FEARNA STORAGE

# Fearna Pumped Storage Hydro Scheme
# EIA Report

## Chapter 16 – Noise and Vibration

## February 2025

## Quality Information

| Prepared by | Checked by | Approved by |
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## Revision History

| Revision | Revision Date | Details | Authorised |
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| 01 | February 2025 | Issue to ECU | Fraser Allison |

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# 16. Noise and Vibration

## 16.1 Executive Summary

16.1.1 This Chapter sets out the assessment of the potential noise and vibration impacts and likely effects on environmental receptors associated with the Proposed Development.

16.1.2 For this purpose, the closest residential properties to the scheme have been identified as noise sensitive receptors adjacent to the C1144 to the east of the principal worksite approximately 3500m distant.

16.1.3 Receptors at Invergarry in proximity to the A87 have been considered in respect to the link to the Southern Access Route (SAR) where relevant to the assessments undertaken herein.

16.1.4 A baseline survey was scoped out via consultation given the parameters of the scheme and intervening distance to key receptors.

16.1.5 Details of the consultation process and agreed assessments and related methodologies are provided in **Section 16.3** to this Chapter.

16.1.6 Detailed assessment of noise from the operation of the Proposed Development has been scoped out of a quantitative assessment, as the reversible pump-turbine, generators and associated equipment would be located underground within the powerhouse, reducing noise breakout to the surface to a negligible level, The control of operational noise would be integral to the design of the power house, as all the main items of generation equipment would be located within it thus reducing potential atmospherically discharging noise impacts resulting.

16.1.7 A qualitative risk assessment has been undertaken, and suitable planning conditions related design limits discussed with the authority which are proposed to be carried forward into conditioning of the scheme if permitted.

16.1.8 Predictions have been based on sound emission data applicable to the construction plant and equipment forecast for use on works associated with upgrade, or construction, of new access roads/tracks.

16.1.9 Consideration is given to blasting noise and vibration impacts where reasonable to do so in the context of noise and vibration related evidence available at EIA stage.

16.1.10 The following key mitigating measures have been identified for the purpose of controlling noise levels produced by the construction and operation of The Proposed Development:

16.1.11 Construction noise and vibration would primarily be managed through a Construction Noise & Vibration Management Plan (CNVMP), which would be formally agreed with The Highland Council (THC), prior to construction work commencing.

16.1.12 The construction of the Proposed Development has been designed with a mass balance of rock, aggregate and soil materials, thus reducing off-site disposal quantities and noise impacts resulting from associated vehicle movements.

## 16.2 Introduction

16.2.1 This Chapter considers the potential effects, including cumulative effects, of the Proposed Development on noise and vibration during construction and operation. Where likely significant effects are predicted during construction and operation, appropriate mitigation measures are proposed, and the significance predicted residual effects are assessed.

16.2.2 The noise emission that may be generated by the Proposed Development has been assessed in terms of the potential noise impact upon the nearest residential receptors and other receptors as defined during the scoping phase, with consideration being given to whether the resulting effects would be 'significant'. In general terms this requires consideration of changes to, or increases in, environmental noise levels resulting from the Proposed Development as well as considering temporal factors.

16.2.3 The assessment covers potential noise and vibration impacts associated with the construction and operation of the Proposed Development, with particular focus given to noise levels generated during the construction phase, which is likely to extend over a period of 5-6 years for the main civil engineering construction.

16.2.4 The potential impact and likely effects of construction noise have been assessed by using predicted noise levels compared to absolute guidance noise limits.

16.2.5 The assessment recognises the advice and guidance provided in the Scottish Government Technical Advice Note (TAN) (Scottish Government, March 2011), which cites BS 5228-1 (BSI, 2014), as providing the relevant guidance and code of practice relating to construction noise and BS 5228-2 (BSI, 2014) as the relevant guidance relating to construction vibration.

16.2.6 The Chapter is supported by the following Appendices:

- Appendix 16.1 – SQA Statement
- Appendix 16.2 – Construction Noise Modelling Exercises Input Data Summary
- Appendix 16.3 – Draft Construction Noise & Vibration Management Plan (CNVMP)

16.2.7 This assessment has been carried out by SLR Consulting.

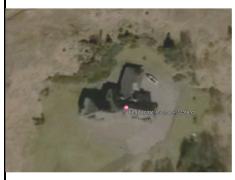
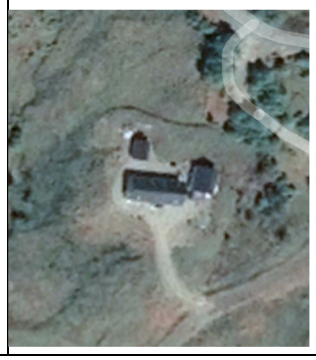
## 16.3 Scope of Assessment

### Study Area

16.3.1 The Study Area encompasses the area over which all desk-based and field data were gathered to inform the assessment presented in this Chapter.

16.3.2 The scope of the noise assessment covers the area defined at scoping stage that includes the Noise Sensitive Receptors (NSRs) identified as being closest to the lower reservoir works, site establishment works and associated access roads/tracks. The position of the NSR locations are described in **Table 16.1** below.

**Table 16.1 NSR Locations**

| NSR Location | Description | Location | | Imagery |
|---|---|---|---|---|
| | | Northing | Westing | |
| NSR1 | Existing Hydroelectric Powerhouse South of C1144 to West of Site | 57°04'28.99" N | 5°15'8.92" W |  |
| NSR2 | Kingie Lodge North of C1144 East of Site | 57°03'53.89" N | 5°08'27.46" W |  |
| NRS3 | Residential Dwelling North of C1144 and South of Kingie Lodge | 57°03'52.07" N | 5°08'23.73" W |  |
| NSR4 | Residential Dwellings Near Faichem/Invergarry and River Garry<br><br>(Associated with potential Southern Access Route works) | Various Around Approximate<br><br>57°04'18.24" N | 4°49'47.74" W |  |
| NSR 5 | Tigh Sheorais (Cross Household) | 57°04'02.91" N | 5°05'16.64" W |  |
| NSR 6 | Tigh Na Eilde (Tanglewood) | 57°03'56.23" N | 5°04'57.05" W |  |

| NSR Location | Description | Location | | Imagery |
|---|---|---|---|---|
| | | Northing | Westing | |
| NSR 7 | Dwellings about Coille Mhorgil | Various Around Approximate | |  |
| | | 57°03'50.06" N | 5°07'56.98" W | |
| NSR 8 | Garry Gualach | 57°03'31.24" N | 5°01'03.50" W |  |

16.3.3 NSR 1 is an unmanned existing hydroelectric powerhouse, on this basis sensitivity to noise and vibration (at the magnitudes and distances expected) would be negligible from the outset, and on this basis no further assessment of this potential receptor is considered warranted.

16.3.4 NSR 2, 3 and 7 have been considered in respect to site traffic on the southern access route (SAR).

16.3.5 NSR 4 has been identified and considered with respect to the site access and traffic from the A87.

16.3.6 NSR 5 and 6 are considered in respect to potential impacts relating to SC1 where relevant.

### Consultation Responses

16.3.7 To inform the scope of the assessment for the Proposed Development, consultation was undertaken with statutory and non-statutory bodies. **Table 16.2** summarises the scoping and consultation responses relevant to noise and vibration and provides information on where and/or how points raised have been addressed in this assessment.

16.3.8 Full details on the consultation responses and scoping opinion can be reviewed in **Chapter 4: Assessment Methodology, Scoping and Consultation**.

**Table 16.2 Consultation Responses**

| Consultee | Issue Raised | Response / Action Taken |
|---|---|---|
| James Mckenzie<br>Energy Consents Unit (ECU) | **3.11** The noise and vibration assessment should be carried out in line with relevant legislation and standards as detailed in section 15 of the scoping report.<br>Section 15. Noise and Vibration<br>**15.5.10**: The remoteness of the location from residences is obvious; it is in a Wild Land Area. But, given the landslide risk already found in the vicinity of the dams, we would urge analysis of construction vibration (particularly from blasting) on all the surrounding bluffs and rock formations.<br>**15.5.15**: analysis of traffic noise through the village should be considered. | SLR have considered analysis of potential of vibration (particualrly due to blasting).<br>Analysis of traffic noise through the village. Construction blasting and vibration assessment scoped in. |

| Consultee | Issue Raised | Response / Action Taken |
|---|---|---|
| Roddy Dowell<br><br>Principal Planner – Strategic Projects Team, The Highland Council (THC) | **Operational Noise**<br><br>**3.50** Highland Council's Environmental Health Team note that given the distance from the site to the nearest receptor, the applicant proposes to scope out all operational noise other than any above ground noise associated with the operation of plant and activities.<br><br>The scoping report proposes to scope out noise from the powerhouse. Whilst they appreciate there is a significant separation distance from the powerhouse and surrounding receptors they advised that the powerhouse be included in any operational noise assessment.<br><br>**3.51** The report also proposes to scope out a baseline noise survey and to apply fixed limits.<br><br>Environmental Health would normally expect a noise assessment for this type of development to be undertaken in accordance with BS4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound. This methodology compares predicted noise levels against existing background levels however, if predicted levels are very low then a baseline survey may not be required. Without seeing the predicted levels, a definitive answer on the need for a baseline survey cannot be given at this time. It is agreed that a baseline survey would not be required for the construction noise assessment. Operational traffic noise can be scoped out of further assessment.<br><br>**Construction Noise**<br><br>**3.52** Planning conditions are not used to control the impact of construction noise as similar powers are available to the Local Authority under Section 60 of the Control of Pollution Act 1974. Generally, people are tolerant of construction noise during typical hours which are taken to be 8am to 7pm Monday to Friday and 8am to 1pm on Saturdays.<br><br>Works for which noise is inaudible at the curtilage of any noise sensitive property could still be carried out outside these times.<br><br>**3.53** It is understood the nearest noise sensitive receptor to the development site is Kingie Lodge at a distance of 3km. It is considered unlikely that construction noise will have a significant impact, and a detailed noise assessment of that aspect would not be required.<br><br>**3.54** Environmental Health noted it appears that the site will be accessed by an existing forest route to the south of Loch Garry which will be extended by a temporary access track to join the road closer to the hydro site.<br><br>Noise from construction traffic and the formation of the temporary track has the potential for greater disturbance and a construction noise assessment in respect of | On the basis of the response received the following has been accommodated into this assessment:<br><br>Principal construction noise impact assessment scoped out for main works to PSH facility.<br><br>Noise impact assessment of construction for road and access improvement works scoped in.<br><br>Noise impact assessment of construction traffic utilising routes near sensitive receptors scoped in.<br><br>Additional consultation undertaken on necessity of a baseline noise survey with additional evidence and justification for scoping out of such exercises.<br><br>Relevant text for noise and vibration forming a CNVMP to be included in the CEMD. |

| Consultee | Issue Raised | Response / Action Taken |
|---|---|---|
| | these aspects of the development will be required. The assessment should include:<br><br>**1)** A description of construction activities with reference to noise generating plant and equipment.<br><br>2) A detailed plan showing the location of noise sources, noise sensitive premises and any survey measurement locations.<br><br>3) A description of any noise mitigation methods that will be employed and the predicted effect of said methods on noise levels.<br><br>4) A prediction of noise levels resultant at the curtilage of noise sensitive receptors.<br><br>5) An assessment of the predicted noise levels in comparison with relevant standards. It is expected that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. The applicant will be required to submit a scheme demonstrating how this will be implemented. Particular attention should be given to the use of tonal reversing alarms and ground compaction plant which are often the most intrusive noise generating elements of a large construction project.<br><br>**3.55** Regardless of whether a construction noise assessment is required, it is expected that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. The applicant will be required to submit a scheme demonstrating how this will be implemented.<br><br>Particular attention should be given to the use of tonal reversing alarms and ground compaction plant which are often the most intrusive noise generating elements of a large construction project. | |
| Robin Fraser Environmental Health- The Highland Council (TBC) | SLR highlighted various justifications for the use of a fixed limits approach to operational noise impact assessment.<br><br>The below response was received regarding a cooperatively agreed design limit.<br><br>*"In all likelihood, given the separation distances involved and taking into account the additional information you've provided below, I'm inclined to agree that noise levels are unlikely to be significant and that a fixed limit would be appropriate. However, while NR20 is still useful as a night time noise standard we are finding that it doesn't offer sufficient protection for daytime and evening amenity. NR20 internal could equate to an external level of around 40dB(A) which in many cases would be well in excess of quiet rural background levels.*<br><br>*I note that you've said that levels will very likely be below 25dB(A) external at the nearest NSR and that would be acceptable as a fixed limit assuming no significant tonal* | Baseline surveying scoped out.<br><br>Operational noise impact assessment to consider a fixed design limit of 25dBA $L_{Aeq,T}$ external to sensitive receptors<br><br>Operational traffic noise can be scoped out of further assessment. |

| Consultee | Issue Raised | Response / Action Taken |
|---|---|---|
| | *element to the noise. On that basis, I'm happy that a baseline survey can be scoped out. "* | |

### Issues Scoped out of Assessment.

16.3.9 The following aspects have been scoped out of the assessment:

- Based on the location of the Site and the nature of the Proposed Development, which would be require a limited number of staff, it has been agreed acceptable to scope potential effects associated with operational road traffic noise out of the EIA.
- Additionally, noise associated with moving water will likely be all sub-surface noise and any above ground noise at sensitive receptors will be imperceptible and will therefore be scoped out of the EIA.
- It is proposed to scope out noise impact assessment of the existing noise climate on operational areas of the Site, on the basis the existing noise climate is unlikely to be problematic for design of control rooms or other occupied staff areas.
- It has been agreed to scope out baseline surveying and assess operational noise of above ground fixed plant and services associated with the proposed development on the basis of an agreed 25dBA $L_{Aeq, T}$ fixed limit.
- It has been agreed to scope out principal airborne construction works noise impact assessment relating to the main PSH facility due to significant intervening distances, but to continue to consider access route improvement construction noise, and usage of construction routes in relative proximity to receptors during the construction phase.
- As detailed in **Chapter 2: The Proposed Development**, with proper maintenance the Proposed Development should remain functional indefinitely. If the project were to be decommissioned, it is anticipated that the potential effects on noise and vibration would be equal to or lesser than the construction impacts. As such, a separate assessment of potential decommissioning effects on noise and vibration is not included in this Chapter.

