Chapter 17: Noise & Vibration

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Glossary of Terms

General Definitions

'A' Weighted Sound Pressure Level, dB(A)	The human ear does not hear sound equally through the audible frequency range. At low frequencies and at very high frequencies the ear is less sensitive. In order to reflect this subjective response, the 'A' weighted network has been devised. The network applies suitable corrections to a noise, dependant on the frequency, so that the resultant 'A' weighted sound pressure level is representative of what would be perceived by the human ear. Subjectively, a difference of 3dB(A) in sound level may be just noticeable and a difference of 10dB(A) represents a doubling or halving of loudness. The graph below shows typical A-weighted sound levels for a range of acoustic environments.
Frequency, Hertz (Hz)	The number of sound pressure fluctuations in a period of one second. Subjectively observed in the human ear as pitch. The audible frequency range for the human ear is 20-20,000 Hz.
Sound	Sound is usually generated by the vibration of a surface, or by turbulence in the air. This gives rise to pressure fluctuations in the air, or some other elastic medium. Sound is transmitted through the medium as sound waves and may be described in terms of sound pressure or sound power. Noise is generally defined as unwanted sound.
Sound Pressure Level, dB	Sound pressure level is measured in units of decibels on a logarithmic scale reference to the threshold of hearing, 2 x 10-5 Pascals. This scale is accepted as the best way of measuring the exceedingly wide range of sounds that can be heard by the human ear in a convenient manner. Being a logarithmic scale, a doubling of sound pressure level results in a numerical increase of only 3 decibels. For example if the sound produced by a telephone ringing is 75 decibels, the effect of two similar phones ringing at the same time is 78, not 150 decibels.

Measurement Descriptors

Broadband	Energy over a wide range of frequencies, often the complete audible frequency range. Broadband measurements will typically cover all audible frequencies in one reading.
Equivalent Continuous Sound Level, Laeq,t	The steady level of sound over a prescribed period of time which would contain the same total sound energy as the actual fluctuating noise under consideration in the same period of time. It can broadly be considered as an average sound level and is the internationally accepted parameter for assessing the annoyance caused by noise from most sources.
Maximum Sound Level, LAmax	The maximum sound or noise level over a time period. Can be determined in terms of the different time weightings (or time constants), i.e. LASmax (slow), LAFmax (fast) and LAImax Impulsive).
Narrow-band	Acoustic Energy over a restricted range of frequencies. Used to ascertain the strength of audible tones, and to assist in identifying particular sources of noise in a complex sound environment.
Sound Power Level LwA	A measure of the total sound energy radiated from a source. Like sound pressure levels this is also expressed in dB(A), but instead it is referenced to 10-12 watts. Sound power level is a characteristic of a source and so its value does not vary with distance or environmental conditions.
Statistical Sound Levels, LA10,T and LA90,T.	The level of noise exceeded for, respectively, 10% or 90% of the time period (T) being sampled. The LA10,T level correlates well with road traffic noise disturbance. LA90,T is the parameter most commonly used when quantifying Background Noise Level.

Time Weightings	A time weighting defines how the exponential averaging in RMS measurement is completed. It defines how the fluctuating sound pressure variations are smoothed, or averaged, to allow useful readings. There are 3 weightings: F (fast), S (slow) and I (impulse). Most measurements are completed using the F time weighting, which uses a 125 ms time constant.

Industrial Noise Assessment (terms used in BS 4142:2014 *Methods for rating and assessing industrial commercial sound*)

Ambient Sound Level LAeq,T	Totally encompassing sound in a given situation at a given time usually composed of sound form many sources, near and far.
Background Sound Level, LA90,T	The A-Weighted sound pressure level of the residual sound level at the assessment position that is exceeded for 90% of a given time interval, T, measured using time weighting, F, and quoted to the nearest whole number of decibels.
Rating Level LAr,Tr	The Specific noise level plus any adjustment for the characteristic features of the noise (e.g. tones or impulsivity)
Residual Sound Level LAeq,T	The ambient noise remaining at given position in a given situation when the specific noise source is suppressed to a degree such that it does not contribute to the ambient noise.
Specific Sound Level LAeq,Tr	Sound produced by the source under assessment. Measured in terms of the equivalent continuous A-Weighted Sound Pressure Level at an assessment position over a given referred time interval, Tr

