picker and one HIAB lorry.

14.6.7 All NSRs are located in a relatively quiet, rural environments with little contribution from anthropogenic sources of noise or vibration. NSR4 and NSR10 are located near A82 and therefore fast moving road traffic noise can be heard in the day-time and evening and less frequently at night. NSR5 is located off the A831 and will similarly experience fast moving road traffic noise. All other NSRs are near local residential roads and will experience

occasional road traffic movements, but the typical acoustic environment will include natural sound such as birds and vegetation noise.

14.6.8 Audible "humming" that may be coming from Foyers Pumped Storage Hydro scheme has been observed by some residents around Grotaig at times. AECOM's noise monitoring personnel also observed a distant humming sound during collection of equipment in the morning in the same area, which was consistent with the local resident's description, though a verified location of the sound was not identified by AECOM at the time.

14.6.9 Regarding vibration in the baseline environment - there are currently no known significant sources of vibration in the area. Consequently, ambient vibration monitoring has not been undertaken. In any case, pre-development vibration levels are not usually necessary to assess the likelihood of vibration damage or annoyance from new vibration sources likely to be introduced into the area.

14.6.10 If the Proposed Development was not to proceed the described baseline noise and vibration conditions would not be expected to change notably.

14.7 Embedded Mitigation

14.7.1 To achieve 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 activities on the northern Access Track connecting the Temporary Workers Accommodation to the A831, the Lower Control Works and the southern Access Track at A82 Alltsigh. The good practice embedded measures are detailed below.

Airborne Noise from Construction Works within the Proposed Development Site Boundary

14.7.2 Establishing and maintaining good community relations throughout the construction process is important to keep residents and stakeholders informed on progress and the measures put in place to minimise noise impacts. This addresses the EHO recommendation, "*for a liaison group be established between the developer/contractor and the local community"* and the measures will include:

- Voluntary compliance to construction working hours for work potentially creating noise at the receptor, set by the EHO:
  - Monday to Friday; 08:00 to 18:00 - 55 dB $L_{Aeq,1hour}$
  - Saturdays; 08:00 to 13:00 - 55 dB $L_{Aeq,1hour}$
  - Saturdays; 13:00 to 18:00 - 45 dB $L_{Aeq,1hour}$
  - Out-with the above times, noise from construction related activities shall not exceed 35 dB $L_{Aeq,1hour}$
- 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 Construction Contractor for the Construction Phase which minimises the requirement for diesel generators at the Proposed Development 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 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 Proposed Development 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 Proposed Development Site shall include information on minimising noise and reminding them to be considerate of the nearby residents.
- 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.

Airborne Noise from Marine Haul Route

- Details of the route and vessel used to transport material between the Lower Control Works and Inverness using Loch Ness are not available at this stage. However, to comply with the BS 5228-1 Category A Threshold Values and THC's more stringent criteria for airborne construction noise at NSRs in **Section 14.3 Consultation**, the following embedded mitigation will be implemented:
- Selection of the frequency and timing of vessel movements to reduce the predicted equivalent continuous sound pressure level over the one hour reference period at NSRs;
- Appropriate selection of the vessel's engine and propulsion design i.e. diesel/petrol, hybrid, electric to reduce the predicted equivalent sound pressure level over the one hour reference period at NSRs; and
- Selection of the vessel's route to maximise the distance to NSRs where practical in order to reduce the predicted equivalent sound pressure level over the one hour reference period at receptors.

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 THC;
- Agreement of the methods employed to control air overpressure and vibration from blasting operations agreed with THC prior to any blasting, as well as the frequency of blasting and a 90% confidence limit for blast PPV values at receptors. The PPV blasting vibration limit should follow the requirements set by THC in **Sections 14.3.2 - 14.3.4**;
- Avoidance of ground blasting in the early morning, late afternoon or evening;
- Establishing an air overpressure limit at NSRs following the guidance provided within BS 6472-2 (120 – 150 dB(lin));
- 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 Proposed 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 Contractor and the local planning authority to facilitate the exchange of information regarding blasting events where requested to do so by THC;
- Carrying out of all blasting using BPM, to ensure that the resultant noise, vibration and air overpressure are minimised in accordance with current British Standards and guidelines; and

- 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.

14.7.3 The noise and vibration mitigation measures will be incorporated into the outline Construction Environmental Management Plan (oCEMP) **(Appendix 3.4: oCEMP (Volume 5: Appendices)**, which will form the basis of the final CEMP to be implemented by the Construction Contractor.

14.7.4 Note that for purposes of the following quantitative assessment of effects, reduction in construction noise levels provided by the general mitigation measures listed above are not included as a conservative worst-case assumption. However, the report does take embedded mitigation/design into account when assessing effects overall. Should any of the general measures be specifically required in order to reduce the residual magnitude of impact and significance of effects they are listed specifically under **Section 14.9 Additional Mitigation and Monitoring.**

14.8 Assessment of Effects

14.8.1 This section presents the findings of the assessment for the Pre-Construction and Enabling, 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, to derive the significance classification of effects.

Pre-Construction and Enabling, and Construction Phases

Introduction

14.8.2 Construction work of any type that involves heavy plant activity will generate noise, which may result in complaints from NSRs if appropriate scheduling and control of works is not exercised. Noise levels generated by construction activities and experienced by NSRs, depend upon several 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 Proposed Development Site, known as its ‘on-time’ – when the ‘on-time’ of different plant overlap the overall cumulative sound power level is potentially higher;
- The distance between the noise source and the NSR; and
- The attenuation of sound due to ground absorption, air absorption and barrier effects.

14.8.3 To evaluate noise effects during the Pre-Construction and Enabling works and Construction Phase 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. The specific plant and equipment will be identified by the Construction Contractor.

14.8.4 To present a quantitative assessment, assumptions regarding the plant required for different activities have been made. The assessment has adopted a conservative approach by assuming all plant will operate simultaneously. In practice the actual levels at NSRs 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 the Construction Contractor and therefore the outcomes of the Construction assessment should be viewed in this context.

14.8.5 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, THC would determine whether BPM is being applied. Should this not be the case, action under the Control of Pollution Act 1974 may be taken.

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

- Pre-Construction and Enabling Phase;
  - Existing access track improvements.
  - River Coiltie area works;

- Access Tunnel construction.
- Opening of borrow pits;
- Construction compound and works accommodation setup; and
- New Access Track construction.
- Diversion of core/public paths.

- Construction Phase:
  - Headpond works;
  - Tailpond works;
  - Tunnelling works;
  - Switchroom building and High Voltage Gas Insulated Switchyard (GIS) works; and
  - Access Tracks as Haul Routes.