## 16.4 Legislation, Policy and Guidance

### Legislative and Policy Context

#### National Planning Policy

16.4.1 Section 169 within the Scottish Planning Policy (SPP) (June 2014) states that:

***Other Renewable Electricity Generating Technologies and Storage***

*167. Development plans should identify areas capable of accommodating renewable electricity projects in addition to wind generation, including hydro-electricity generation related to river or tidal flows or energy storage projects of a range of scales.*

*168. Development plans should identify areas which are weakly connected or unconnected to the national electricity network and facilitate development of decentralised and mobile energy storage installations. Energy storage schemes help to support development of renewable energy and maintain stability of the electricity network in areas where reinforcement is needed to manage congestion. Strategic development planning authorities are expected to take the lead in dealing with cross-boundary constraints and opportunities and will coordinate activity between constituent planning authorities*

*"**Development Management***

*169. Proposals for energy infrastructure developments should always take account of spatial frameworks for wind farms and heat maps where these are relevant. Considerations will vary relative to the scale of the proposal and area characteristics but are likely to include:…… impacts on communities and individual dwellings, including visual impact, residential amenity, noise and shadow flicker;……opportunities for energy storage"*

#### *Planning Advice Note 1/ 2011 Planning and Noise*

16.4.2 Current national guidance on noise is contained in Planning Advice Note (PAN) 1/2011 Planning and Noise (The Scottish Government, 2011). In para 2 PAN 1/2011 states that it:

*"promotes the principles of good acoustic design and a sensitive approach to the location of new development. It promotes the appropriate location of new potentially noisy development, and a pragmatic approach to the location of new development within the vicinity of existing noise generating uses, to ensure that quality of life is not unreasonably affected and that new development continues to support sustainable economic growth."*

16.4.3 Para 3 of PAN 1/2011 states:

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

16.4.4 There are no Noise Action Plans in proximity to the Site.

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

#### Relevant Legislation

16.4.6 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.

16.4.7 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.

16.4.8 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 approval for the methods to be used and any noise and vibration control techniques that may be required.

16.4.9 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.

### Local Planning Policy

16.4.10 The adopted Highland-wide Local Development Plan (HwLDP) (Ref 1) Policy 67 'Renewable Energy Developments' states "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 (see Glossary), 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".*

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

*"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."*

16.4.12 Section 4.2, Hydro-Electricity of The Highland Council: Renewable Energy Strategy (THC, 2005) states it is a planning requirement that:

*"Developers will need to provide details of noise levels." Under guidance it states that "Turbines can produce some noise but this can be mitigated relatively easily."*

### Technical Guidance

16.4.13 The following technical guidance has been considered in the assessment.

16.4.14 The noise and vibration assessment will be carried out in accordance with Institute of Environmental Management & Assessment (2014), '*Guidelines for Environmental Noise Impact Assessment'*.

16.4.15 Relevant sections of the following guidance documents and British Standards will be referred to. The phase of assessment that the document would be referenced in are indicated.

*Significance of Effect for all Phases of the Site Life:*

- Guidelines for Environmental Noise Impact Assessment, produced by the Institute of Environmental Management and Assessment (IEAM), and published in October 2014.

*Construction Phase*

- BS5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise'.

- BS5228-2:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration'.

- PAN 50 Annex A: 'The Control of Noise at Surface Mineral Workings and Planning Advice Note 1/2011: planning and noise'.
- PAN 56 Planning and Noise (In relation to guidance on blasting and overpressure limits).
- AQTAG09 Air Quality 'Technical Advisory Group 09 Guidance on the effects of industrial noise on wildlife'

*Operational Phase*

- BS8233:2014 'Guidance on sound insulation and noise reduction for buildings'.
- The 'Guidelines for Community Noise' document (WHO, 1999) and 'Night Noise Guidelines for Europe' (WHO, 2009).
- BS4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'.
- AQTAG09 Air Quality 'Technical Advisory Group 09 Guidance on the effects of industrial noise on wildlife'
- Calculation of Road Traffic Noise (CRTN).
- Design Manual Roads and Bridges (DMRB) LA 111.

## 16.5 Methodology

### Desk Study

16.5.1 An initial desk study has been undertaken to determine and confirm the sensitive receptor locations as identified at scoping stage.

16.5.2 Additional receptors identified in relation to the SAR have also been included within the assessment.

### Field Study

16.5.3 As above it has been agreed to scope out baseline surveying where fixed limit approach to assessment has been considered reasonable. Details of the consultation agreements are enclosed above in **Section 16.3.**

### Assessment Methodology

16.5.4 This scoping assessment aims to identify the significance of the potential effects of the Proposed Development.

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

16.5.6 The spatial scope of the assessment encompasses any areas where construction works are to be undertaken, or operational noise sources will be located, and extends to the closest noise and vibration sensitive receptors.

16.5.7 Potential airborne noise impacts on ecological receptors are considered within **Chapter 8: Terrestrial Ecology** and **Chapter 10: Ornithology**. Potential underwater noise and vibration impacts on ecological receptors are considered within **Chapter 11: Aquatic Ecology**. Where relevant guidance has been provided within this Chapter to inform these assessments.

16.5.8 As a general overview, the assessment methodology contains the following key stages:

- identification of NSRs and rating of sensitivity;
- establishing the relevant design limit or criterion at a given noise sensitive receptor (NSR).

- quantitative assessment, to determine (by prediction) the magnitude of each of the identified main potential impacts;
- qualitative assessment, to allow consideration of other (lesser) potential impacts where a more detailed predictive-based assessment is considered impracticable, or unnecessary; and
- evaluation of the significance of noise effects through the relationship of the receptor's sensitivity to noise and the magnitude and duration of noise impacts.

Assessment Guidance

*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)*

16.5.9 Noise levels generated by demolition and construction activities are subject to Local Authority control under the Control of Pollution Act 1974. Supplementary advice is provided by British Standard BS 5228-1:2009 'Code of Practice for Noise and Vibration Control on Construction and Open Sites' with respect to noise assessment and mitigation.

16.5.10 BS 5228-1:2009 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 5228-1:2009 database is used when predicting noise levels associated with various construction activities.

16.5.11 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 of $L_{Aeq,T}$ as a function of baseline sound levels at the receptors, as shown in **Table 16.3** below.

**Table 16.3 Example Threshold of Potential Significant Effect at Dwellings**

| Assessment Category and Threshold Value Period | Threshold Value $L_{Aeq,T}$ dB Facade | | |
|---|---|---|---|
| | Category A [a] | Category B [b] | Category C [c] |
| Night Time (23:00-07:00) | 45 | 50 | 55 |
| Evening and Weekend [d] | 55 | 60 | 65 |
| Daytime (07:00-19:00) and Saturdays (07:00-23:00) | 65 | 70 | 75 |

**NOTE 1**: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

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

**NOTE 3**: Applies to residential receptors only.

(a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

(b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.

(c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

(d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

16.5.12 For the appropriate period (night, evening / weekend, day), the ambient noise level is determined and rounded to the nearest 5 decibels (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.

16.5.13 Where construction activities involve large scale and long-term earth moving activities, BS 5228 recommends noise limits more akin to surface mineral extraction than conventional construction activities.

16.5.14 For these activities the document recommends application of the Technical Guidance to the National Planning Policy Framework and THC suggest that a "limit of 55 dB $L_{Aeq,1h}$ [free-field] is adopted for daytime construction noise for these types of activities but only where the works are likely to occur for a period in excess of six months".

16.5.15 Regarding vibration the guidance states: "The peak particle velocity generated by the operations shall not exceed 5mm / second measured at the building nearest to the operations. This applies to all operations other than blasting."

*The Highland Council General Recommendations on Construction Noise*

16.5.16 THC's general recommendations on construction noise include noise limits as shown in **Table 16.4**. This guidance has not been published but THC nevertheless ask that it is considered, primarily when setting limits within Section 61 Agreements with construction contractors under the Control of Pollution Act. A long-term construction site relates to any works ongoing for more than 6 months.

**Table 16.4 Noise limits, Long-term construction sites**

| Days | Times | Maximum Noise Levels | |
|---|---|---|---|
| | | $L_{Aeq\ (1\ hour)}$ | $L_{AMax}$ |
| Mondays to Saturdays | 0800 to 1900 hours | 55 dB(A) | - |
| If Permitted | 1900 to 2200 hours | <10 dB(A) above background | - |
| If Permitted | 2200 to 0800 hours | 40 dB(A) | 50 dB(A) |
| Sundays (if permitted) | 0000 to 2400 hours | 40 dB(A) | 50 dB(A) |

Notes:-

1. These standards are for guidance only. The duration of the construction works will have a significant bearing on whether limits can be relaxed or tightened. Where construction activities involve large scale and long-term earth moving activities the limits in [Table 15-6] should be applied.
2. The $L_{Aeq}$ (1 hour) is the equivalent continuous A-weighted sound pressure level arising from work operations measured (on Fast weighting) or calculated over any continuous period of 60 minutes.
3. The $L_{pA(max)}$ is the maximum A-weighted sound pressure level (on Fast weighting) arising from work operations during the time period.

The $L_{Aeq}$ (1 hour) and $L_{pA(max)}$ are free field measurements or calculations at the the boundary or external amenity area of any noise-sensitive premises**.

** Normal working hours for Saturdays are taken to be 0800 to 1300 hours.*

*** Noise-sensitive premises shall include dwellings, offices, schools, hospitals and similar establishments.*

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

16.5.17 As mentioned above BS 5228-1:2014 references the Technical Guidance to the National Planning Policy Framework when considering noise from long-term construction sites involving large scale earth moving.

16.5.18 This Technical Guidance does not apply in Scotland however Planning Advice Note PAN 50 'Controlling the Environmental Effects of Surface Mineral Workings' provides equivalent guidance in Annex A: The Control of Noise at Surface Mineral Workings.

16.5.19 PAN 50 states "It will often be necessary to raise the noise limits to allow temporary but exceptionally noisy phases in the mineral extraction operation which cannot meet the limits set for routine operations. A prime example would be to allow for the construction of baffle mounds. Other activities which would also merit a temporary raised limit include soil- stripping, removal of spoil heaps, and construction of new permanent landforms. These activities are in themselves noisy, but can bring long term benefits… It is suggested that 70 dB $L_{Aeq,1h}$ (free field) for periods of up to 8 weeks in a year should be considered to facilitate this, but planning authorities and operators may also wish to weigh up the effects of shortening this period and allowing higher levels of noise, in order to get such temporary operations completed as quickly as possible. However, some operations may require longer than 8 weeks for completion, and in such cases, an increased limit up to 70 dB $L_{Aeq,1h}$ (free-field) may be allowed during these periods."

*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)*

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

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

**16.5.22** **Table 16.5** (adapted from Table B.1, BS 5228-2:2009) details PPV levels and their potential effect on humans and provides a semantic scale for description of vibration impacts on human receptors.

**Table 16.5 Guidance on Effects of Vibration Levels**

| **Vibration level PPV (mm/s)** | **Effect** |
|---|---|
| 0.14 to 0.3 | Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. |
| 0.3 to < 1 | Vibration might be just perceptible in residential environments. |
| 1.0 to <10 | It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents. |
| >= to 10 | Vibration is likely to be intolerable for any more than a very brief exposure to this level. |

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

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

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

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

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

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

16.5.27 The criteria contained within BS 6472-1:2008 are provided in **Table 16.6**.

**Table 16.6 VDV Criteria from BS 6472-1:2008**

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

16.5.28 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.

16.5.29 Vibration dose values below the ranges in **Table 16.5** are rated as *'adverse comment not expected'* and vibration above the ranges in **Table 16.5** are rated as 'adverse comment very likely'.

16.5.30 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 Wb weighting, while the horizontal axes use the $W_d$ weighting. The definitions of the frequency weightings are given in BS 6472-1:2008.

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

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

16.5.32 BS 6472-2:2008 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.

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

16.5.34 The standard suggests that accredited blasting contractors will appropriately design blasts to minimise effects at NSRs.

16.5.35 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 10.0mm/s during the day. At night this reduces to 2.0mm/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."

16.5.36 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 3.0mm/s, and in practice most will be below this level".

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

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

16.5.39 Whilst not providing specific air overpressure limits, BS 6472-2:2008 provides the following information on acceptable overpressure pressures: "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)."

16.5.40 The air overpressure levels measured at properties near quarries in the United Kingdom are historically generally around 120 dB(lin), which is 30 dB(lin) below, or only 3% of, the limit for cracking pre-stressed poorly mounted windows (150 dB(lin)).

16.5.41 It is important to remember thar dB(lin) logarithmic metric levels for blast overpressure are not correlated to audibility as per the dB(A) metric used for audible sound.

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

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

16.5.43 BS 7385-2:1993 provides a frequency-based vibration criterion for transient vibration induced cosmetic damage, which is reproduced in **Table 16.7**.

**Table 16.7 Transient vibration guide values for cosmetic damage**

| Type of Structure | Peak Component Particle Velocity in Frequency range of Predominant Pulse (1 and 2) | |
|---|---|---|
| | 4Hz-15Hz | 15 Hz and Above |
| Reinforced or framed structures<br>Industrial and Heavy Commercial Buildings. | 50mm/s at 4Hz and above. | |
| Un-reinforced or light framed structures.<br>Residential or Light Commercial type buildings. | 15mm/s at 4Hz increasing to 20mm/s at 15Hz3 | 20mm/s at 15Hz increasing to 50mm/s at 40Hz 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.