17 Noise & Vibration

17.1 Executive Summary

17.1.1 A noise impact assessment has been completed for the purpose of describing the potential noise impacts and likely effects on environmental receptors associated with the Revised Coire Glas Pumped Storage Scheme (The Proposed Development). For this purpose, the closest residential properties to the scheme have been identified as noise sensitive receptors and a comprehensive ambient noise survey has been completed to establish the baseline ambient noise at these key receptor positions.

17.1.2 The potential noise impacts have been identified as noise from temporary construction works together with operational noise.

17.1.3 To estimate the noise levels resulting from temporary construction works a quantitative assessment has been completed, using predictive noise modelling, in line with guidance provided in BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.*

17.1.4 However, 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 within the underground cavern power station, with the bulk of the mountain and the long connecting tunnels reducing noise breakout to the surface to a negligible level.

17.1.5 Predictions have been based on sound emission data applicable to the construction plant and equipment forecast for use on the main construction activities, including site establishment works, lower control works (two screened inlet/outlet structures), jetty and works associated with upgrade, or construction, of new access roads/tracks.

17.1.6 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:

- 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 (The Planning Authority), prior to construction work commencing;
- The Caledonian Canal System would be used as far as practicable in the delivery of various equipment and materials, as well as in the disposal of tunnel spoil, thereby reducing heavy vehicle road use for this process. Furthermore, the creation of a temporary 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; and
- The control of operational noise would be integral to the design of the cavern power station, as all the main items of generation equipment would be located underground.

17.1.7 The residual effects of noise associated with The Proposed Development, with the mitigation measures included in the scheme, may be summarised as follows:

- For the temporary / long-term lower control works and jetty, noise and vibration effects would be not significant;
- For the temporary / medium-term site establishment works, noise and vibration effects would be not significant;
- For the temporary / short-term access road works, noise effects would be potentially significant, however, as the works would impact on a small number of individual properties for only a short period, the overall significance of the effect would be Low;
- In relation to the temporary increase in traffic noise, due to additional traffic during the construction phase of The Proposed Development, the small increase in noise level on the main A-roads leading to the development site would provide a negligible adverse impact, with the significance of the noise effect being slight;
- Due to the much higher percentage increase in traffic on the minor access road from the A82 to Kilfinnan (referred to as Kilfinnan Road), the larger increase in noise ($L_{A10,18\ hour}$ >5dB), would provide a major adverse impact, with the significance of the noise effect being large; and
- For the permanent operation of the cavern power station, the noise and vibration effects would be not significant.

17.2 Introduction

17.2.1 This Chapter describes the potential noise and vibration impacts of the Revised Coire Glas Pumped Storage Scheme (The Proposed Development) and the likely effects on environmental receptors, in this case the residential properties located closest to each aspect of the scheme.

17.2.2 Details of The Proposed Development, comprising the construction and operation, are included in Chapter 3: Description of Development.

17.2.3 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, 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.

17.2.4 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 seven years for the main civil engineering construction. To this effect, a quantitative prediction of noise is provided, in relation to the construction activities identified as potentially providing adverse impact.

17.2.5 To establish the current baseline noise level, the assessment presents the results of a comprehensive ambient noise survey, comprising remote noise monitoring of 1-week duration, at each of the closest noise sensitive receptor locations to the development site.

17.2.6 The potential impact and likely effects of construction noise have been assessed by using predicted noise levels to evaluate the resulting noise change and allow comparison with

both existing ambient noise and absolute noise limits. This recognises the advice and guidance provided in the Scottish Government Technical Advice Note (TAN) (Scottish Government, March 2009), 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.