14.8.7 The following activities listed in **Table 14-16 Pre-Construction and Enabling and Construction Phases - noise activity approximate programme** have been identified from the Construction Programme **(Chapter 2: Project and Site Description (Volume 2: Main Report))** and provided together with the duration of each activity. Predictions have been performed of the noise levels from each construction activity at the identified NSRs on a monthly basis using the approximate start and end dates outlined i**n Table 14-16 Pre-Construction and Enabling and Construction Phases - noise activity approximate programme**

Table 14-16 Pre-Construction and Enabling and Construction Phases - noise activity approximate programme

Construction Areas	Task ID	Major Construction Activities	Start Date	End Date
Pre-Construction and Enabling Phase				
Existing Tracks	A	Existing access Improvements	Jan-26	Jul-26
River Coiltie Area	B	River Coiltie crossing	Jan-26	Apr-26
		Tunnel portal and compound	Feb-26	May-26
		Primary Tunnel Portal and Construction – including Drill and Blast activity and internal haul road movements.	May-26	Jun-28
Borrow Pit	C	Opening of borrow pits	Apr-26	Jun-26
Construction compounds	D	Construction compound setup	Apr-26	May-26
		Works accommodation setup	Jan-26	May-26
New Access Tracks	E	Temporary and permanent Access Track construction	Apr-26	Oct-26
Core/public paths	F	Diversion of core/public paths	Apr-26	Aug-26
Construction Phase				
Headpond	G	All works	Apr-27	Oct-29
Tailpond	H	All works	Jul-26	Jul-29
Tunnels	I	Remaining Tunnelling works including associated internal haul road movements	Jul-27	Jul-30
GIS Switchyard	J	All works	May-26	Aug-28
Haul Road	K	Material Deliveries	Jan-26	Jul-30

14.8.8 The following remaining subsections, from **paragraph 14.8.10 - 14.8.63**, together present an assessment of all noise and vibration generating activities identified with potential to cause significant adverse effects at NSRs.

14.8.9 It is noted here that some activities associated with Pre-Construction and Enabling and Construction Phases have the potential to overlap in time. This means that it is important to assess the noise and vibration effects of these

two phases together rather than in isolation. It follows that if the residual effects are acceptable despite these overlapping phases, then the residual effects from the Pre-Construction and Enabling, and Construction Phases would also be no worse and also acceptable.

Airborne and Groundborne Noise - Surface Plant Works

14.8.10 All surface plant works sound level predictions are based on equipment operating and located above ground or within a tunnel portal. The airborne noise levels on the surface from equipment working within underground areas would be negligible at any NSR whether considering the noise propagation path via the portal or as groundborne noise. Groundborne noise from construction has not been considered further on this basis.

14.8.11 During the Pre-Construction and Enabling Phase (Tasks A to F), it is expected that the noisiest activities will be related to earthworks, Access Track upgrades\setup and the movement of vehicles on the Access Track off the A831. These are included in the Surface Plant Works section below.

14.8.12 During the Construction Phase (Tasks G to K), it is expected that the noisiest activities will be the drilling and blasting during the construction works for the Main Access Tunnel Portal entrance and the piling activities required at the Lower Control Works. The noise from blasting at the portal entrance has been assessed separately.

14.8.13 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 or possibly tunnel boring machine) will be underground and will therefore be further screened from NSRs.

14.8.14 Following the completion of the Construction Access Tracks it is assumed that an average of 18 HGV movements per hour at 16 km/h (10 mph) (based on 178 movements in a 10 hour day[15]) relating to delivery of material to site will use all tracks.

14.8.15 A one hour construction noise level has been predicted at the identified most affected NSRs using a 10 hour construction working day, based on 08:00 – 18:00 to meet the requirements set out by the EHO, see **Section 14.3 Consultation**. For assessment purposes, it is assumed that all the equipment listed in **Appendix 14.3: Road Traffic Noise Study Links (Volume 5: Appendices)** for the construction activities listed in **Table 14-16 Pre-Construction and Enabling and Construction Phases - noise activity approximate programme** would be operating simultaneously throughout the months they are scheduled to take place, and for the full 10 hours working day Monday to Friday (08:00 – 18:00) and Saturday morning (08:00 to 13:00), but excluding Sundays.

14.8.16 For activities which take place at a defined location, the activity (and therefore noise emission) has been spread over the activity area. For activities which are progressive (e.g. Access Track construction), the rate of progress is assumed to be steady, and the activity area has been divided by the number of months the activity is anticipated to take, with the noise emissions from each section allocated to the appropriate month. **Table 14-17 Predicted free-field construction noise levels - per activity** presents the predicted free-field construction typical daily noise level at each NSR for each activity the for the overall loudest month.

14.8.17 Additionally, for the progressive works (e.g. Access Track construction), the noise emissions for the worst-case day have been calculated. Tasks have been assumed to be located at the closest approach to an NSR from the nearest Access Track.

14.8.18 These conservative assumptions have been used when establishing the predicted noise 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 14-17 Predicted free-field construction noise levels - per activity

Task	Activity	Predicted free-field construction noise level $L_{Aeq,T}$ (dB) at NSR									
		NSR 1	NSR 2	NSR 3	NSR 4	NSR 5	NSR 6	NSR 7	NSR 8	NSR 9	NSR 10
Pre Construction and Enabling Phase											
A	Existing access improvements	23	23	-	-	61	41	-	43	28	-
B	River Coiltie area works	19	15	4	-	18	20	-	25	23	-

[15] Mon to Sat 08:00 – 18:00 based on THC EHO requirements outlined in Section **14.3 Consultation**

C	Opening of borrow pits	16	2	-	-	5	21	-	27	20	-
D	Construction compounds	22	21	-	-	16	21	-	26	24	-
E	New Access Tracks	25	25	45	33	20	25	38	30	27	23
F	Diversion of core / public paths	-	-	-	-	61	21	-	23	20	-
Construction Phase											
G	Headpond works	36	32	30	22	19	19	23	24	29	21
H	Tailpond works	24	33	49	44	-	-	41	-	31	32
I	Tunnelling works	25	27	6	10	22	22	-	28	28	-
J	GIS Switchyard	19	18	-	-	12	17	-	22	20	-
K	Haul Road - material deliveries	14	13	5	-	40	23	-	23	15	-
Pre Construction and Enabling Phase and Construction Phase Combined											
	Overall loudest month	37	35	50	44	61	41	43	43	34	32

14.8.19 **Table 14-18 Worst-case daily free-field noise levels - existing access improvements** shows the predicted daily worst-case free-field construction noise levels at each NSR for Access Track construction during the Pre-Construction and Enabling Phase. This is based on all plant and equipment being at the worst-case location with respect to the NSR.