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

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

*Calculation of Road Traffic Noise*

16.5.46 Construction traffic from the development proposals may temporarily alter noise levels near the affected local road network. A noise assessment will be undertaken in accordance with the DMRB Volume 11 Section 3 Part 7 Noise and Vibration, considering the identified most affected links.

16.5.47 The Annual Average Weekly Traffic (AAWT) and percentage of Heavy Goods Vehicles (HGVs) will be determined "With Scheme" (with the development proposals) and "Without Scheme" (without the development proposals).

Based on these traffic numbers, the Basic Noise Level (BNL) will be established for the "With Scheme" and "Without Scheme" scenarios. Scenarios for the base year 2022 and base year including the development have been assessed. The BNL is the dB $L_{A10,\ 18hr}$ noise level at 10 m from the kerb of the road assessed.

16.5.48 The impact magnitude for each assessment of each link will be presented and the predicted changes in noise levels will be compared to the relevant impact magnitude threshold limits.

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

16.5.49 BS 4142:2014 contains a methodology for the assessment of the significance of effect of industrial and commercial noise in relation to the background sound level. The basis of BS 4142 is a comparison between the background sound level in the vicinity of residential locations and the rating level of the sound source under consideration, with penalties applied to the industrial sound to take account of characteristics which may cause annoyance to residents. The relevant parameters are as follows:

- Background Sound Level – $L_{A90,T}$ – defined in the Standard as the 'A' weighted sound pressure level that is exceeded by the residual sound at the assessment location 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 – $L_{Aeq,Tr}$ – 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;

- Residual Sound Level - $L_{Aeq,T}$ - the equivalent continuous 'A' weighted sound pressure level at the assessment location in the absence of the specific sound source under consideration, over a given time interval, T; and

- Rating Level – $L_{Ar,Tr}$ – the specific sound level plus any adjustment made for the characteristic features of the noise.

16.5.50 The standard recognises that certain acoustic features of a sound source can increase the impact over that expected based purely on the sound level. The standard identifies the following features to be considered:

- Tonality – a penalty of 2 dB is applied for a tone which is just perceptible at the receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible;

- Impulsivity - a penalty of 3 dB is applied for impulsivity which is just perceptible at the receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible. An impulse is defined as the sudden onset of a sound;

- Intermittency – a penalty of 3 dB can be applied if the intermittency of the specific sound is readily identifiable against the residual acoustic environment at the receptor. I.e e. it has identifiable on / off conditions.

16.5.51 Other sound characteristics – a penalty of 3 dB can be applied where the specific sound features characteristics that are neither tonal nor impulsive but are readily distinctive against the residual acoustic environment.

16.5.52 Once any adjustments have been made, the background level and the rating levels are compared. The standard states that:

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

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

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

*The lower the rating level is to the measured background sound level, the less likely it is that the specific sound 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."*

16.5.53 The standard emphasises the importance of taking context into consideration and identifies a range of pertinent factors including:

- the absolute level of the sound;

- the character and level of the residual sound compared to the character and level of the specific sound, for example, comparing the frequency spectrum and variation over time; and

- the sensitivity of the receptor.

16.5.54 The standard specifies the specific sound level as an $L_{Aeq}$ with a one hour assessment period during the day (07:00-23:00) and a fifteen minute assessment period at night (23:00- 07:00).

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

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

16.5.56 Of relevance to this assessment, for discussion of "steady external noise sources" it provides guideline values for internal ambient noise levels within dwellings. These are reproduced in **Table 16.8**.

**Table 16.8 Indoor Ambient Noise Levels for Dwellings**

| Activity | Location | 07:00 to 23:00 | 23:00 to 07:00 |
|---|---|---|---|
| Resting | Living room | 35 dB $L_{Aeq,16hr}$ | - |
| Dining | Dining Room | 40 dB $L_{Aeq,16hr}$ | - |
| Sleeping (daytime resting) | Bedroom | 35 dB $L_{Aeq,16hr}$ | 30 dB $L_{Aeq,8hr}$ |

## Criteria for Sensitivity of Receptors

### *General*

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

16.5.58 In accordance with TAN 1/2011 and the IEMA Guidelines, the sensitivity of receptors to noise or vibration is based on their usage as defined in **Table 16.9**.

16.5.59 This classification deviates from that defined in **Chapter 4: Assessment Methodology, Scoping and Consultation**. 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.

16.5.60 Therefore, the below classifications in **Table 16.9** has been applied.

**Table 16.9 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 |

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

## Criteria for Magnitude of Impacts

### *Construction Noise*

16.5.62 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 5228-1:2009 in **Table 16.3** with significance of effect as shown in **Table 16.10** below.

16.5.63 The only exception to this is the construction works which involves large-scale earth moving.

16.5.64 For these works, in accordance with THC guidance and PAN 50, a Threshold Value of 55 dB $L_{Aeq}$ has been applied during weekdays, and 40dB $L_{Aeq, T}$ on Sundays.

**Table 16.10 Construction Noise Magnitude of Impact Criteria**

| Magnitude of Impact | Construction and Demolition Sound Level above Threshold Value (dB) |
|---|---|
| Negligible | <1 |
| Minor | 1>3 |
| Moderate | 3>5 |
| Major | 5+ |

16.5.65 Where short-term construction works are proposed for the purposes of mitigating the effects of the Proposed Development, consideration has therefore been given to mitigating any impacts where there is a likelihood that the construction noise levels will exceed the limit of 70 dB $L_{Aeq,1h}$ in PAN 50.

*Construction Vibration*

16.5.66 For all activities except blasting, construction vibration impact criteria at the nearest NSRs have been taken from BS 5228-2:2009 for this assessment as shown in **Table 16.11**

**Table 16.11 Magnitude of Impact for Construction Vibration**

| Magnitude of Impact | PPV (mm/s) | Effect |
|---|---|---|
| Negligible | 0.14 to < 0.3 | Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration. |
| Minor | 0.3 to < 1 | Vibration might be just perceptible in residential environments. |
| Moderate | 1.0 to < 10 | It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation is given to residents. |
| Major | >= 10 | Vibration is unlikely to be tolerable for any more than a very brief exposure to this level. |

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

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

*Groundborne Noise*

16.5.69 The proposed tunnelling and the operation of the turbines have the potential to generate groundborne noise at nearby receptors.

16.5.70 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' which described a number of published guidelines for assessing impacts of groundborne noise.

16.5.71 This includes the guidelines published by the American Public Transit Association which suggest criteria for acceptable maximum levels of groundborne noise affecting various building types, including a criterion of 35 dB $L_{Amax}$ for groundborne noise affecting residential properties, during the day or night. This criterion is increasingly being adopted (as 35 dB $L_{ASmax}$) by Local Authorities in the UK when defining acceptable groundborne noise levels for new developments.

16.5.72 These criteria are typically applied to permanent groundborne noise sources, such as new underground railway lines, however in the absence of suitable alternative criteria these have also been applied to the assessment of groundborne noise during construction. The criteria are detailed in **Table 16.12**.

**Table 16.12 Magnitude of Impact for Groundborne Noise**

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

*Construction Traffic Noise*

16.5.73 The impact of the change in noise level will be determined with reference to the classification of magnitude of impacts used in short-term traffic noise assessments presented in DMRB LA111 is shown in **Table 16.13**.

**Table 16.13 Magnitude of Impact for Construction Traffic Noise**

| Magnitude of Impact | Description |
|---|---|
| Negligible | No change in LA10,18hr noise level. |
| Minor | Change in $L_{A10,18hr}$ noise level between 0.1 and 2.9 dB. |
| Moderate | Change in $L_{A10,18hr}$ noise level between 3.0 and 4.9 dB. |
| Major | Change in $L_{A10,18hr}$ noise level of 5.0 dB or more. |

*Operation – Industrial/ Noise*

16.5.74 With regard to operational airborne noise, the classification of magnitude of impacts is presented in **Table 16.14** which is based upon the advice of BS 4142:2014+A1:2019 (levels during the operational phase and then subtracting the measured background noise level from the rating sound level).

**Table 16.14 Magnitude of Impact for Operational Sound**

| Magnitude of Impact | Difference Between Rating and Background Levels |
|---|---|
| Negligible | ≤ 0 |
| Minor | 1 to +4 |
| Moderate | +5 to +9 |
| Major | ≥ +10 |

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

*Operation – Groundborne Vibration*

16.5.76 With regard to operational groundborne vibration, the classification of magnitude of impacts is presented in **Table 16.15** which is based upon the advice of BS 6472-1:2008 for the avoidance of adverse comment. Groundborne vibration is assessed separately for construction and operation because the source is effectively permanent and therefore has the potential to result in greater effects. The guidance in BS 6472-1:2008 relates to permanent sound sources as opposed to temporary sources which are covered in BS 5228:2009.

**Table 16.15 Magnitude of Impact for Operational Groundborne Vibration**

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

*Ecological Receptors*

16.5.77 The impact of construction and operational noise on ecological receptors will be determined with reference to the AQTAG 09 guidance. The impact of construction noise upon ecological receptors is considered with reference to the criteria as detailed below in **Table 16.16**.

16.5.78 Guidance considers impacts above a threshold of 55dB $L_{Aeq, T}$ and 80dB $L_{AFMax}$ respectively.

**Table 16.16 Magnitude of Impact for Ecological Receptors**

| Magnitude of Impact | Exceedance in the $L_{Aeq,T}$ Noise Level |
|---|---|
| Negligible | Threshold value not exceeded. |
| Minor | Threshold value exceeded by a maximum of 2 dB. |
| Moderate | Threshold value exceeded by a maximum of 4 dB. |
| Major | Threshold exceeded by a maximum of 5dB |

Significance of Effects

16.5.79 Based on the derived magnitude of impact and the sensitivity of the receptor to noise and / or vibration, the significance of effects is as shown in **Table 16.17**.

**Table 16.17 Significance Criteria**

| Sensitivity Of receptor | Magnitude of Impact | | | |
|---|---|---|---|---|
| | **Major** | **Moderate** | **Minor** | **Negligible** |
| Very High | Major | Major | Moderate | Minor |
| High | Major | Moderate | Minor | Negligible |
| Medium | Moderate | Minor | Negligible | Negligible |
| Low | Minor | Negligible | Negligible | Negligible |

16.5.80 **Table 16.18** puts the levels of the magnitude of adverse impacts and effect significance in context. This is based on the IEMA Guidelines for Environmental Noise Impact Assessment and the UK Government's Planning Practice Guidance (PPG) web-based resource.

**Table 16.18 Magnitude of Impact and Significance of Effect**

| Magnitude of Impact | Description of Effect | Significance |
|---|---|---|
| Major | Disruptive, causes a material change in behaviour and / or attitude. Potential for sleep disturbance. Quality of life diminished due to change in character of the area | More likely to be significant<br>Less likely to be significant |
| Moderate | Intrusive, noise can be heard and causes small changes in behaviour and / or attitude. Potential for non-awakening sleep disturbance. Affects the character of an area such that there is a perceived change in the quality of life | |
| Minor | Non-intrusive, can be heard but does not cause any change in behaviour or attitude. Can slightly affect the character of an area but not such that there is a perceived change in the quality of life | |
| Negligible | No discernible effect on the receptor | Not significant |

16.5.81 The above significance derivation does not apply to the assessment of potential for damage to underground services. BS 5228-2:2009 does not provide significance of effect criteria for assessing vibration impacts on building services in the context of EIA.

16.5.82 The significance of effect where commented upon is therefore applied based upon whether the predicted vibration levels meet the BS 5228-2:2009 limits. Where the limits are not exceeded, this has been classified as being Not Significant. Where they are exceeded, they are considered Significant.

### Assumptions and Limitations

16.5.83 For clarity any assumptions of limitations of each item of the assessment are provided below in the relevant section of the assessment.

## 16.6 Baseline Conditions

### Existing Baseline

16.6.1 A description of the NSRs positions chosen for the noise impact assessment is provided in **Table 16.1**. These positions were chosen as being representative of the nearest properties to The Proposed Development, the SAR, and the access to the SAR form the A87 and the public road network beyond.

16.6.2 No baseline sound monitoring is proposed to be undertaken following agreement at consultation.

16.6.3 Publicly available data has been reviewed to identify the likely sources contributing to the baseline sound climate in the vicinity of the Proposed Development. There are no publicly available noise maps for the region, and road traffic on the C1144 Public Road would be expected to be the principal baseline noise source.

16.6.4 No other significant sources of baseline sound have been identified and it is likely that the sound climate is typical of a remote or rural area and primarily geophonic and biophonic in nature.

16.6.5 Under the proposal for operational sound to be scoped out of detailed assessment, due to the very large distance between the proposed powerhouse locations and the closest NSR positions, SLR submit this removes the requirement for completion of an ambient sound survey, to support an assessment to the requirements of BS 4142. Subsequent to consultation it has been agreed to consider operational noise from the powerhouse in the context of a fixed limit assessment to 25dB $L_{Aeq, T}$ outside sensitive receptor locations. Assessment will discuss this in the context of BS4142:2014+A1:2019.

16.6.6 Furthermore, in accordance with the guidance provided in BS 5228-1 and BS 5228 -2, the potential effects of construction noise and vibration can be assessed by comparing the construction noise level against the lower fixed limit cut-off values of 65dB $L_{Aeq,T}$ during weekdays, and 55dB $L_{Aeq, T}$ on Sundays.