17.3 Scope of Assessment

Study Area

17.3.1 The key components of The Proposed Development are situated on Forestry Commission (Scotland) land to the south west of Laggan Locks, comprising two main areas of work: the upper reservoir and dam; and the lower reservoir works, linked by a series of underground tunnels and caverns.

17.3.2 The upper reservoir works are located in a remote mountainous region, approximately 3.5 km from the closest noise sensitive receptors (NSR's) located at Kilfinnan, on the north side of Loch Lochy. Due to the large separation distance and extensive terrain screening, construction works carried out at this location would produce an insignificant level of noise at the closest receptors and, consequently, negligible noise impact. This aspect of construction works has therefore been scoped out of noise assessment.

17.3.3 The lower control works (including the screened inlet / outlet structures) and jetty, are located to the south side of South Laggan Forest and on the north side of Loch Lochy. The site of these works is approximately 1.1 km from the closest noise sensitive receptor (NSR) (NSR 1: Corrigour Hotel) located on the south side of the A82 and the south side of Loch Lochy. The closest noise sensitive position on the north side of Loch Lochy is represented by a group of properties comprising Kilfinnan Lodges (NSR 2), approximately 2.2 km to the northeast.

17.3.4 The lower reservoir works would be accessed off the A82 at North Laggan, following the minor public road and forestry tracks, both to be upgraded. A temporary haul road is also proposed to connect the upper and lower works. There are a number of isolated properties set back along the minor public access road from the A82 to Kilfinnan, and a group of properties (Kilfinnan Lodges) located south of the forestry track (forming part of Great Glen Way).

17.3.5 Site establishment areas would be required, with these located in the vicinity of the upper reservoir, lower reservoir works and within Glen Garry Forest, along the access route to the upper reservoir and dam. The closest properties to the site establishment areas are Kilfinnan Lodges, some 430 m northeast of the lower reservoir works site establishment area, together with an isolated property (referred to as White Bridge House) located within Forestry commission land, approximately 1.7 km, from the upper reservoir site establishment area.

17.3.6 The scope of the noise assessment covers the area that includes the properties identified above as being closest to the lower reservoir works, site establishment works and associated access roads/tracks. The position of the NSR's are described in Table 17.7 and illustrated on Figure 17.1.

Consultation

17.3.7 Table 17.1 provides a summary of the scoping responses issued by consultees, in relation to issues associated with noise and vibration from The Proposed Development, and how these have been addressed in the assessment.

Table 17.1: Summary of scoping responses relating to the assessment of noise and vibration

Consultee	Summary Response	Comment/Action Taken
Highland Council	The Council has no significant concerns over the amended project. During previous consultation, the Council recommended carrying out more than one round of noise measurement samples at each of the agreed noise sensitive receptors to ensure the baseline noise survey was representative of typical ambient noise levels	A comprehensive ambient noise survey has been completed, by use of remote noise monitoring at each receptor position, for a duration of 1 week, covering weekday and weekend periods. A statistical analysis of 'qualifying noise data', recorded under acceptable weather conditions, has been completed for the purpose of establishing representative background noise levels, in line with relevant Standards and Guidelines
Scottish Canals	Scottish Canals would like the potential effects of construction noise and vibration to be included in the assessment, in particular any blasting or other excavation process impacts on canal operations, staff and customers and potential impacts on the integrity of the historic structures of the Caledonian Canal.	Inclusion of predictive noise mapping allows review of construction noise levels across the region, as well as at specific NSR positions. As described in Sections 17.7.29-31, 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. At this stage historic structures would be identified for potential inclusion in the vibration monitoring plan. 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.
Transport Scotland	The Scoping Report indicates that an updated noise assessment will be undertaken, in addition to an assessment of the potential construction vibration and dust effects. This is considered acceptable.	Noted and covered by the assessment. An assessment of dust is included in Chapter 18 (Air Quality).