Table 14-18 Worst-case daily free-field noise levels - existing access improvements

Ref	Activity	Noise level $L_{Aeq,T}$ (dB) at NSR									
		NSR 1	NSR 2	NSR 3	NSR 4	NSR 5	NSR 6	NSR 7	NSR 8	NSR 9	NSR 10
A	Existing access Improvements	24	23	-	-	72	45	-	44	28	-

14.8.20 The results presented are without the quantitative benefit of embedded mitigation. All predicted noise levels are subject to the limitations and assumptions relating to construction in **paragraphs 14.5.72 - 14.5.73**.

14.8.21 **Table 14-17 Predicted free-field construction noise levels - per activity** and **Table 14-18 Worst-case daily free-field noise levels - existing access improvements** both use colour to indicate exceedances of the three relevant Threshold Values 65 dB, 55 dB and 45 dB. Values equal to or below 0 dB are indicated with a dash.

14.8.22 In order to determine the worst Magnitude of Impact over the Construction Phase it is necessary to compare the difference between the predicted construction noise levels and relevant Threshold Value for each NSR with the **Table 14-8 Construction noise magnitude of impact**.

14.8.23 The measured baseline noise 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 14-8 Construction noise magnitude of impact** with the exception of monitoring location M5 (NSR5), at which short-term attended monitoring was undertaken and 62 dB $L_{Aeq,1hr}$ was measured. It is reasonable to assume the equivalent continuous noise level would be lower over the full 12 hour reference period and that it too would be 5 dB or more below the Category A Threshold Values.

14.8.24 Category A is the most stringent assessment category with the lowest noise thresholds. It is robust to assume the applicable Threshold Values for the construction noise assessment at all NSRs are from Category A:

- 65 dB $L_{Aeq,T}$, 55 dB $L_{Aeq,T}$, and 45 dB $L_{Aeq,T}$, during the weekday daytime/Saturday morning (07:00 – 13:00), weekday evenings/Saturday (13:00 – 23:00), and
- night-time respectively with reference time period T being dependant on the period being considered.

14.8.25 Further to this the EHO at THC requested Threshold Values that are 10 dB lower than the Category A Threshold Values in the weekday daytime/Saturday morning, weekday evenings/Saturday (13:00 – 23:00) and night-time periods, thresholds of 55 dB $L_{Aeq,1hr}$, 45 dB $L_{Aeq,1hr}$ and 35 dB $L_{Aeq,1hr}$ respectively. The Threshold Value on a Sunday is equal to the night-time Threshold Value of 35 dB $L_{Aeq,1hr}$. Noise generating activities from surface plant are not planned as routine during Sundays or the night-time period and are therefore not assessed in this chapter.

14.8.26 The following paragraphs discuss the predicted most affected NSRs to provide context to the levels presented in **Table 14-17 Predicted free-field construction noise levels - per activity**.

14.8.27 At NSR3 the worst-case predicted typical monthly construction noise level of 50 dB $L_{Aeq,T}$ is due to Tailpond works. This is below the defined weekday daytime and Saturday ABC Category A Threshold Values, and would also meet with THC's more stringent requested Threshold Values for weekday daytimes and Saturday mornings, but would exceed the Saturday afternoon Threshold Value by 5 dB.

14.8.28 At NSR5, the worst-case predicted typical monthly construction noise level of 61 dB $L_{Aeq,T}$ is due to Access Track construction close to this receptor during the Pre-Construction and Enabling Phase. The worst-case noise level for this activity, as it moves along the Access Track, is predicted to be 72 dB $L_{Aeq,T}$. The impact of the works to divert footpaths is similar. However, both of these activities are transient, working along the route of the existing Access Track, therefore whilst the impact is above both the ABC Category A Threshold Values and the THC Threshold Values for all time periods, the impact will be of short duration.

14.8.29 It is important to note that in practice the construction noise levels would be lower than that predicted as works would benefit from the embedded mitigation measures in **Section 14.7 Embedded Mitigation.** BS5228-1 Table B.1 provides indicative decibel reduction ranges relating to common plant and equipment noise mitigation i.e. 5 to 20 dB. If the benefit of embedded mitigation conservatively provided only a 5 dB reduction, the predicted level would be 67 dB $L_{Aeq,T}$ for the worst case day which, exceeds the ABC Category A Threshold Values by 2 dB in the day-time and Saturday morning which is a Medium magnitude of impact according to **Table 14-8 Construction noise magnitude of impact.** The THC Threshold Value for daytime and Saturday morning would still be exceeded by 12 dB and this would be higher when comparing to afternoon, evening and the night-time thresholds.

14.8.30 Furthermore, at NSR5, once the Access Track and footpath works are completed the noise level is predicted to be no higher than 40 dB $L_{Aeq,T}$, resulting from HGV movements on the Access Track. This is below all daytime, evening and night-time Category A Threshold Values. It is also below the THC Threshold Values with the exception of the night-time period.

14.8.31 At NRS6, the worst-case predicted typical monthly construction noise level is 41 dB $L_{Aeq,T}$, resulting from existing access improvement works, this is below the ABC Category A Threshold Values in all periods and below THC criteria for day-time weekday, Saturday morning, and Saturday afternoon and exceeds the 35 dB $L_{Aeq,1hr}$ for evening and night-time periods. The worst-case predicted daily noise level for this activity, which is 45 dB $L_{Aeq,T}$ is equal to the ABC Category A Threshold Values for evenings and weekends and equal to the THC Threshold Values for Saturday afternoon. This impact would also be of short duration as the works progress along the Access Track.

14.8.32 At all other NSRs the worst-case predicted monthly construction noise levels are below the ABC Category A Threshold values and below the more stringent Threshold Values for daytime weekday, Saturday morning, and Saturday afternoon/evening Threshold Values requested by THC.

14.8.33 If the same construction works planned for weekday daytime and Saturday morning periods were to be undertaken in any of the other periods (i.e. evenings, night-time and Sundays) this would result as follows with respect to:

- ABC Category A Threshold Values all work would comply in all periods, except the aforementioned NSR5 during the construction of new Access Track and footpath diversion works. Which exceeds the daytime Threshold Value of 65 dB $L_{Aeq,T}$ by 2 dB (with embedded mitigation is a Moderate effect at worst) and therefore all other more sensitive time periods too.
- THC EHO Threshold Value of 35 dB $L_{Aeq,1hr}$ for evenings (1800-2300), Sundays and night-time (2300 - 0800) being exceeded at NSRs 1, 3, 4, 5, 6, 7 and 8. However should construction works be required in evenings, night-time and/or Sunday periods that these would be phased and planned to comply with the relevant THC limit at the receptor by the appointed Construction Contractor as required.