16.6.7 Highland Council long term fixed limit of 55dBA $L_{Aeq, 1\ hour}$, for construction noise from significant earthworks alone during the daytime and for vibration there are clear predefined limits for human and building response which can be considered without baseline assessment also.

16.6.8 Following consultation, it has been agreed principal construction works noise and vibration impact assessment has been scoped out of detailed assessment.

16.6.9 However, noise and vibration impact assessment specifically of construction for road and access improvement works has been scoped in. Given this does not comprise significant long-term earthworks, BS5228:2014 has been considered the relevant design limit guidance.

16.6.10 The identified receptors are understood to be residential buildings or accommodation, including lodges or assumed to contain residential uses within a building of mixed use e.g. farmhouse.

16.6.11 From desktop observation, using mapping software from 2020, other solid structures are associated with the Dam at Loch Quoich with no residential use sensitivity.

16.6.12 Receptors impacted by works to forestry tracks are discussed separately below.

16.6.13 NSR's were described in the Scoping Report and are consistent with the locations assessed.

16.6.14 It is considered that NSR2, NSR3 and NSR4 are of principal interest being occupied receptors of a residential or recreational habitable use.

### Future Baseline

16.6.15 Should the Proposed Development not proceed, any future change to baseline ambient sound would most likely result from changes to traffic flows in the area, primarily on the C1144 unrelated to the Proposed Development.

## 16.7 Mitigation by Design

16.7.1 The full project description and methodologies associated with its construction are detailed in Chapter 2.0 of the EIA.

16.7.2 The Proposed Development would operate by transferring water between a lower reservoir, the existing Quoich reservoir, and an upper reservoir created by raising the natural level of Loch Fearna.

16.7.3 The reservoirs would be connected by a system of underground waterways, with an underground powerhouse by the shore of the Quoich reservoir.

16.7.4 Thus, by the nature of the installation the surrounding topography and physical intervention by significant physical material would offer similarly significant mitigation in respect to noise egress from the turbines within the powerhouse.

16.7.5 In addition, the location and layout of the scheme also offers the opportunity to win and use materials within the Site associated with borrow pits, which will minimise off-site transport on the road network and noise resulting.

## 16.8 Potential Significant Effects

16.8.1 Based on the key parameters of the Proposed Development, without mitigation, the following potential effects have been considered within this chapter following scoping and subsequent consultations and agreements:

- Noise from construction traffic and the formation of the temporary tracks.
- Noise and vibration associated with construction road traffic on the surrounding road network and those receptors adjacent.
- Vibration and air overpressure associated with blasting and material extraction and enabling works.
- Any above ground noise associated with the operation of the propsoed development and activities occurring at the new pumped storage power facility considering fixed limits as previously highlighted.

## 16.9 Construction Effects

16.9.1 An outline programme has been prepared for the Proposed Development and is attached at **Appendix 2.4 - Outline Project Programme**.

### Construction General

16.9.2 It is anticipated that the construction and commissioning period would last approximately five to six years, and the workforce would reach approximately 500 people on-site at the peak of the construction phase. The number of construction workers on-site will vary depending on the stage of the works.

16.9.3 Normal construction shifts would generally apply for the surface works – access tracks, dams, powerhouse, upper control works and lower control works - but these could be subject to some variation to suit the ongoing work, weather conditions and time of year.

16.9.4 It is anticipated that surface works would generally be undertaken between 07.00 and 19.00 hours, seven days a week and that underground operations would continue 24 hours a day, seven days a week. As the workforce would be housed within the wider site, these hours should not lead to any “out-of-hours” traffic on the local roads.

16.9.5 It is proposed that the movement of HGVs into or out of the Site would only take place between 08.00 and 18.00 on Mon - Friday and 08.00 - 16.00 hours on Saturdays and Sundays.

16.9.6 Surface blasting on site would only take place between the hours of 09.00 to 17.00 on Monday to Friday inclusive and 10.00 to 14.00 on Saturdays, Sundays and on National Public Holidays, unless agreed otherwise in advance in writing by the Planning Authority.

16.9.7 Underground operations and other agreed works that would continue to take place out-with normal surface working hours, would have management measures in place to ensure that any noise and lighting is mitigated for receptors above ground.

Construction Noise- General Works

16.9.8 As discussed in section 16.2.15 a construction noise impact assessment for the principal construction works for the proposed development has been scoped out of detailed assessment due to the significant intervening distances.

16.9.9 As highlighted by the authority:

*" Planning conditions are not used to control the impact of construction noise as similar powers are available to the Local Authority under Section 60 of the Control of Pollution Act 1974. Generally, people are tolerant of construction noise during typical hours which are taken to be 8am to 7pm Monday to Friday and 8am to 1pm on Saturdays.*

*Works for which noise is inaudible at the curtilage of any noise sensitive property could still be carried out outside these times. "*

16.9.10 It is understood the nearest noise sensitive receptor to the main PSH development site is Kingie Lodge at a distance of 3km. It is considered unlikely that construction noise will have a significant impact, and a detailed noise assessment of that aspect would not be required.

16.9.11 Environmental Health noted it appears that the site will be accessed by an existing forest route to the south of Loch Garry which will be extended by a temporary access track to join the road closer to the hydro site.

16.9.12 Regardless of whether a construction noise assessment is required, it is expected that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. The applicant will be required to submit a scheme demonstrating how this will be implemented.

16.9.13 Particular attention should be given to the use of tonal reversing alarms and ground compaction plant which are often the most intrusive noise generating elements of a large construction project."

16.9.14 On this basis a comprehensive CNVMP is provided alongside this chapter to be accommodated into the wider CEMP for the proposed development.

16.9.15 An indicative assessment of construction noise for track improvement works, as relevant with potential for significant effect, and other affects such as from blasting overpressure and vibration have therefore been included completed in accordance with relevant guidance.

Construction Noise - Improvement Works on Southern Access Route

16.9.16 All traffic will report to the Invergarry Staging Area. Which is expected to fall outside the SAR and further along the existing road network.

16.9.17 The site will then be accessed by the SAR, diverting from the A87, and bypassing the majority of the C1144 and noise sensitive receptors located along its length in the approach to Loch Quoich, this is indicated on Figure 2.1 – Location Plan.

16.9.18 Operatives will leave vehicles at the staging area off site and use provided shuttle buses along the A87, and the SAR to access Site Compound 1 (SC1) and accommodation provision and subsequently be shuttled beyond to the main PSH works area at Loch Quoich.

16.9.19 The SAR will therefore act as embedded mitigation to the scheme diverting site related construction traffic away from key noise sensitive receptors.

16.9.20 However improvement works to trackways will be required to facilitate this traffic this along the SAR route,

16.9.21 On this basis SLR have undertaken a track improvement construction noise impact assessment for the principal improvement works to the SAR.

16.9.22 The worst case will be the closest centre point along the route for a segment of road works relative to the nearest noise sensitive receptor of interest. With impacts reducing as works progress beyond, relative to each noise sensitive receptor in question.

16.9.23 For the upgrade of access roads/tracks associated with the SAR, predictions have been completed in accordance with the procedures detailed in Section F.2.2 of BS 5228-1. The operational noise data, in terms of $L_{Aeq,T}$ at 10m distance, has been referenced from Annex C of the Standard for an anticipated road construction plant compliment

16.9.24 At this stage, detail of the plant requirements for road construction and upgrade works are not finalised, an assumes typical quantitative plant selection has been presented in **Table 16-A2-1** and **Table 16-A2-2 of Appendix 16-2.**

16.9.25 Predictions assume a typical plant operating scenario for this item of work for such road works as has been assumed, as illustrated in the **Figure 16-A2-1** of **Appendix 16.2.**

16.9.26 The assessment reviews impact at a location representative of the closest approach for each relevant receptor individually, with respect to the works proposed. This therefore reflects the worst-case noise impact during any construction period for these works.

16.9.27 The assessment assumes upgrade works are made sequentially along the proposed route with distance to receptor increasing prior and after this segment (and thus magnitude of noise impact decreasing) respectively beyond this location in either direction.

16.9.28 Impacts for these items have been considered with reference to the design limits presented in BS5228 and compared with the unpublished THC guidance for information purposes and discussion.

16.9.29 The magnitude of impact and its assessment against the relative thresholds is presented in **Table 16.19** and **Table 16.20** respectively.

**Table 16.19 SAR Construction Improvement Works Noise Impact Assessment**

| NSR Location | Description | Closest Distance from NSR to SAR Improvement Works (m) | Predicted Noise Level dB $L_{Aeq,T}$ | HTC Limit dB $L_{Aeq, 1\ hour}$ | | BS5228:2014 Category A Limit dB $L_{Aeq, 1\ hour}$ | |
|---|---|---|---|---|---|---|---|
| | | | | Weekday And Saturday | Sunday | Weekday And Saturday | Sunday |
| NSR2 | Kingie Lodge | 475 | 50 | 55 | 40 | 65 | 55 |
| NRS3 | Residential Dwelling North of C1144 | 525 | 49 | 55 | 40 | 65 | 55 |
| NRS4 | Residential Dwellings Near Faichem/ Invergarry and River Garry | 130 | 60 | 55 | 40 | 65 | 55 |
| NSR 5 | Tigh Sheorais (Cross Household) | 1600 | 39 | 55 | 40 | 65 | 55 |
| NSR 6 | Tigh Na Eilde (Tanglewood) | 1455 | 40 | 55 | 40 | 65 | 55 |
| NSR 7 | Dwellings about Coille Mhorgil | 640 | 47 | 55 | 40 | 65 | 55 |
| NSR 8 | Garry Gualach | 720 | 46 | 55 | 40 | 65 | 55 |

**Table 16.20 SAR Construction Improvement Works Noise Impact Assessment Magnitude Significance**

| NSR Location | Description | Closest Distance from NSR to SAR Improvement Works (m) | Predicted Noise Level dB $L_{Aeq,T}$ | HTC Limit Compliance Magnitude | | BS5228:2014 Category A Limit Compliance Magnitude | |
|---|---|---|---|---|---|---|---|
| | | | | Weekday And Saturday | Sunday | Weekday And Saturday | Sunday |
| NSR2 | Kingie Lodge | 475 | 50 | Negligible | Major | Negligible | Negligible |
| NRS3 | Residential Dwelling North of C1144 | 525 | 49 | Negligible | Major | Negligible | Negligible |
| NRS4 | Residential Dwellings Near Faichem/ Invergarry and River Garry | 130 | 60 | Major | Major | Negligible | Major |
| NSR 5 | Tigh Sheorais (Cross Household) | 1600 | 39 | Negligible | Negligible | Negligible | Negligible |
| NSR 6 | Tigh Na Eilde (Tanglewood) | 1455 | 40 | Negligible | Negligible | Negligible | Negligible |
| NSR 7 | Dwellings about Coille Mhorgil | 640 | 47 | Negligible | Major | Negligible | Negligible |
| NSR 8 | Garry Gualach | 720 | 46 | Negligible | Major | Negligible | Negligible |

16.9.30 It can be seen from Table 16.20 that for weekday works on road improvements to the SAR, the magnitude of impact at worst case affected links is predicted to be a localised temporary **negligible adverse magnitude** with reference to BS5228:2014 at high sensitivity receptors and therefore **negligible significance of effect** which is not significant.

16.9.31 For weekday works with reference to the THC guidance, which is advisory, it is recognised that a perceived **major adverse magnitude impact** is predicted at NSR4, which is a high sensitivity receptor and therefore **major significance of effect** which is significant.

16.9.32 For Sunday works on road improvements to the SAR, when unmitigated, magnitude of impact at worst case affected links at NSR 4 is predicted to be a localised temporary major adverse magnitude with reference to BS5228:2014 at high sensitivity receptors and therefore major significance of effect which is significant.

16.9.33 For Sunday works with reference to the THC guidance is advisory, it is recognised that a perceived major magnitude impact is predicted at NSR2, NSR3. NSR4. NSR7 and NSR8 and therefore **major significance of effect** which is significant.

16.9.34 Mitigation and context are accordingly discussed in Section 16.12.

Construction Traffic Noise on Public Highways

16.9.35 Construction traffic may alter noise levels on the affected network for the duration of the construction period. Receptors most indicated to be impacted by these activities would be those identified in the vicinity of the A87 Junction at Invergarry identified as NSR4.

16.9.36 Traffic data for the construction stage has been provided within the "Transport and Access" chapter to the EIA.

16.9.37 It is noted that no AAWT (Average Annual Weekday Traffic) figures are provided due to the relatively low overall traffic flow. On this basis calculations have considered the AADT (Average Annual Daily Traffic) figures provided and compared with the publicly available baseline traffic survey data from point (30776) published at roadtraffic.dft.gov.uk.

16.9.38 For the purposes of this assessment this is considered representative when considering noise change only as a result of the construction phase.

16.9.39 In accordance with the DMRB LA111, an assessment to include the indicated road link for which traffic flow data has been provided based upon comparison of the 2023 Baseline and the projected maximum likely daily traffic associated with the construction works.

16.9.40 The links below have been considered:

16.9.41 A87 Site Access

16.9.42 For this link the BNL has been established for the "With" and "Without" Construction Activities of the Scheme in the 2029 baseline year, utilising the 2023 traffic count at point 30776 as representative of 2029 baseline. This is considered robust in that 2028 baseline may be higher reducing perceived impacts.

16.9.43 Note: The scenario presented is for the highest intensity construction period (June 2034) in respect to average daily construction traffic expected for robustness of assessment.

16.9.44 The BNL is the calculated $L_{A10,\ 18\text{-}hr}$ dB noise level at 10m from the kerb of the road assessed.

16.9.45 The public data set for location point 30776 is presented below in **Table 16.21.**

**Table 16.21 Average Annual Daily Traffic (A87 DfT Point 30776) 2023**

| Survey Location | Light (Cars, LGV) | Heavy (Bus/HGV) | Heavy % | Total |
|---|---|---|---|---|
| A87 at access to SAR | 1305 | 98 | 6.6 | 1474 |

16.9.46 On the basis of the project transport data included in **Appendix X to Chapter X "Transport Access"** the below flows in **Table 16.22** are considered to represent the highest intensity of activity on the public network in any 1 day.