14.8.34 Overall, at all NSRs (except NSR5) in the daytime and evening when compared to ABC Category A Threshold Values of 65 dB $L_{Aeq,12hr}$ and 55 dB $L_{Aeq,4hr}$ respectively, the magnitude of impact classification ranges between

Very Low and Low which is a Negligible to Minor effect and therefore **Not Significant** when Pre-Construction and Enabling and Construction Phase are considered overlapping and in isolation.

14.8.35 At NSR5 in the daytime and evening, during the Pre-Construction and Enabling Phase, the short-term progressive nature of the Access Track construction works means that the magnitude of impact is Medium which would be a Moderate adverse significance of effect and therefore considered as **Significant** for this activity only based on ABC Category A Threshold Values. All other works/activity in the vicinity of NSR5 are no worse than Minor which is **Not Significant** when Pre-Construction and Enabling and Construction Phase are considered overlapping and in isolation.

Vibration – Surface Plant (Excluding Impact Piling)

14.8.36 Research by the Transport and Road Research Laboratory[16] 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 m, and those generated by vehicles with rubber tyres (e.g. a heavy lorry or dump truck) would be imperceptible at more than 10 m from the haul road.

14.8.37 There is one potential residential address point, NSR10 Alltsigh Cottage, located 6 m from the existing southern Access Track connecting A82 to the valve house at the Headpond. There is also a Youth Hostel located near to NSR10 which is approximately 15 m from the access but also 15 m from the A82.

14.8.38 It is understood that the main construction Phase site access from the trunk roads is proposed from the A831 via Balnain. During the Operational Phase the main access will also be from the A831 via Balnain, with access from the A82 via Alltsigh utilised for Operational access to the valve house.

14.8.39 It is not expected that Access Track upgrades would be required in proximity of NSR10. However, as a conservative assumption, if tracked equipment was required to widen\upgrade the track, it would not be required to be within 10 m of the property for a period of time likely to produce levels of vibration that would cause annoyance with reference to **Table 14-4 Guidance on effects of vibration levels**.

14.8.40 As the access from the A82 via Alltsigh is primarily for access to the valve house during the Operational Phase, noise or vibration from frequent Construction Phase vehicles using this track over a prolonged period is not assessed.

14.8.41 Furthermore, with reference to **paragraphs 14.5.21 - 14.5.22**, the threshold at which cosmetic building damage may occur is much higher than the threshold at which complaints are likely. Therefore, no NSRs are predicted to be at risk of cosmetic or structural damage from activities relating to Construction Phase work.

14.8.42 As a result, the magnitude of impact from surface plant vibration is predicted to be Very Low and therefore the significance of effect is expected to be Negligible for all High Sensitivity NSRs and buildings, which is considered to be **Not Significant**.

Vibration – Piling

14.8.43 Piling activities would be required at the Lower Control Works (Task H within **Table 14-16 Pre-Construction and Enabling and Construction Phases - noise activity approximate programme)** at the Tailpond.

14.8.44 The NSRs on the east shore of the Tailpond, that can already see the west shore would likely have direct line of sight to the piling activity. All NSRs on the east shore are >1 km from the LCW.

14.8.45 Impact piling would be a worst-case assumption for generating vibration at sensitive receptors, however, as the distance to people and buildings is >1 km, adverse vibration effects from even the largest typically available impact piling rig equipment would not be a material concern.

14.8.46 Accordingly, the magnitude of impact is predicted to be Very Low and therefore the significance of effect is expected to be Negligible for all High Sensitivity receptors and buildings, which is considered to be **Not Significant**.

[16] Transport and Road Research Laboratory (TRL). (1977). D.J. Martin, *Ground Vibrations Caused by Road Construction Operations*.

Blasting – Air Overpressure and Vibration

14.8.47 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 and portals, which will require blasting.

14.8.48 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 08:00 – 18:00 Monday to Friday to meet with EHO requirements outlined in **Section 14.3 Consultation**. However, underground blasting (at the powerhouse cavern, surge shafts and Construction and Access Tunnels) may be a 24-hour operation. As explained in PAN 50 Annex D[17], blasting generates both air overpressure and vibration simultaneously. At this stage of the Proposed Development design, the detail of blasting (such as mass of charge, site location, hole spacing, detonation delay) is not determined and would be established prior to undertaking blasting works.

14.8.49 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.".

14.8.50 Using the calculation method discussed in **paragraph 14.5.55** indicative first estimates of the Maximum Instantaneous Charge (MIC) are shown in **Table 14-19 Indicative first estimates of the MIC to not exceed applicable threshold for different blasting locations** based on not exceeding the PPV 6 mm/s threshold and therefore remaining **Not Significant.**

Table 14-19 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 Coordinates		Approximate Distance to Closest Receptor (m)	Indicative first estimates of the MIC to not exceed applicable threshold (kg)
Headpond, Upper Control Works Area	Daytime	6	248235	823434	2.3 km between nearest edge of Headpond and NSR	7499
Main Tunnel Area			248894	827342	2.8 km	11114
Headpond, Upper Control Works Area	Night-time	2	248235	823434	2.3 km between nearest edge of Headpond and NSR	1899
Main Tunnel Area			248894	827342	2.8 km	2815

14.8.51 Night-time blasting on the surface is not currently 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.

14.8.52 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, the above 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 Proposed Development Site and explosive packing by the Construction Contractor. BS 6472-2 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.

[17] PAN 50 Annex D - Controlling the Environmental Effects of Surface Mineral Workings, February 2000, Scottish Government

14.8.53 Note that BS 5228-2 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 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."*

14.8.54 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.

14.8.55 The EHO at THC has not quoted any specific vibration limits at receptors for blasting and has stated, "For blasting, the applicant will be required to submit a scheme demonstrating that the best practicable means [BPM] will be employed to minimise the impact of noise and vibration". It is proposed that the Construction Contractor would provide a suitable scheme outlining BPM and this would be included in the CEMP.

14.8.56 With appropriate design by suitably qualified blasting contractors, the worst-case magnitude of impacts due to blasting is predicted to be Low 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.**

Construction Traffic Noise – Public Highways

14.8.57 The potential changes in road traffic noise on public highways as a result of the Proposed Development have been considered in the Pre-Construction and Enabling and Construction Phases for each road link in the Traffic and Transport Chapter defined study area. These links are shown in **Figure 14.3: Road Traffic Noise Study Links (Volume 3: Figures).**

14.8.58 Road traffic data has been provided by the Applicant's traffic consultant for the peak month (June 2028) for the following parameters for each road link, in both the future "Baseline" and "Baseline plus Construction" scenarios:

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

14.8.59 The assessment has considered both Pre-Construction and Enabling and Construction Phases separately. However, as the traffic flows during the Construction Phase represent a worst-case, only the Construction Phase has been assessed quantitatively.