**Table 16.22 Peak Construction Daily Traffic (A87 to SAR junction)**

| Location | Light (Cars, LGV) | Heavy (Bus/HGV) | Heavy % | Total |
|---|---|---|---|---|
| A87 at access to SAR | 46 | 180 | 80 | 225 |

*including abnormal loads.

16.9.47 Calculations have been undertaken to compare the cumulative construction traffic + baseline (2023) with the baseline (2023) to derive potential noise change.

16.9.48 This is presented in **Table 16.23** below.

**Table 16.23 Peak Construction Daily Traffic (A87 to SAR junction at Invergarry)**

| Location | Condition | Light (Cars, LGV) | Heavy (HGV) | Heavy % | Velocity (KPH) | Total | BNL dB $L_{A10,18\ hour}$ |
|---|---|---|---|---|---|---|---|
| A87 at access to SAR. | Baseline 2028 (2023)* | 1305 | 98 | 6.6 | 45 | 1474 | 64.1 |
| A87 at access to SAR | Baseline 2028 (2023)*+ Constr. Traffic | 1351 | 276 | 20 | 45 | 1627 | 66.3 |

*Assumed representative of 2028.

16.9.49 It should be noted that the modelling exercise is not able to accommodate and consider HGV speed limit restrictions on links.

16.9.50 In addition, there is potential uncertainty with noise prediction from low traffic flows and the use of annual average daily traffic flows (AADF), as opposed to average annual weekday traffic data (AAWT), nonetheless it is considered that the relative uncertainty is negligible given it applies to both the baseline and baseline plus construction traffic scenario under consideration.

16.9.51 It is found that 2.2dB change would be expected on the A87 as a result of construction traffic during the highest intensity 1 day period.

16.9.52 The magnitude of impact at worst case affected links is predicted to be a localised temporary **minor magnitude** at high sensitivity receptors and therefore **minor significance** of effects which is not significant.

16.9.53 A general scheme of construction traffic mitigation is presented in the “Transport and Access” chapter. Note in respect to immediate receptors in proximity to the propsoed site, the provision of an offsite staging area avoids noise impacts from substantial traffic accessing the SAR or C1144 directly.

Construction Traffic Noise and Vibration on Southern Access Route (SAR) from A87 to to Site Compound 1 (SC1)

16.9.54 For the purpose of this assessment, traffic on the SAR travelling between the A87 junction to the principal SC1 work area associated with the scheme, has been considered construction traffic where no existing traffic flow exists presently.

16.9.55 SLR has considered the noise sensitive residential receptors in respect to their distance from the SAR.

16.9.56 Where noise sensitive receptors lie closer to the SAR link between the A87, and SC1 the traffic flows within this section have been considered, similarly where a noise sensitive receptor lies between SC1 and the Fearna PSH site, traffic flows on this link have been considered.

16.9.57 **Table 16.24** below highlights the distance, predicted Peak Daily traffic flow characteristics between the SAR and SC1, and SC1 and the Fearna PSH site respectively.

**Table 16.24 Peak Construction Daily Traffic (SAR to SC1 construction traffic data)**

| Link Description | Peak Total Daily Traffic Flow | |
|---|---|---|
| | Shuttle Bus | HGV+ Unusual Load |
| A87 to SC1 via SAR (Link A) | 46 | 180 |
| SC1 to Fearna PSH Site via SAR (Link B) | 250 | 180 |

16.9.58 On the basis of the above, SLR has robustly assumed that in any peak 1 hour period 50% of the above light shuttle bus traffic, and that 25% of HGV movements may occur in any peak 1 hour period.

16.9.59 Given the limited quantity of road traffic along the access route falling below the limit of reliability for CRTN methods1, being generally about the threshold of 50 No. movements per hour, a haul road method has been used as described by BS 5228-12 as defining an equivalent line source in model space. Octave band input data of been taken from SLR's library of measurements of HGVs and cars at 10 MPH/16 KPH from similar sites.

16.9.60 Noise predictions have been completed for each of the above work activities and to the NSR's identified have been summarised in **Table 16.25**, using procedures outlined above.

**Table 16.25 Input Noise Data (SAR to SC1)**

| Speed, km/h | Vehicle Type | Input Sound Power Level, dB $L_{wA}$ |
|---|---|---|
| 16 | HGV | 93 |
| | Shuttle Bus | 80 |

16.9.61 For the prediction of additional noise due to vehicle movements along the SAR, the method described in Section F.2.5.2 of BS 5228-1 has been used, referencing the following expression:

$$L_{Aeq,T} = L_{wA} -33 + 10\log Q – 10\log V -10\log d – 10 \log (av,/180^{o})$$

Where:

- $L_{wA}$ is the sound power level of the Dump Trucks;
- Q is the number of vehicles per hour;
- V is the average vehicle speed (km/h);
- d is the distance of the receiving position from the centre of the haul road (m); and
- av is the angle of view of the haul road from the receptor position.

[1] Section II, Para 30. Department of Transport Welsh Office – The Calculation of Road Traffic Noise. HMSO, 1988.

[2] Section F2.5. British Standard BS 5228-1:2009 +A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.

16.9.62 The calculations undertaken are presented in full in **Appendix 16-2.**

16.9.63 The magnitude of impact and its assessment against the relative thresholds is presented in **Table 16.26** and **Table 16.27** respectively below.

**Table 16.26 Peak Hour Construction Daily Traffic (SAR to SC1 Construction Traffic Data) Noise Impact Assessment**

| NSR Loc. | Desc. | Dist. NSR to SAR (m) And Relevant Link. | Predicted Field Incident Noise Level at 1m from NSR dB $L_{Aeq, T}$ | HTC Limit dB $L_{Aeq, 1\ hour}$ | | BS5228:2014 Category A Limit dB $L_{Aeq, 1\ hour}$ | |
|---|---|---|---|---|---|---|---|
| | | | | Weekday | Sunday | Weekday | Sunday |
| NSR2 | Kingie Lodge | 475 (Link B) | 16 | 55 | 40 | 65 | 55 |
| NRS3 | Residential Dwelling North of C1144 | 525 (Link B) | 16 | 55 | 40 | 65 | 55 |
| NRS4 | Residential Dwellings Near Faichem/ Invergarry and River Garry | 130 (Link A) | 20 | 55 | 40 | 65 | 55 |
| NSR 5 | Tigh Sheorais (Cross Household) | 1600 (Link A) | 10 | 55 | 40 | 65 | 55 |
| NSR 6 | Tigh Na Eilde (Tanglewood) | 1455 (Link A) | 10 | 55 | 40 | 65 | 55 |
| NSR 7 | Dwellings about Coille Mhorgil | 640 (Link B) | 14 | 55 | 40 | 65 | 55 |
| NSR 8 | Garry Gualach | 720 (Link A) | 14 | 55 | 40 | 65 | 55 |

**Table 16.26 Peak Hour Construction Daily Traffic (SAR to SC1 Construction Traffic Data) Magnitude Assessment**

| NSR Location | Description | Predicted Noise Level dB $L_{Aeq,T}$ | HTC Limit Compliance Magnitude | | BS5228:2014 Category A Limit Compliance Magnitude | |
|---|---|---|---|---|---|---|
| | | | Weekday And Saturday | Sunday | Weekday And Saturday | Sunday |
| NSR2 | Kingie Lodge | 16 | Negligible | Negligible | Negligible | Negligible |
| NRS3 | Residential Dwelling North of C1144 | 16 | Negligible | Negligible | Negligible | Negligible |
| NRS4 | Residential Dwellings Near Faichem/ Invergarry and River Garry | 20 | Negligible | Negligible | Negligible | Negligible |
| NSR 5 | Tigh Sheorais (Cross Household) | 10 | Negligible | Negligible | Negligible | Negligible |
| NSR 6 | Tigh Na Eilde (Tanglewood) | 10 | Negligible | Negligible | Negligible | Negligible |
| NSR 7 | Dwellings about Coille Mhorgil | 14 | Negligible | Negligible | Negligible | Negligible |
| NSR 8 | Garry Gualach | 14 | Negligible | Negligible | Negligible | Negligible |

16.9.64 The magnitude of impact at affected receptors is predicted to be a localised temporary **negligible magnitude** with reference to BS5228:2014 and HTC guidance at high sensitivity receptors and therefore **negligible significance of effect**, considered **not significant.**

Construction Vibration – Surface Plant Except Piling

16.9.65 Research by the Transport and Road Research Laboratory found that the levels of groundborne vibration from tracked earth moving equipment (such as a bulldozer or excavator) are imperceptible to humans at a distance of approximately 20m, and those generated by vehicles with rubber tyres (e.g. a heavy lorry or dump truck) would be imperceptible at more than 10m.

16.9.66 Site tracks, haul routes and the SAR will not come within 500m of an identified sensitive receptor during site access; hence vibration is not likely to be perceptible or of a magnitude that could cause complaint.

16.9.67 On public roads, vibration would be not greater than that experienced from existing HGV passes and thus is not explored further.

16.9.68 It is concluded that the magnitude of vibration impacts for surface plant would be no worse than Minor adverse magnitude at the closest NSRs. Which is a localised, temporary, negligible significance of effect for all NSRs, which is considered to be not significant.

16.9.69 Hydraulic hammers and breakers that are mounted on excavators will cause groundborne vibration from their impulsive percussive action.

16.9.70 Typical safe working distances from this type of equipment are shown in **Table 16.27** below.

16.9.71 This table has been taken from the Australian document "Construction Noise Strategy (Rail Projects)" (NSW Transport Construction Authority) as indicative advice for safe working distance to comply with the vibration criterion levels published within BS 6472-1:2008 and BS 7385-1:1993.

**Table 16.27 Recommended safe working distances for Hydraulic Hammers**

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

16.9.72 In the worst case, at the closest interface, receptors are more than 400 m from where hydraulic hammer rock breaking may occur within the identified SC1

16.9.73 As such the values provided within Table 18.26 demonstrate that all identified high sensitivity NSRs are unlikely to perceive the vibration from hydraulic hammer rock breaking.

16.9.74 It is concluded that the magnitude of vibration impacts for surface plant would be no worse than **negligible adverse magnitude** at the closest NSRs. Which is a localised, temporary, **negligible significance of effec**t for all NSRs, which is considered to be **not significant.**

Construction Vibration - Piling

16.9.75 Piling is anticipated to be required during the construction of the powerhouse and dams. Piling vibration impact has therefore been considered.

16.9.76 Predictions of the groundborne vibration generated by the piling have been performed using the methodology in BS 5228-2:2009+A1:2014. It is anticipated that that all piles will be driven to refusal and that the maximum pile driver hammer energy has the potential to be around 225kJ.

16.9.77 This is greater than the stated range of hammer energy in the prediction method, which is 1 to 85 kJ. BS 5228-2:2009+A1:2014 doesn't state an applicable distance range for the prediction methodology, however the research on which it is based (Groundborne vibration caused by mechanised construction works, Hiller and Crabb, 2000) validated the equation with measured levels at distances of up to 120m.

16.9.78 The closest residential NSR to the piling location is NSR 4 at a distance of 3,450m.

16.9.79 At this distance the predicted vibration level is <1mm/s. However, on the basis that the hammer energy levels and distance from the source exceed the range of accuracy of the standard the potential levels at the receptor have been considered further by examining the historic case study data in BS 5228-2:2009. There are seven reported measurements of vibration levels generated by sheet steel piling at distances in excess of 100m and these are shown below in **Table 16.28.**

**Table 16.28 BS 5228-2:2009 relevant historic data on vibration from driven sheet steel piling**

| Soil conditions | Theoretical Energy Per Blow (kJ) | Distance (m) | PPV (mm/s) |
|---|---|---|---|
| Fill / 6 m alluvium / 4 m to 6 m peat, clay, sand and silt / 1.3 m sand | 71.6 to 143.2 | 130-250 | 0.1 |
| gravel / 5 m stiff clay / 9 m dense sand / hard chalk | | | 0.015 to 0.025 |
| Not recorded | Not recorded | 300 | 0.015 |

16.9.80 It should be noted that the data in **Table 16.28** are for lower energies per blow than proposed, and that it may not have been the case that piles were driven to refusal.

16.9.81 Nevertheless, given that the limit of 1mm/s (at which impact magnitudes become moderate) is 10 times the highest of the measured evidence levels from BS5228 reference data, it is considered highly likely that the actual levels will be below this noting the significantly larger intervening distances to receptors.

16.9.82 It is concluded that the magnitude of vibration impacts for piling would be no worse than **minor adverse magnitude** at the closest NSRs. Which is a localised, temporary**, negligible significance of effect** for all NSRs, which is considered to be **not significant.**

16.9.83 SLR understand there are no sensitive underground services in the vicinity of the proposed works.

16.9.84 Therefore, further assessment of infrastructure receptors has been scoped out of assessment.

16.9.85 Regarding the accuracy of these predictions BS 5228-2 states:

*16.9.86 'The various formulae which have been developed empirically to predict vibration levels at a receiving point do not take into account variability of ground strata, the pile-soil interaction process, coupling between the ground and the foundations, etc. Hence these formulae can only provide a first assessment of whether or not the vibrations emanating from a site are likely to constitute a problem.*

*16.9.87 More accurate assessment can be achieved by the calibration of the site, i.e. the establishment of a site-specific formula. In the case of impact pile driving, the data necessary for the derivation of the formula can be obtained from one or more trial drive(s) using a piling rig, and recording the vibration levels at various distances from the pile position."*

Construction Groundborne Noise and Vibration - Tunnelling

16.9.88 Tunnel Boring Machine (TBM) or "drill and fire" techniques are anticipated to be used to excavate the Tunnels required by the development design.

16.9.89 BS 5228- 2:2009 provides guidance on calculating first estimates of potential groundborne vibration and noise levels from tunnel boring (Annex E.1). The empirical formulae within Table E.1 of the standard used to calculate groundborne vibration and noise from tunnelling are limited to the distance range of 10m to 100m. The closest NSR to the Waterway route is which is approximately 3,800m from the Tunnel locations identified.

16.9.90 The formulae have been employed to gain an indication of the groundborne vibration and noise at a nominal distance of 100m, the groundborne vibration is predicted to be PPV 0.45mm/s. The groundborne noise level is predicted to be a sound pressure level of 19dB. The groundborne noise

level generate by the TBM is anticipated to be very steady and hence it is considered that this level equates to a value of 19dB $L_{ASMax}$.

16.9.91 All NSRs are at distances greater than 100m (by an order of magnitude) from the tunnelling works proposed, and it would be expected that groundborne vibration and noise effects would decrease with increasing distance.

16.9.92 While this may be true, the authors of the original document cited by BS 5228:2009: 'Groundborne vibration caused by mechanised construction works' (Traffic and Transport Research Laboratory) warn that due to the formulae being derived from TBM activities over a limited range of materials, it is possible that formulae may underestimate predicted values for tunnelling in stronger rock.

16.9.93 They also caution against the extrapolation of the formulae for distance greater than 100m. However, given the very large disparity in distance to receptors relative to the above evidence, it is not considered that monitoring or further assessment is warranted.

16.9.94 These results indicate that for distances of at least 100m from the tunnelling, groundborne vibration and noise impacts are expected to be negligible respectively.

16.9.95 Given that the effects of groundborne vibration are therefore of localised, temporary minor magnitude and those of groundborne noise are of localised, temporary negligible significance of effect. Both effects are Not Significant beyond 100m noting the minimum receptor distance of approximately 3,800m to proposed tunnel works.

16.9.96 As mentioned above further calculations have not been carried out to determine potential vibration damage to underground services where none of significance are known to be present.

16.9.97 The TBM will not travel close to BT Openreach Cables, or the Scottish Water main infrastructure and therefore assessment of vibration impacts on these aspects has been scoped out of further assessment.

Construction Groundborne Vibration - Blasting/Drilling

16.9.98 The level of ground-borne vibration arising from mechanised construction works, at a receptor position, is difficult to predict, as there are a number of factors that may influence the production and transmission of vibration in the ground, including:

- local ground (or soil) conditions at the construction site;
- the distance between source and receiver;
- the ground geology between source and receptor (the transmission path); and
- local ground conditions at the receptor position.

16.9.99 Whilst BS 5225-2 (Annex E) provides empirical formulae, to allow prediction of resultant PPV values from mechanised construction works, the parameter range for input distance only extends to 110m, which would tie in with the expectation that prediction of vibration to large distances would have limited accuracy.

16.9.100 Annex D and E of BS 5228-2 provides historic case data on vibration levels produced by various piling operations, which would typically produce ground vibration through percussive, or vibratory modes of piling.

16.9.101 As would be expected, the majority of the presented data relates to vibration produced at distances up to 100m, which are most representative of typical sensitivity range. However, relevant detail on larger distances includes a measurement of PPV 0.1mms-1 at 130m and 0.025mms-1 at 250m, both resulting from driving sheet piles using a diesel hammer rig.

16.9.102 The lower reservoir works would include for use of mechanised equipment, such as rock drills and drilling rigs, which have potential for producing localised ground vibration. However, a qualitative assessment, including review of BS 5228-2 guidance, would indicate that, due to the large separation distance (>2800m to the closest residential noise sensitive receptor position), the

resulting vibration PPV levels would be below 1mms-1, and consequently the potential impact would be negligible.

16.9.103 The more likely cause of ground vibration and associated potential impact, would be from blasting completed mainly in connection with lower reservoir works, which may include:

- blasting activities associated with construction of the inlet/outlet area;
- blasting activities associated with construction of the powerhouse shafts; and
- blasting activities associated with construction of tunnels.

16.9.104 There may also be some blasting required within the borrow pits.

16.9.105 The level of vibration resulting from blasting is dependent on site-specific factors, such as distance from the blast, explosive charge weight and ground geology between blast and receiver.

16.9.106 Whilst vibration levels due to blasting activities are likely to be low, due to the large distance separation between the blasting sites and closest receptor positions, this would be confirmed by undertaking vibration tests during either blasting trials, or during the early stages of blasting operations.

16.9.107 As outlined in section E.2 of BS 5228-2, for the purpose of predicting site-specific ground vibration resulting from blasting it is necessary to complete a series of concurrent vibration measurements at different distances from the blast site. These measurements are then used to produce a scaled-distance graph, which can be used to indicate likely vibration magnitudes at various distances and to establish maximum instantaneous charge size, to meet acceptable vibration PPV limits.

16.9.108 Potential adverse impact from ground vibration would therefore be avoided by employing good blast design, in particular to the use of the appropriate charge sizes, to meet vibration limits appropriate to both human response and to protect buildings from damage (see **Table 16.7**). The methodology for the vibration testing programme would be provided in the CNVMP, when more detail on the design of the blasting activities are known.

Blast Generated Air Overpressure

16.9.109 BS 5228-2 states that there is no known evidence of blast generated air overpressure causing structural damage to buildings, with adverse comment more likely to result from the air overpressure exciting secondary vibrations (such as in windows) at audible frequencies.

16.9.110 The Standard further notes that, due to uncertainties with meteorological conditions, it is not possible to predict the location of the maximum air overpressure from a blast. Given the additional consideration that windy conditions can mask the blast generated air overpressure levels it is not accepted practice to set specific limits for air overpressure.

16.9.111 The best practical approach for the control of air overpressure, as noted in BS 5228-2, is to take measures in the design of the blasting technique, to minimise its generation.

16.9.112 Potential adverse impact resulting from air-overpressure produced by blasting operations would therefore be avoided by employing good blast design in consultation with the blasting specialist.

16.9.113 Additionally, monitoring of air-overpressure during blasting activities would be completed during the initial stages of the project in conjunction with ground vibration measurements to further evidence the low risk of concern, using the same seismograph instrumentation.

16.9.114 Detail of the monitoring programme would be included in the CNVMP, when more detail on the design of the blasting programme is known.

16.9.115 Potential blasting vibration impacts on ecological receptors are considered within **Chapter 8: Terrestrial Ecology** and **Chapter 10: Ornithology**.

Construction Blasting (Risk of Rockfall)

16.9.116 As the distances involved, physical safety is not indicated to be an issue, stand-off distances for operatives involved in blasting works for example would be significantly smaller and still considered safe with respect to the percussive wave experienced from blasting activity.

16.9.117 Previous studies such as "Impact Assessment of Blasting on Vulnerable Landslide Area" (Dev, Pratap et all, 2015) have shown that beyond circa 250m distance a PPV exceeding 5mms$^{-1}$ as a result of blasting is unlikely during damn building, even with explosive charges exceeding 1000kg in size which is unlikely to reflect proposals at Fearna.

16.9.118 The predicted PPV would thus therefore be well below the threshold for transient vibration induced minor cosmetic damage to buildings (from BS 7385-2:1993), for even light weight unreinforced structures, damage thresholds are still orders of magnitude (15mms$^{-1}$) above the threshold of perception and the substantially higher equivalent values likely to provoke complaint or movement of material.

16.9.119 The principal concern would be tourists in the vicinity being able to anticipate blasts as best as practicable so as not to be shocked by construction activity disrupting safety.

16.9.120 Again, this would be best managed through clear signage alongside any recreational signage in the surround, as well as on websites associated with climbing, rambling or walking in the area, which could be frequently updated with blasting times and if possible, intervals of said blasts.

16.9.121 In all likelihood once a blasting event is experienced by an individual (at a safe distance) the phenomena would not be of further concern as a tourist would become accustomed to its periodicity and magnitude particualrly if well signposted.

16.9.122 Ultimately good blasting design, and review of potential geological faults in the region is likely to be sufficient to ensure rock fall and other impacts can be avoided in areas which may still be accessed by the public in the vicinity.

16.9.123 In regards to landslide risk, this is covered in length specific to the project with reference to document *"5223504-ATK-RP-GE-002 Landslide Hazard Assessment Rev 002".*

16.9.124 This preliminary assessment has deemed the landslide hazard risk to be low, AtkinsRéalis considers that more detailed analysis using numerical modelling will however be required at such time as ground investigations occur.

Operational Airborne Noise

16.9.125 Potential operational airborne noise sources associated with Proposed Development are as follows:

- 1turbines and generators;
- .transformers and switchgear;
- emergency generators; and substation.

*Underground or Enclosed Equipment*

16.9.126 The turbines, generators, transformers, switchgear, and emergency generators will be located within the powerhouse.

16.9.127 The emergency generators will only operate in the event of a power cut to the Site, which is highly unlikely to occur.

16.9.128 The sound power levels of the turbines, generators, emergency generators and associated equipment are not yet known. However, modern gas insulated switchgear equipment emits very low noise levels during operation.

16.9.129 At this stage, no detailed information is available regarding the sound power level or acoustic character of sound from the proposed transformers; however, these commonly produce a strong tonality at levels of 50 and / or 100Hz due to the frequency of mains electricity.

16.9.130 Given the installation is enclosed it is highly unlikely that there will be any audible operational noise from the below ground equipment and tunnels will result at the surface due to the intervening rock and building infrastructure providing significant mass and sound insulation and therefore additional attenuation over that already afforded by intervening distance.

16.9.131 Where rock is generally between 1,600kg/$m^3$ (sediments) and 2,600kg/$m^3$ granite, achieving attenuation of airborne sound of 50-55dB $R_w$ at just 150mm depth.

16.9.132 Similarly concrete and even lightweight building materials will provide attenuation of airborne sound upwards of 40dB $R_w$.

16.9.133 In addition, noting the closest residential NSR position is located in excess of a distance of 3,500 m from the proposed operational elements at the lower loch.

16.9.134 At this propagation distance, the sound level reduction, relative to hemispherical source sound power emission above ground, would be -79 dB, taking account of distance attenuation.

16.9.135 Other propagation features, such as atmospheric attenuation, ground attenuation correction and physical screening due to topography would only further increase this figure.

16.9.136 The reversible pump-turbines, motor-generators and other main equipment items would be housed inside, thus reducing noise breakout from the building to the outside environment to low levels from the outset in the immediate surround.

16.9.137 The mitigating design features, alongside the large receptor distance, would ensure that the specific sound level at the closest receptors would likely be below 25 dBA outside dwellings and therefore below 10dB $L_{Aeq,T}$ indoors accounting for additional losses of 12-15dB for an open window. Which aligns with consultation discussion with THC.

16.9.138 Hydro turbines are installed on concrete inertia bases, with turbines that are orientated vertically commonly being housed in the basement of the powerhouse and having the spiral casing of the turbine partially embedded in concrete. These measures are designed to minimise vibration on and local to the equipment, so preventing it entering the ground.

16.9.139 There may be potential for low frequency noise (LFN) from the operation of the turbines, but this is deemed unlikely due to the depth of the turbines installation level (over 60m below ground level) and the incorporated attenuation and building design as well as substantial intervening distances involved to NSR locations as noted.

16.9.140 BS4142:2014+A1:2019 refers to the University of Salford ‘Procedure for the assessment of low frequency noise complaints - NANR45’ (2005) for the assessment of LFN.

16.9.141 LFN can be very difficult to predict with a high level of certainty and similarly hard to identify and resolve if present. This is because it can be generated by the unexpected interactions between system components and can be amplified by the geometry of the Development Site and receptor buildings.

16.9.142 However, there are several risk factors that are known to make the generation of LFN more likely. The potential issue of LFN will be considered throughout the detailed design for the Proposed Development and mitigated through design.

16.9.143 However, these are unlikely to be an issue due to the distance between the source of the vibration (the turbines) and the nearest NSR (>3,500m).

16.9.144 Even at 400m the levels at which minor adverse magnitude impacts would occur (0.1 mm/s for night-time groundborne vibration and 30 dB $L_{ASmax}$ for groundborne noise) are highly unlikely to be

exceeded, clearly at higher distances as evidenced between the Site and residential NSR locations the risks are further reduced, and likely negligible magnitude at the distances in question.

16.9.145 Therefore, negligible magnitude impacts of negligible significance of effect are expected. Both effects are not significant beyond 400m noting the minimum receptor distance of approximately 3,800m the powerhouse and other infrastructure associated with the proposed Development.

*Above Ground Equipment- Operational Airborne Noise Limits*

16.9.146 The transformers will be owned by the project. There are presently two options under discussion/design devleopment – 18no. 18/400kV 120MVA single phase transformers or 6no. 350MVA three-phase transformers.

16.9.147 The Project's switchgear will be GIS and housed within a building, noise egress will be well controlled and ultimately limited by the building fabric surrounding.

16.9.148 At this stage the SSE switchgear will be external AIS switchgear – this will be 3no. 400kV metering circuit breakers. This may however change to GIS during design devleopment, but this is not confirmed at this stage.

16.9.149 Typically, based on prior experience of PSH projects such a substation would generate sound pressure levels of no greater than 70 dB(A) at 5m from the substation fence. In all likelihood where plant is enclosed within a structure this only will reduce external noise emissions further.

16.9.150 Equipment associated with the operation of the Powerhouse building and Switchyard will be at least 3,500m from any residential NSR location.

16.9.151 Based on the above findings and based on the previously discussed acoustic distance losses resulting, it is considered that the risk of noise impact from static plant during the operational phase at Site is low.