14.8.60 The peak month of the Construction Phase has been assessed in the Winter and Summer periods at the request of the EHO and based on the June 2028 baseline data. As the area is popular with tourists it can be much busier in summer and therefore traffic flows were counted for both Winter and Summer.

14.8.61 The Basic Noise Level (BNL) has been determined for the "Baseline" and "Baseline plus Construction" traffic scenarios using CRTN[8] BNL methodology. The difference between calculated BNLs is used to determine a magnitude of impact based on **Table 14-7 Receptor Sensitivity** and **Table 14-14 Significance of Effect.** The results are presented for each link in **Table 14-20 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Winter Period** and

14.8.62 **Table 14-21 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Summer** Period**.**

Table 14-20 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Winter Period

	Link Name	Winter Baseline				Winter Baseline plus 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	A82 Inverness ATC5	4471	4	66	65.9	4581	6	66	66.4	CRTN	0.5	Very Low/ Negligible
2	A82 North Drumnadrochit	4471	4	48	64.2	4581	6	48	64.8	CRTN	0.6	Very Low/ Negligible
3	A82 Drumnadrochit ATC6	5399	5	33	64.2	5403	5	33	64.3	CRTN	0.0	Very Low/ Negligible
4	A82 Lewiston ATC7	4546	5	40	63.8	4550	5	40	63.9	CRTN	0.0	Very Low/ Negligible
5	A82 Urquhart Castle ATC8	3058	12	50	62.4	3062	12	50	62.4	CRTN	0.0	Very Low/ Negligible
6	A82 Grotaig ATC13	2672	6	70	62.4	2676	7	70	62.4	CRTN	0.0	Very Low/ Negligible
7	A82 Alltsigh ATC9	2682	6	69	62.3	2686	6	69	62.4	CRTN	0.0	Very Low/ Negligible
8	A82 Invermoriston ATC10	2750	6	67	62.2	2754	7	67	62.2	CRTN	0.0	Very Low/ Negligible
9	A82 Fort Augustus ATC12	2123	6	54	59.9	2127	6	54	60.0	CRTN	0.1	Very Low/ Negligible
10	A887 Invermoriston ATC11	1163	7	64	NO CHANGE	1163	7	64	NO CHANGE	NO CHANGE	0.0	Very Low/ Negligible
11	A831 Milton ATC4	2363	2	50	58.9	2477	6	50	60.1	CRTN	1.2	Low/ Minor
12	A831 Strathnacro ATC2	1515	2	76	59.4	1727	12	76	62.0	CRTN	2.6	Low/ Minor
13	A831 Balnain ATC1	1120	2	60	NO CHANGE	1120	2	60	NO CHANGE	NO CHANGE	0.0	Very Low/ Negligible
14	A833 ATC3	975	3	50	55.2	1073	12	50	57.9	CRTN	2.7	Low/ Minor

Table 14-21 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Summer Period

	Link Name	Summer Baseline				Summer Baseline plus 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	A82 Inverness ATC5	7798	3	66	67.9	7908	4	66	68.2	CRTN	0.3	Very Low/ Negligible
2	A82 North Drumnadrochit	7798	3	48	66.1	7908	4	48	66.4	CRTN	0.4	Very Low/ Negligible
3	A82 Drumnadrochit ATC6	9580	2	33	65.7	9584	3	33	65.7	CRTN	0.0	Very Low/ Negligible
4	A82 Lewiston ATC7	8166	2	40	65.4	8170	2	40	65.5	CRTN	0.0	Very Low/ Negligible
5	A82 Urquhart Castle ATC8	7133	3	50	65.8	7137	3	50	65.8	CRTN	0.0	Very Low/ Negligible
6	A82 Grotaig ATC13	5531	3	70	66.9	5535	3	70	66.9	CRTN	0.0	Very Low/ Negligible
7	A82 Alltsigh ATC9	5539	3	69	66.8	5543	3	69	66.8	CRTN	0.0	Very Low/ Negligible
8	A82 Invermoriston ATC10	5473	4	67	66.6	5477	4	67	66.6	CRTN	0.0	Very Low/ Negligible

	Link Name	Summer Baseline				Summer Baseline plus 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)			
9	A82 Fort Augustus ATC12	4326	3	54	64.3	4330	3	54	64.3	CRTN	0.0	Very Low/ Negligible
10	A887 Invermoriston ATC11	2344	4	64	NO CHANGE	2344	4	64	NO CHANGE	NO CHANGE	0.0	Very Low/ Negligible
11	A831 Milton ATC4	3789	5	50	61.9	3903	7	50	62.5	CRTN	0.6	Very Low/ Negligible
12	A831 Strathnacro ATC2	2004	2	76	60.6	2216	10	76	62.7	CRTN	2.1	Low/ Minor
13	A831 Balnain ATC1	1742	1	60	NO CHANGE	1742	1	60	NO CHANGE	NO CHANGE	0.0	Very Low/ Negligible
14	A833 ATC3	1682	2	50	57.4	1780	8	50	59.2	CRTN	1.8	Low/ Minor

14.8.63 On the basis of the classifications reported in the last column for Winter and Summer periods in **Table 14-20 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Winter Period** and

14.8.64 **Table 14-21 Predicted change in Basic Noise Level when comparing Baseline and Baseline plus Construction Traffic in the Summer** Period during construction, overall the significance of effect is expected to be Minor at worst for all High Sensitivity NSRs near the public highways links listed above in the Pre-Construction and Enabling and Construction Phases, which is considered to be **Not Significant** for both.

Operational Phase

14.8.65 Operational equipment above ground has the potential to cause annoyance or disturbance at NSRs. The only Operational noise present above ground is at the GIS Switchyard. Modern gas insulated switchgear equipment emits very low noise levels during operation. Operational noise from the GIS Switchyard has been considered below.

14.8.66 At this stage, no detailed information is available regarding the sound power level or acoustic character of sound from the proposed transformers at either GIS Switchyard or Powerhouse cavern; however, these commonly produce a strong tonality at levels of 50 and / or 100 Hz due to the frequency of mains electricity. This has been considered as part of the GIS Switchyard airborne noise assessment below. However, given the depth of the cavern (~500 m) and the distance to the nearest NSRs, it is highly unlikely that there will be any perceptible Operational noise or vibration from the below ground equipment (i.e. turbines, generators, emergency generators) at the surface level. Below ground equipment is planned to be limited to producing 85 dB L_{pA} at 1 metre and this will be confirmed following appointment of the equipment supplier.

14.8.67 There is no Operational noise associated with the Lower Control Works.

Airborne Noise

14.8.68 The GIS Switchyard is located approximately 3.3 km from the nearest NSR. and it will be designed to not exceed $L_{Aeq,1hr}$ 80 dB at 1 m from the perimeter of its footprint.

14.8.69 In line with the BS4142 methodology a *rating level* (note, italics are used for BS4142 descriptors in this paragraph) is compared to the *background sound level* at the nearest NSR and the difference is used to determine the potential impact on the receptor depending on the context. The *rating level* is determined by applying character correction to the predicted *specific sound level* at the receptor. In this instance as the GIS Switchyard would not be expected to be audible at the receptor no character correction would be required such that the *rating level* would be equal to the *specific sound level*. The specific sound level is determined as a 1 hour level in the day-time and 15 minute in the night-time however in this instance as the installation would 24/7 operation the 15 minute and 1 hour levels would be the same.

14.8.70 The specific sound level has been predicted using Cadna 2024 R1, ISO 9613-2 and point source located at the substation footprint set to be an equivalent of 80 dBA at 1 m. intervening ground topology and ground absorption was included in the 3D model.

14.8.71 The predicted worst-case broadband specific noise level at the nearest NSR is -4 (minus four) dB $L_{Aeq,T}$ which is well below the measured ambient noise level and *background sound level* at any NSR surveyed. On this basis the outcome of a BS 4142 would be Very Low impact which is Negligible effect.

14.8.72 Furthermore, using a typical transformer spectrum (with prominent peaks at (100 Hz , 200 Hz and 400 Hz) to meet 80 $L_{Aeq,1hr}$ dB at 1 metre, the predicted unweighted level at 100 Hz is 9 dB. This is 21 dB below 30 dB limit set out by the EHO in **Section 14.3 Consultation.**

14.8.73 On this basis, the worst-case magnitude of impact due to Operational noise is predicted to be Very Low and the significance of effect is predicted to be Negligible adverse for all High Sensitivity NSRs, which is considered to be **Not Significant.**

Groundborne Noise

14.8.74 The Headpond and Power Cavern Complex are approximately 2.5 km from the nearest NSR on the west shore of the Tailpond. At this distance, groundborne noise levels are highly unlikely to exceed the 35 dB L_{ASmax} threshold for potentially adverse impacts (**Table 14-11 Magnitude of impact for groundborne noise**) or the THC's recommended limit of 30 dB L_{ASmax}.

14.8.75 To provide context for this conclusion it is worth considering predicting L_{ASmax} using the method provided in TRL[16], Equation 25, which is for a tunnelling machine. Using this method, at 100 m the predicted groundborne noise level would be 19 dB L_{ASmax}. It is noted the method is less reliable at representing propagation through hard rocks, for very large sources of energy or at distances beyond the range of empirical data on which the method was derived (100 m). For this reason, a predicted level at 2.5 km is not calculated directly, but as this type of activity would not exceed 30 dB L_{ASmax} at 100 m, it reasonable to conclude that Operational activity in the Power Cavern Complex would also not exceed 30 dB L_{ASmax} at 2.5 km.

14.8.76 Therefore, Operational groundborne noise is predicted to be at worst Very Low, with a Negligible adverse significance of effect for all High Sensitivity NSRs, which is **Not Significant.**

Vibration

14.8.77 Similar to Operational groundborne noise, due to the 2.5 km distance to the nearest receptors, groundborne vibration levels are not predicted to exceed the 0.1 $ms^{-1.75}$ threshold for night-time (which aligns with THC's requirement) as per BS 6472-1.

14.8.78 Given this, the worst-case impact magnitude is Very Low, with a Negligible adverse significance of effect for all High Sensitivity NSRs, which is **Not Significant.**

14.9 Additional Mitigation and Monitoring

14.9.1 The need for specific additional mitigation measures has also been identified in relation to potential adverse noise and vibration effects for the following only:

- Pre-Construction and Enabling Phase Surface Plant – Construction of the Access Road off the A831 and footpaths.

  The ABC Category A Threshold Value 65 dB $L_{Aeq,12hr}$ is exceeded by 2 dB at NSR5 and THC's criteria of 55 dB $L_{Aeq,1hr}$ is exceeded by 12 dB at NSR5 when assuming all equipment is active when at the closest approach to NSR5 on the worst-case day. Therefore, additional mitigation is discussed in this section to reduce the potential significant adverse effects.

- Pre-Construction and Enabling and Construction Phase Blasting – Air Overpressure and Vibration

  Although predicted effects are Negligible and therefore Not Significant, this has been determined based on indicative first estimates of the allowable MIC values in the daytime to avoid significant effects during blasting at the nearest NSR. Mitigation in the form of consultation with a specialist blasting contractor is required to confirm the indicative first estimates of allowable MIC values are a worst-case and determine blasting requirements as required.

Pre-Construction and Enabling Phase Surface Plant – Construction of the Access Track off the A831 and footpaths

14.9.2 The assessment of surface plant activity during construction of the access road off the A831 has shown the potential to cause NSR5 to experience a Major Adverse effect which would be **Significant.** To address this, a temporary noise reducing barrier has been considered as specific additional mitigation to reduce the predicted potential adverse effects.

14.9.3 Noise mitigation in the form of a temporary 4 m high noise barrier along the northern carriageway of the Access Track between the site entrance on the A831 and co-ordinates 245134, 829568 (which is a length of approximately 480 m) has been considered and is predicted to reduce noise levels at NSR5 to 50 dB LAeq,T in the worst-case month and 57 dB LAeq,T in the worst-case day inclusive of the conservatively assumed benefit of 5 dB reduction provided by embedded mitigation. Note this is under the assumption that all plant and equipment required for Tasks A and F would be used for those tasks at the same time, which is an over estimation. This already comfortably meets the ABC Category A Threshold Value in the daytime and Saturday morning of 65 dB $L_{Aeq,T}$.

14.9.4 Therefore, it is feasible that a combination of less equipment being active in practice, quantified embedded and/or additional barrier mitigation can be considered to reduce the 57 dB $L_{Aeq,T}$ in the worst-case day even further to achieve the more stringent THC criterion of 55 dB (weekday daytime and Saturday morning) where possible which is equal to ABC Category A Threshold Value for evenings, Saturday afternoons and Sundays.