16.9.152 It is submitted that the conditions as proposed and discussed at consultation can be utilised to control operational noise emissions.

16.9.153 Qualitative submission of a noise impact assessment to discharge this condition could then be provided outside the EIA framework if needed at such time as firm details of the plant schedule and substation layout are known in detail.

16.9.154 Operational airborne noise limits can be determined using the BS 4142:2014 assessment methodology with the rating level derived assessed against the fixed 25BA $L_{Aeq,\,T}$ limit discussed with THC.

16.9.155 Note that as per BS 4142:2014+A1:2019, the target rating level includes any potential character corrections (due to characteristics such as tonality, impulsivity and intermittency) to the specific sound level. At this stage information on the characteristics of the sound sources (e.g. any tonal features) are yet to be determined, however these will be considered during detailed design.

16.9.156 Detailed assessment of the proposed operational limits should include any relevant correction for characteristics such as tonality, impulsivity and intermittency), with recognition that the majority of noise generating equipment is beneath ground at depth. It is anticipated based the evidence presented here and from the outset that that limits such as those above can readily be achieved.

16.9.157 Specific consideration will be given to the context, in particular, as the absolute levels are considered very low and such low limits may not be necessary to avoid effects on NSRs.

16.9.158 Any necessary noise control design measures will be finalised during detailed design to ensure appropriate operational noise limits are achieved, therefore impacts no greater than minor magnitude will occur.

16.9.159 There may be potential for low frequency noise (LFN) from the operation of the turbines, but this is deemed unlikely due to the depth of the turbines below ground level and the incorporated attenuation and building design.

16.9.160 BS4142:2014 refers to the University of Salford 'Procedure for the assessment of low frequency noise complaints - NANR45' (2005) for the assessment of LFN.

16.9.161 LFN can be very difficult to predict with a high level of certainty and similarly hard to identify and resolve if present. This is because it can be generated by the unexpected interactions between system components and can be amplified by the geometry of the Proposed Development and receptor buildings.

16.9.162 However, there are several risk factors that are known to make the generation of LFN more likely. The potential issue of LFN will be considered throughout the detailed design for the Development and mitigated through design.

16.9.163 However, on the basis the draft conditions are put in place, and complied with by design, impacts of no greater than **Negligible magnitude** are expected, which is a **negligible significance of effect**. Which is **Not Significant**.

## 16.10 Ecological Receptors

16.10.1 Noise and vibration impact on ecological receptors are discussed in Chapter 8: Terrestrial Ecology and Chapter 10: Ornithology.

16.10.2 Potential underwater noise and vibration impacts on ecological receptors are considered within Chapter 11: Aquatic Ecology. Where relevant guidance has been provided within this Chapter to inform these assessments.

16.10.3 In summary subject to mitigation identified the Terrestrial Ecology discusses potential disturbance of fauna utilising retained habitat via human presence, construction noise, vibration, and temporary construction lighting. This finds potential impacts as Not Significant.

16.10.4 Similarly the Ornithology Chapter discusses potential disturbance of fauna utilising retained habitat via human presence, construction noise, vibration, and temporary construction lighting. And finds potential impacts as Not Significant subject to identified mitigation.

16.10.5 The Aquatic Ecology chapter finds potential acoustic impacts to be Not Significant subject to mitigation as identified.

16.10.6 The chapter highlights that Construction noise and vibration would be managed through a Construction Noise & Vibration Management Plan (CNVMP) which would be agreed prior to construction works.

## 16.11 Cumulative Effects

16.11.1 When considering how contributions from two separate noise sources add together, to produce a cumulative total noise, it is important to have some understanding of the principals of noise level addition.

16.11.2 The addition of sound levels (or more correctly sound pressure levels) is sometimes referred to as 'decibel addition', or 'logarithmic addition'. In arithmetic addition, the sum of 50+50 is 100, but in decibel addition, 50dB + 50dB = 53dB. As the difference between noise levels becomes greater the total value (or cumulative total) becomes closer to the higher value. For example, where two sources produce sound levels of 50dB and 45dB, respectively, the total, or cumulative, sound level is 51.2dB, representing a small 1.2dB increase to the higher of the two sound levels. When the difference between the sound levels is 10dB, e.g. 50dB + 40dB, then the total is only 50.4dB, so more or less an insignificant increase.

16.11.3 The way sound levels add together means that where a sound level from a new source is below the current ambient sound level by 10dB, or greater, there is no significant change to the current ambient sound level.

16.11.4 In a similar way, if there are two new sound sources (from two separate new developments), the contribution from each source would have to be relatively close and at least within 5dB of each other at the same receptor position, in order for the cumulative effect of the two sources to produce a perceptible increase (above 1dB). In practice, cumulative effects of noise are therefore unlikely, unless developments are closely aligned in terms of having equal sound emission and similar distance to receptors.

16.11.5 Giving consideration to these points, the favourable siting of the power station, and relatively large distance from the closest receptors, would result in an insignificant specific noise level at receptors and no change to existing ambient noise levels, during the operational lifetime.

16.11.6 Accordingly, operational noise from the powerhouse would be unlikely to contribute to the specific noise resulting from any other potential developments planned in the area, of which SLR are not aware of any of significance in respect to noise generation in the immediate vicinity.

16.11.7 The low noise contribution from the longer-term elements of the construction works which have largely been scoped out of detailed assessment would similarly be unlikely to contribute significantly to cumulative noise resulting from any other potential developments planned in the area.

16.11.8 It has also been demonstrated that the higher noise levels, resulting in significant change (5dB(A) or higher) to current daytime ambient noise levels, would be produced by construction activities, such as road improvement works that would be undertaken in closer proximity to the noise sensitive receptor positions.

16.11.9 As these are only short to medium terms works, they would not contribute for a significant time period to continuous noise resulting from any other potential developments planned in the region.

16.11.10 On this basis , cumulative impacts are considered of **negligible magnitude,** of **negligible significance** of effect. Which is **not significant.**

## 16.12 Mitigation

### Construction Traffic Noise

16.12.1 Traffic during the construction the Proposed Development has been proposed to use the improved Southern Access Route (SAR) which would then avoid direct travel for much of the site traffic via the C1144 during the construction phase, thereby avoiding passage in close proximity to sensitive receptors alongside the C1144, this in itself acts as a form of mitigation for the scheme's construction.

16.12.2 Furthermore, the creation of a haul road to connect the lower reservoir works area to the upper reservoir and dam, provides an opportunity to supplement rock quarried within the upper reservoir, with suitable tunnel spoil from the underground works, for dam construction, thus reducing off-site disposal quantities.

16.12.3 In regard to works on the SAR, it is highlighted that at the closest approach to receptors works are unlikely continue for more than 2–3-week period for any 1 segment of road improvement works of a 100m span. Thus, is should be understood that the assessment is worst case, and that works at these distances are temporary, and relatively limited in duration.

16.12.4 The works area will move further away from the identified NSR locations, prior to, and after, this segment of works completes reducing impacts for the remainder of the SAR improvement works as distances to NSR increase respectively.

16.12.5 More detail regarding the options for the transportation and re-use of spoil is described in Chapter 2: Proposed Development.

### Monitoring

16.12.6 Monitoring of noise during construction works would be covered in a section included in the CNVMP (see **Appendix 16.3**). It is expected that monitoring of noise would only be carried out in response to a specific complaint.

16.12.7 Vibration and air-overpressure monitoring would be carried out, either during trials, or during the early stages of blasting operations, for the purpose of predicting site-specific ground vibration and air-overpressure resulting from these operations. Detail of the monitoring programme would be included in the CNVMP, when more detail on the design of the blasting programme is known.

### Construction Noise and Vibration General

16.12.8 Construction noise and vibration would primarily be managed through a CNVMP, which would be formally agreed with THC prior to construction work commencing.

16.12.9 Adherence to best practicable means (BPM) controlled through a comprehensive CVNMP has been evidentially demonstrated through practice to result reductions in construction noise in the region of 5dB.

16.12.10 Once clearer detail of the construction plant and processes are known, the appointed main contractor would develop and submit, for approval by THC, the project specific CNVMP which would detail how noise and vibration emissions would be managed during construction works. The plan would detail control measures, such as hours of work, mitigation strategy, monitoring proposals and protocol for receiving and dealing with any complaints.

16.12.11 As a general principle, consideration would be given in the CNVMP for adopting the 'best practicable means' to noise and vibration control, with particular consideration given to the guidance provided in Section 8 (Control of Noise) of BS5228-1, for the purpose of minimising noise emission. For information, an outline of the typical detail provided in the CNVMP, is included in **Appendix 16-3** to this chapter.

### Blasting Overpressure and Vibration

16.12.12 The air overpressure and vibration effects of blasting can be reduced 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.

16.12.13 Generally, it is noted and should be understood that the "drill and blast" method utilises small charges to better control the path of progress which aligns well with the above general best practice.

16.12.14 Methods employed to control air overpressure and vibration from blasting operations will need to be agreed with THC prior to any blasting, as well as the frequency of blasting and a 90% confidence limit for blast PPV values at NSRs. The PPV blasting vibration limit should follow the guidance provided within BS 6472-2:2008 of between 6.0 and 10.0mm/s during the daytime and 2.0mm/s at night.

16.12.15 Above ground blasting should not be undertaken in the early morning, late afternoon or evening. The local community will be given advance notice prior to any blasting.

16.12.16 Given the intervening dense rock, there are not expected to be any significant issues with continuous underground blasting, particularly where tunnel exits are orientated away from receptors and at significant distances. If necessary, trial blasting "above ground" would identify the worst case scenario for either above, or below ground blasting, the results which could be reported on as evidence to support the above underground blasting practices.

16.12.17 An air overpressure limit at NSRs should follow the guidance provided within BS 6472-2:2008 (120 - 150 dB(lin)) and be agreed with THC. THC is reminded that overpressure reported in dB(lin) does not correlate with audibility measured in dB(A).

16.12.18 It is recommended that a blast monitoring scheme for air overpressure and vibration be implemented.

16.12.19 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.

16.12.20 All blasts at the Site should be monitored and records maintained so that the historical peak particle velocity from blasts can be produced as required.

16.12.21 A close working relationship between the construction / blasting operator and the local planning authority will be required for the exchange of information regarding blasting events.

16.12.22 All blasting should be carried out using Best Practicable Measures (BPM) where available, to ensure that the resultant noise, vibration and air overpressure are minimised in accordance with current British Standards and guidelines.

16.12.23 Blast designs should be developed 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.

16.12.24 Fly rock requirements will be controlled through Health and Safety legislation.

### Operational Noise and Vibration

16.12.25 The best available operational methods should be employed at all times, having regard to the principles of BPM to minimise noise and vibration from the development.

16.12.26 Control measures to prevent underground plant noise from exceeding appropriate operational noise limits will be finalised during detailed design. These control techniques may include measures such as orientation away from NSRs, vent attenuators, acoustic lining within the vent shaft, and acoustic louvres at intake and extract terminals.

16.12.27 If required, mitigation for LFN and groundborne noise and vibration could include vibration isolation, mufflers, attenuators, etc. and will be considered during the detailed design stage.

16.12.28 Distance attenuation noting the site layout and context would also be significantly beneficial as would the enclosing structure design as noted to equipment propsoed in relation to the switchyard.

### Operational Traffic Noise

16.12.29 Operational traffic noise was scoped out of the EIA at consultation.

16.12.30 Nonetheless for context, traffic associated with the operational phase would be considered of negligible importance with 30 staff travelling to the site daily split across 3 circa 8 hour shift patterns.

16.12.31 This would result in no more than an estimated 20 car movements (10 in either direction) in any one hour period of shift change. Car passes will typically be isolated, in that they will not all occur simultaneously.

16.12.32 On this basis haul route methods of assessment as referenced above from BS5228:2014 where traffic flows are low have been considered, SLR calculate a noise level of <16dB $L_{Aeq,\ 1\ hour}$ at distance of 10m from the C1144 reflective of NSRs along the C1144. When considered against the BS4142:2014 1 hour assessment period for daytime.

16.12.33 This aligns with compliance of the discussed operational noise level limits at consultation of 25dBA $L_{Aeq, T}$.

## 16.13 Residual Effects

**Construction Phase**

Construction Traffic (Offsite)

16.13.1 It is considered that ultimately the construction phase traffic will be limited in the temporal domain, resulting in **negligible residual adverse impact** at high sensitivity NSRs once construction is completed of **negligible significance,** which is therefore **not significant.**

16.13.2 Where appropriate mitigation for the construction phase in the form of a CVNMP is provided in **Appendix 16.3** to this Chapter, and additional mitigation is provided in the transport and access chapter to the EIA. Although not specifically relating to noise impacts.

Construction Noise - Improvement Works on Southern Access Route

16.13.3 It is considered that ultimately the construction phase traffic will be limited in the temporal domain, resulting in **negligible residual adverse impact** at high sensitivity NSRs once construction is completed of **negligible significance,** which is therefore **not significant.**

16.13.4 It is considered that as highlighted the assessment undertaken considered the worst-case noise impact at the closest approach of a particular segment of the SAR improvement works to NSR4, in actuality works at this specific area are likely to be limited to a period of days, after which and prior to which improvement works will be at a greater distance along the proposed route from the identified receptors. Impacts are predicted to exceed only the Sunday construction noise criteria from BS5228:2014, it is likely in context that activites at this location would thus occur to 1-2 Sundays in entire construction programme at this magnitude.

16.13.5 It is therefore considered that in the context of the 5-6 year programme these findings are inherently limited in the time domain, in addition as noted above mitigation in the form of a CVNMP has evidentially been demonstrated to reduce construction noise levels by 5dB thus resulting in **negligible residual adverse impact** at high sensitivity NSRs once construction is completed of **negligible significance,** which is therefore **not significant.**

Construction Works Noise and Vibration-Blasting

16.13.6 Air overpressure and vibration effects from blasting are inevitable. Methods to control air overpressure and vibration from blasting operations will be agreed with THC prior to any blasting.