14.9.5 The 4 m high barrier has been determined to feasibly provide adequate noise level reduction at NSR5, particularly when considering NSR5 noise levels will be lower than those predicted as all plant and equipment will not likely operate simultaneously throughout a day. BS 5228-1 Appendix B.4 provides information on the minimum specification for acoustic barriers, *"In design it might be necessary for sound transmitted both through and around the barrier to be considered. However, in most practical situations the overall attenuation will be limited by transmission over and around the barrier, provided that the barrier material has a mass per unit of surface area in excess of about 7 kg/m² and there are no gaps at the joints."*

14.9.6 Specifically, with the temporary noise barrier in place the Threshold Values in **Table 14-8 Construction noise magnitude of impact** would not be exceeded in the worst-case month during the ABC Category A daytime, weekends and evening periods.

14.9.7 However, when considering THC's request for the weekday daytime and Saturday morning Threshold Value to be 55 dB $L_{Aeq,1hr}$ - the worst-case monthly average would meet this limit, but the worst-case day would exceed the level by 7 dB.

14.9.8 The predicted worst-case daytime noise levels at NSR5 are based on all equipment operating at the closest approach to NSR5, where in practice not all plant would be in use at the same time. Further to this, the 7 dB exceedance is without the quantified benefit of embedded mitigation which would further reduce the construction noise levels experienced at NSR5 i.e. to 2 dB exceedance on the basis of conservative 5 dB reduction provided by embedded mitigation.

14.9.9 It is therefore considered feasible that THC's weekday daytime and Saturday morning threshold value of 55 dB $L_{Aeq,1hr}$ would be met in practice with the benefit of a 4 m high noise barrier together with the quantified reduction through the range of embedded mitigation measures as described and that the residual magnitude of impact would be no worse than Low, resulting in a Minor adverse significance of effect, which is **Not Significant**.

Construction Blasting – Air Overpressure and Vibration

14.9.10 The assessment has identified:

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

14.9.11 However, BS 6472-2 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.

14.9.12 On this basis, the final design of the blasting requirements will be undertaken by a specialist blasting contractor to avoid vibration and air overpressure impacts that are greater than minor adverse at NSRs. Impacts are therefore **Not Significant.**

14.10 Residual Effects

14.10.1 A summary table is presented below for the Pre-Construction and Enabling and Construction; and Operational Phases that indicates whether the residual effects, after the implementation of all mitigation, are Significant or Not Significant at a given receptor or group of receptors.

Table 14-22 Summary of Effects: Pre-Construction and Enabling and Construction Phases

Receptor	Description of Effects	Magnitude of Impact	Additional Mitigation	Residual Magnitude of Impact	Significance
Pre-Construction and Enabling Phase					
All NSRs*	Construction Surface Plant Noise	Very Low to Low	None	Very Low to Low	Negligible to Minor, Not Significant
NSR5	Construction Surface Plant Noise: Construction of the Access Road and footpaths off the A831 in the vicinity of NSR5.	Medium	4 m high, 480 m long acoustic barrier from the A831 to approximate co-ordinate. [245134, 829568]	Low	Minor, Not Significant
All NSRs	Construction Surface Plant Vibration (except Piling)	Very Low	None	Very Low	Negligible, Not Significant
All NSRs	Construction Blasting – Air Overpressure and Vibration	Low	Specialist Blasting Contractor	Very Low	Negligible, Not Significant
All NSRs near Public Highways	Vehicles using Public Highways	No Change, Very Low to Low	None	No Change, Very Low to Low	Negligible to Minor, Not Significant
Construction Phase					
All NSRs	Construction Surface Plant Noise	Very Low to Low	None	Very Low to Low	Negligible to Minor, Not Significant
All NSRs	Construction Surface Plant Vibration (except Piling)	Very Low	None	Very Low	Negligible, Not Significant
Receptors on western and eastern shores of Loch Ness	Construction Surface Plant – Piling Vibration	Very Low	None	Very Low	Negligible, Not Significant
All NSRs	Construction Blasting – Air Overpressure and Vibration	Low	Specialist Blasting Contractor	Very Low	Negligible, Not Significant
All NSRs near Public Highways	Vehicles using Public Highways	No Change, Very Low to Low	None	No Change, Very Low to Low	Negligible to Minor, Not Significant

* Except NSR5 during the construction of the Access Track off A831 while works are in the vicinity of the property.

Table 14-23 Summary of Effects: Operational Phase

Receptor	Description of Effects	Magnitude of Impact	Additional Mitigation	Residual Magnitude of Impact	Significance
All NSRs	Airborne Noise	Very Low	None, but note the outcome is based not exceeding 80dB $L_{Aeq,T}$ at 1m from the GIS Switchyard	Very Low	Negligible, Not Significant
All NSRs	Groundborne Noise	Very Low	None	Very Low	Negligible, Not Significant
All NSRs	Vibration	Very Low	None	Very Low	Negligible, Not Significant

14.11 Cumulative Effects

Inter-Cumulative Effects

14.11.1 The assessment of likely cumulative effects is based on the cumulative schemes identified in **Chapter 4: Approach to EIA (Volume 2: Main Report).** Cumulative schemes identified are those that are reasonably foreseeable - i.e. in the public domain at scoping stage, or has been consented but not yet under construction / constructed at the point of writing the assessment / at submission.

14.11.2 The potential for noise levels from Pre-Construction and Enabling and/or Construction Phase works and Operational Phase activities within the Proposed Development Site and for construction related activity outside the Proposed Development Site, namely movement of construction vehicles on public highways, to combine at NSRs from multiple schemes and exceed the identified criteria or THC EHO's requested threshold values, where different, has been considered, as presented below.

Construction and operational activity within the Proposed Development Site

14.11.3 When considering construction activities within the Proposed Development Site in combination with other schemes in **Table 4.8: Cumulative Developments (Chapter 4: Approach to EIA) (Volume 2: Main Report)** it has been determined that the cumulative effects would be Negligible and therefore **Not Significant**. This is on the basis that:

- It is located at a significant distance from key sensitive receptors; and/or
- predicted construction noise levels from the Proposed Development are generally well below the various noise and vibration limits and therefore would have a negligible contribution to any combined exceedance of the noise and vibration limits at sensitive receptors; and/or
- Construction activities are of a temporary or progressive nature such that overlap with activities from other schemes would not occur or be of short duration as to not cause annoyance.

14.11.4 Cumulative Operational noise and vibration effects have been considered from the Proposed Development, together with other reasonably foreseeable schemes, at NSRs. When considering the cumulative effect in combination with other schemes the contribution of the Proposed Development would remain Negligible and therefore **Not Significant**.