16.13.7 Blasting will be carried out using the BPM available to ensure that the resultant noise, vibration and air overpressure are minimised in accordance with current British Standards and guidelines, as required by the Control of Pollution Act 1974.

16.13.8 However, they will be temporary in nature and a liaison group will be set-up to notify the local community in advance of works.

16.13.9 Ultimately however once works are complete, blasting will cease entirely resulting in **negligible residual adverse** impact at high sensitivity NSRs once construction is completed of **negligible significance**, which is therefore **not significant.**

**Operational Phase**

Airborne Noise – Underground and Enclosed Plant

16.13.10 With appropriate consideration of the airborne noise emissions during the detailed design phase the operational noise impacts are anticipated to comply with the condition limits based upon a fixed design rating level limit of 25dBA $L_{Ar.}$

16.13.11 Hence worst-case residual effects remain negligible residual adverse impact of negligible significance, which is therefore not significant.

Airborne Noise – Above Ground Plant

16.13.12 The primary proposed mitigation is distance from the substation to all nearby receptors. The worst-case residual effects remain **negligible residual adverse** impact of **negligible significance**, which is therefore **not significant**.

Groundborne Noise and Vibration

16.13.13 The building design of the transformers, switchgear, workshop and pumping station will have appropriate noise attenuation measures which will mitigate any effects to no worse than **negligible residual adverse** impact at high sensitivity NSRs of **negligible significance**, which is therefore **not significant.**

## 16.14 Conclusion

16.14.1 An assessment of the potential effects of the Proposed Development on noise and vibration has been undertaken. The assessment includes either a qualitative, or quantitative assessment appropriate to each identified potential impact.

16.14.2 Construction noise and vibration would primarily be managed through a Construction Noise & Vibration Management Plan (CNVMP) which would be formally agreed with THC, prior to construction work commencing.

16.14.3 As a general principal, consideration would be given in the CNVMP for adopting the 'best practicable means' to noise and vibration control.

16.14.4 The construction of the Proposed Development has been designed with a mass balance of rock, aggregate and soil materials, thus reducing off-site disposal quantities.

16.14.5 The control of operational noise would be integral to the design of the underground power station, as all the main items of generation equipment would be located in an enclosed structure, with the bulk of the surrounding rock reducing noise breakout from tunnels to the surface to a minimum.

# Appendix 16.1 SQA Statement

## SQA Statement

The assessment has required a suitable level of technical ability and has been undertaken by a Suitably Qualified Person (SQP). An individual with all the following credentials has been considered a SQP for this assessment:

Has a minimum of three years' verifiable experience (within the last five years) of providing noise impact assessments in planning. Such experience has clearly demonstrated a practical understanding of factors affecting acoustics in relation to the proposed development use and in the built environment in general, including acting in an advisory capacity to provide recommendations and design advice in planning, and;

Holds a recognised acoustic qualification and membership of an appropriate professional body. The primary professional body for acoustics in the UK is the Institute of Acoustics.

This assessment has been led and managed by a SQP as defined above.

- Where some elements of the assessment (e.g. measurements) have been carried out by an acoustician who does not meet the requirements above, this has been undertaken with the direct guidance and supervision of a SQP who has reviewed, agreed and overseen the measurement methodology and any results obtained.
- The SQP confirms that the relevant measurements and calculations:
- Represent good industry practice in accordance with available guidance.
- Are appropriate given the development being assessed and scope of works proposed.
- Avoid invalid, biased and exaggerated claims.
- The checker and author of this document confirm that they both comply with the definition of a SQP defined in this Section.

**SLR Consulting Limited**

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Technical Director- Acoustics

**Michelle Dawson BSc (Hons) MIOA**
Technical Director -Acoustics

# Appendix 16.2 - Construction Noise Modelling Input Data Summary

**Table 16-A2-1 Equipment and plant noise data taken from BS 5228-1 Annex C**

| Construction Activity | Equipment / Plant Item | Quantity | BS5228 | $L_{Aeq}$ | Octave Band Sound Pressure Levels dB(Lin) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ref. | dB(A) | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Upgrade of access roads, or construction of new temporary haul road | Bulldozer CAT D6T 153kW 21t | 1 | C.5.15 | 83 | 83 | 81 | 76 | 77 | 82 | 70 | 65 | 58 |
| | Excavator CAT 336F (35t) | 3 | C.5.18 | 80 | 76 | 79 | 75 | 75 | 76 | 73 | 70 | 65 |
| | Excavator CAT 320F (20t) | 3 | C.2.19 | 77 | 95 | 84 | 79 | 73 | 70 | 68 | 64 | 57 |
| | ADT Dump Truck CAT 745C | 4 | C.5.17 | 81 | 85 | 88 | 77 | 75 | 77 | 74 | 69 | 63 |
| | CAT Grader 14M (193Kw) | 1 | C6.31 | 86 | 88 | 87 | 83 | 79 | 84 | 78 | 74 | 65 |
| | Vibratory Compactor CAT CS56B 12t | 2 | C.5.22 | 81 | 92 | 83 | 75 | 79 | 77 | 70 | 67 | 61 |
| | Crawler crane 35t | 1 | C.4.43 | 70 | 80 | 76 | 71 | 63 | 64 | 63 | 56 | 50 |
| | Asphalt paver | 1 | C.5.31 | 77 | 72 | 77 | 74 | 72 | 71 | 70 | 67 | 60 |

## Formation of Southern Access Route (SAR)

For the upgrade of access roads/tracks and construction of a new temporary haul road, predictions have been manually completed in accordance with the procedures detailed in Section F.2.2 of BS 5228-1. The operating noise data, in terms of $L_{Aeq,T}$ at 10m distance, has been referenced from Annex C of the Standard. At this stage, the details of the plant requirements for road construction and upgrade works are not finalised.

Predictions assume a typical plant operating scenario for this item of work for such road works as has been assumed with plant spread along a 100m length segment of new haul route operating for 100% of the time. The plant spread is indicatively presented in **Figure 16-A2-1.**

The assumed BS5228 reference noise levels for typical haul route construction vehicles is provided in **Table 16-A2-2** below.

**Figure 16-A2-1: Temporary Haul Route Plant Formation**

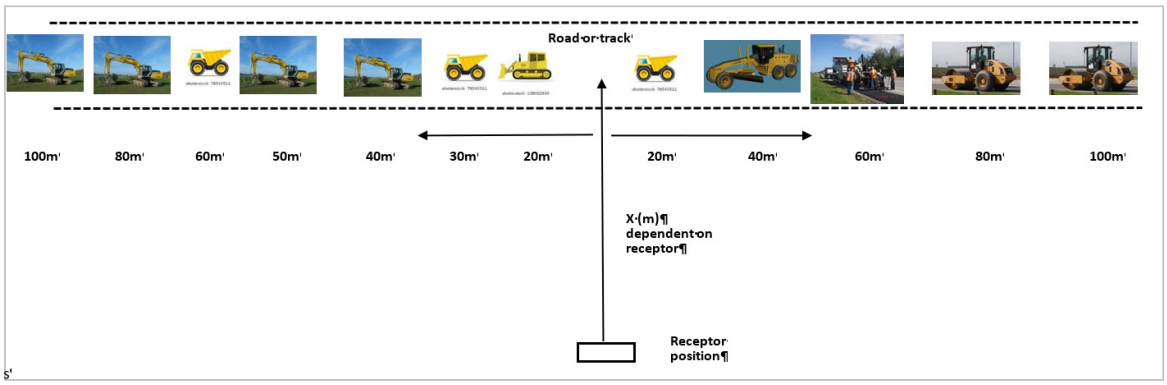

**Table 18-A2-2 Haul Route Improvement Plant Information**

| Plant Type<br>BS5228-1. Plant Item | $L_{Aeq,T}$ @ 10m |
|---|---|
| Excavator (35t) No.1 | 80 |
| Excavator (35t) No.2 | 80 |
| ADT Dump Truck No.1 | 81 |
| Excavator (20t). No.1 | 77 |
| Excavator (20t) No.2 | 77 |
| ADT Dump Truck No.2 | 81 |
| Bulldozer CAT D6T | 83 |
| ADT Dump Truck No.3 | 81 |
| CAT Grader 14M | 86 |
| Asphalt paver | 77 |
| Vibratory Compactor 1 | 81 |
| Vibratory Compactor 2 | 81 |

# Appendix 16.3 - Draft Construction Noise and Vibration Management Plan (CNVMP).

16.14.1 The best available construction methods shall be employed at all times, having regards to the principles of BPM to minimise noise and vibration impacts during the construction of the Proposed Development.

16.14.2 With regard to construction activities, agreement on operational hours and working methods will be sought from THC to minimise noise effects at NSRs.

16.14.3 Working hours will be subject to agreement between the Contractor and THC. In addition, adherence to working hours will be contractually implemented within any subsequent enforcement to be regulated by THC via planning conditions and also via the CNVMP.

16.14.4 Based on the construction assumptions presented within the assessment section, the results from the construction predictions show that for the majority of the receptors the effects will be negligible. Without mitigation, moderate to major adverse effects at NSR4, 5 and 6 are anticipated due to the proposed works related to upgrade of access roads or construction of access roads.

16.14.5 These works would be carried out along the proposed access routes and road surfacing activities would also take place on proposed access routes.

16.14.6 Therefore, identified impacts are expected to be temporary and localised due to the linear nature of these activities.

16.14.7 The use of Site boundary or activity boundary temporary noise barriers can reduce construction noise levels by around 10dB if line of sight from the plant to the receptor is blocked.

16.14.8 Similarly earth bunding or embankment is anticipated to break line of sight between the receptor and those works at the closest approach, thereby reducing noise levels by around 10dB.

16.14.9 BS 5228 gives detailed advice on methods of minimising nuisance from construction noise. This can take the form of reducing source noise levels, control of noise spread and, in areas of very high noise levels, insulation at receptors. It is likely to be a requirement of any construction contract that any constructors at the Site comply with the recommendations in BS 5228.

16.14.10 Where possible, alternative piling methods (such as rotary bored piling) are generally preferable to impact piling, due to their reduced noise and vibration emissions.

16.14.11 The contractor will consider all possible piling methods when determining the most appropriate method for construction of the Proposed Development and select low noise and vibration methods where feasible.

16.14.12 Mitigation measures to achieve BPM (as required by the Control of Pollution Act 1974) may include the following provisions:

- ensure all processes are in place to minimise noise before works begin and should ensure BPM are being achieved throughout the construction programme;
- the appropriate use of plant with respect to minimising noise emissions and regular maintenance. All vehicles and mechanical plant used for the purpose of the works would be fitted with effective exhaust silencers and would be maintained in good efficient working order;
- ensure that modern plant is used, complying with the latest EC noise emission requirements;
- selection of inherently quiet plant where appropriate. Use of electrical items of plant instead of diesel plant; especially in sensitive locations. All major compressors should be

'sound-reduced' models fitted with properly lined and sealed acoustic covers which would be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers;

- machines in intermittent use would be shut down in the intervening periods between work or throttled down to a minimum;
- all ancillary plant such as generators, compressors and pumps would be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures will be provided;
- loading / unloading sites should be located away from residential properties and shielded from those properties where practicable;
- arrange the site operations and vehicle routes to minimise the need for reversing movements, and to take advantage of rises in natural terrain to screen NSRs;
- no employees, subcontractors and persons employed on the Development Site should cause unnecessary noise from their activities e.g. excessive 'revving' of vehicle engines, music from radios, shouting and general behaviour etc. All staff inductions at the Site should include information on minimising noise and reminding them to be considerate of the nearby residents;
- where possible, the hours of noisy operations should be planned considering the effects of noise upon nearby NSR, taking into account the duration of work and the potential consequence of any lengthening of periods of noisy work;
- where possible, the items of plant should be located furthest from the nearby NSR buildings or in locations where acoustic screening is provided by site cabins, buildings, or barriers. Plant known to emit noise strongly in one direction should, when possible, be orientated so that the noise is directed away from the nearest NSR;
- materials should be lowered whenever practicable and not dropped. Any chutes and skips should be lined with sound attenuating material to reduce effect noise; and
- care should be taken when loading / unloading vehicles and dismantling scaffold.

16.14.13 The appointed Contractor will identify potential effects of works noise and vibration once precise working methods (including underground works) and required plant have been confirmed, and in turn appropriate mitigation measures will be implemented.

16.14.14 The Construction Environment Management Plan (CEMP) and Construction Traffic Management Plan (CTMP) will be prepared in accordance with good practice and relevant British Standards.

16.14.15 These will help to minimise effects of construction works and will include consideration of the construction phasing of the Proposed Development. The proposed construction of appropriately located earth / excavated material bunds during the early phase of the construction programme will help to increase the acoustic screening of construction noise.

16.14.16 In order to verify the predictions which have been performed and identify actual levels at nearby receptors, measurements of vibration are recommended at nearby receptors at the start of the proposed piling and tunnelling activities.

16.14.17 In the very unlikely event that these levels are found to exceed the limits agreed with THC, the contractor may be required to identify alternative methods of working which generate less vibration and/or restrict working hours for these activities.

16.14.18 As mentioned above consultation and communication with the local community will be covered in the overarching CEMP and undertaken throughout the construction period.

16.14.19 This will serve to publicise the works schedule, giving warning to residents and climbers regarding periods when higher levels of noise or blasting may occur during specific operations, and providing them with lines of communication where complaints can be addressed.

16.14.20 Dissemination of such information is likely to encourage the community to be more tolerant of any disturbance considering the perceived long-term benefits of the Proposed Development.