14.11.5 On this basis cumulative effects concerning Construction and Operational Phase activities within Proposed Development Site in combination with other schemes is considered **Not Significant.**

Construction vehicle movements on public highways

14.11.6 The assessment of cumulative effects from construction vehicles using public highways in relation to the Proposed Development with that of other schemes has been considered.

14.11.7 The **Appendix 13.1: Transport Assessment (Volume 5: Appendices)** outlines the other schemes that have been considered as part of the cumulative assessment, which are:

- Fort Augustus
- Loch Liath
- Melgarve
- Chrathaich Wind Farm

14.11.8 The daily flows have been collated for these schemes and combined to establish a basis for 18hr AAWT cumulative flows from all schemes as shown in **Table 14-24 The peak cumulative traffic flows on public highways from other schemes** combined.

14.11.9 The BNL has been calculated and compared for the "Baseline" and "Baseline plus Proposed Development plus Other Schemes" traffic flows for the peak month in the Summer and Winter periods. The predicted relative change is shown below for Summer and Winter and the last column summarises the worst-case magnitude of impact and resulting significance of effect for each link.

Table 14-24 The peak cumulative traffic flows on public highways from other schemes combined

Link #	Link Name	Total Peak Daily Construction Traffic Flows (18hr AAWT)	%HGV	Summer Change in BNL, dB	Winter Change in BNL, dB	Worst-case Magnitude of Impact & Significance of Effect
Link 1	A82 Inverness	132	71	0.7	1.0	Low, Minor (**Not Significant**)
Link 2	A82 North Drumnadroc.	132	71	0.8	1.2	Low, Minor (**Not Significant**)
Link 3	A82 Drumnadrochit	108	71	0.4	0.6	Very Low, Negligible (**Not Significant**)
Link 4	A82 Lewiston	108	71	0.4	0.6	Very Low, Negligible (**Not Significant**)
Link 5	A82 Urquhart Castle	108	71	0.4	0.6	Very Low, Negligible (**Not Significant**)
Link 6	A82 Grotaig	108	71	0.4	0.7	Very Low, Negligible (**Not Significant**)
Link 7	A82 Alltsigh	108	71	0.4	0.7	Very Low, Negligible (**Not Significant**)
Link 8	A82 Invermoriston	108	71	0.4	0.7	Very Low, Negligible (**Not Significant**)
Link 9	A82 Fort Augustus	316	54	1.3	2.0	Low, Minor (**Not Significant**)
Link 10	A887 Invermoriston	120	65	0.9	1.5	Low, Minor (**Not Significant**)
Link 11	A831 Milton	24	71	0.8	1.4	Low, Minor (**Not Significant**)
Link 12	A831 Strathnacro	24	71	2.2	2.8	Low, Minor (**Not Significant**)
Link 13	A831 Balnain	24	71	0.4	0.5	Very Low, Negligible (**Not Significant**)
Link 14	A833	0	0	1.8	2.7	Low, Minor (**Not Significant**)

14.11.10 On this basis the inter-cumulative effects in the Pre-Construction and Enabling, Construction and Operational Phases are considered **Not Significant.**

Intra-Cumulative Effects

14.11.11 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; and
- Construction Traffic on Public Roads.

14.11.12 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 Proposed Development, and that any intra-cumulative effects that could occur would only be short term (relative to the lifespan of the operational site), temporary, during construction and spatially separated from receptors, the Intra-cumulative effects are considered **Not Significant**.

14.11.13 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.

14.12 Summary of Effects

14.12.1 This chapter has evaluated the potential noise and vibration effects associated with the Pre-Construction and Enabling, Construction and Operational Phases of the Proposed Development. The assessment has identified key human Noise Sensitive Receptors (NSRs), considered the potential impacts on these and, where necessary, evaluated the effectiveness of proposed mitigation measures in minimising adverse effects. Noise and vibration levels have been assessed against relevant criteria to determine their significance, with a focus on construction related activities, Operational noise sources, and potential residual effects. The findings indicate that, with appropriate management measures in place, all predicted noise and vibration effects remain within acceptable thresholds and are **Not Significant** for each phase of the Proposed Development.

14.12.2 The assessment of noise and vibration effects during both Pre-Construction and Enabling and Construction Phases indicates that all residual effects are Negligible to Minor and that the residual effects are **Not Significant.** Construction surface plant noise and vibration are expected to remain at Very Low to Low levels, with no additional mitigation required. Piling vibration is anticipated to be Very Low, while blasting activities will be managed by a specialist contractor to maintain Very Low residual effects. The construction work to prepare the main Access Track and footpaths near NSR5 is assessed as resulting in a Medium magnitude of impact when a conservative benefit from embedded mitigation is considered, however specific additional mitigation in the form of an acoustic barrier will reduce the impact to Low, which is a Minor residual effect. Vehicle movements on public highways are not expected to introduce significant changes in noise level and are Low magnitude of impact at worst.

14.12.3 Comparison of predicted construction noise levels with THC criteria was also undertaken. With the exception of at NSR5 (during the construction of the Access Track and footpaths at the A831 in the Pre-Construction and Enabling Phase), the assessment has shown that at all other NSRs the THC noise and vibration criteria are also met in the weekday daytime (08:00 - 18:00), Saturday morning (08:00 - 13:00) and Saturday afternoon (13:00 - 18:00) periods and so overall no residual significant adverse effects are anticipated in any phase. Outside of these times i.e. evenings, Sundays and night-time periods the EHO's limits are the most onerous for noise and vibration and therefore above ground works generating noise and vibration would need to be planned accordingly.

14.12.4 While the residual effect at NSR5 is Minor and therefore **Not Significant** It was also acknowledged that Access Track and footpath construction works near NSR5 exceeds the THC criteria by 2 dB in the daytime and Saturday morning periods on this basis. However, this prediction is based on conservative quantification of embedded mitigation as well as an overestimate to the amount of active plant and equipment needed and therefore would likely be compliant with the 55 dB $L_{Aeq,1hr}$ in practice.

14.12.5 During the Operational Phase, noise and vibration impacts are assessed as Very Low across all NSRs, with no additional mitigation required. Airborne noise levels are predicted to be well below the prevailing *background sound levels* at the nearest NSRs (> 2 km away) and therefore remain well within acceptable limits, based on proposed plant and equipment sound pressure levels not exceeding 80 dB $L_{Aeq,1hr}$ at 1 metre from the GIS Switchyard. Groundborne noise and vibration effects are also expected to be Very Low, with Negligible and **Not Significant** residual significance of effects. The assessment confirms that Operational activities will not result in adverse noise and vibration impacts at receptors.

14.12.6 Cumulative effects resulting from the Proposed Development together with other schemes have also been assessed and are considered **Not Significant.**

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