17.4 Policy, Legislation & Guidance

17.4.1 The Scottish Government Planning Advice Note PAN 1/2011 (March 2011) provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The PAN promotes the principles of good acoustic design and a sensitive approach to the location of new development. In particular it identifies the following issues that may be relevant when considering noise issues during the preparation of a development plan:

- Avoidance of significant adverse noise impacts from new developments;
- Applying noise impact criteria reasonably;
- Use of mitigation measures to manage noise impacts; and

- Protection of quiet areas, and avoidance of development significantly adversely affecting Noise Management Areas.

17.4.2 Information and advice on noise impact assessment (NIA) methods is provided in the associated Technical Advice Note (TAN): Assessment of Noise (Scottish Government, March 2009). It includes details of the legislation, technical standards and codes of practice for specific noise issues. Whilst this TAN acknowledges that it does not offer prescriptive guidance on noise assessment, nor should it be considered exhaustive in extent, the methodology adopted for this NIA takes account of this guidance in identifying and evaluating the key noise impacts of The Proposed Development for the purpose of informing the planning decision process.

17.5 Methodology

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

- Identification of NSR's and rating of sensitivity;
- Establishing the current (baseline) ambient noise level at NSR's by completion of noise monitoring;
- 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 receptors sensitivity to noise and the magnitude and duration of noise impacts.

17.5.2 In order to assess the magnitude of potential noise impacts, sensitive receptors are identified and a quantitative prediction, and/or a qualitative assessment is provided for each of the identified impacts. Predictions are based on measured plant and equipment noise levels, as published in BS 5228-1.

17.5.3 For different types of noise and noise sources different prediction and assessment methodologies apply and in each case there is specific guidance that may be referred to in relation to the appropriate procedures to be used for quantifying the magnitude of impact.

Operational Noise Criteria

17.5.4 As explained in more detail in Section 17.7, noise from the operation of The Proposed Development (Operational Noise) has been scoped out of a quantitative assessment as the reversible pump-turbines, motor generators, transformers and other associated equipment would be located within an underground cavern power station.

17.5.5 Notwithstanding the above, it is appropriate to briefly describe the guidance provided in The Scottish Government TAN, and BS 4142 (BSI, 2014), relating to the assessment of industrial and commercial sound.

17.5.6 In particular, the procedure included in the TAN uses the concept of ambient noise change, which is also used in the approach provided in BS 5228-1, for the assessment of impact

from construction noise. However, it should be noted that the TAN assessment example (using BS 4142 to establish receptor sensitivity) and noise change (to assess impact) is specific to noise from an industrial development and BS 4142 is not intended to be applied to the rating and assessment of sound from construction and demolition works.

17.5.7 A quantitative assessment of noise impact from industrial and commercial operations may be made based on the following approaches:

- An estimate of the change in ambient noise level $L_{Aeq,T}$ before and after the industrial development is operational. This being the approach defined in The Scottish Government TAN: Assessment of Noise; and
- The difference between the Rating Level ($L_{Ar,Tr}$) of noise from the development and the existing background noise ($L_{A90,T}$), with the Rating Level being the Specific Noise level ($L_{Aeq,T}$), corrected for presence of any acoustic features (e.g. tonality, impulsivity) that could increase noise impact. This being the approach defined in BS 4142.

17.5.8 The magnitude of impacts, based on the above approaches and as defined in the TAN and BS 4142:2014, are summarised in Table 17.2.

Table 17.2: Magnitude of noise impacts

Change in noise level (TAN)		BS 4142 Assessment Level and Commentary	
$L_{Aeq,T}$ dB	**Magnitude of Impact**	**$L_{Ar,Tr} – L_{A90,Tr}$ (dB)**	**Magnitude of Impact**
>= 5	Major	>= 10	Significant adverse impact
3 to 4.9	Moderate	>= 5	Adverse impact
1 to 2.9	Minor	< 5	Minor adverse impact
0.1 to 0.9	Negligible	0	Low adverse impact
0	No Change	< 0	Further lowering of impact

Construction Noise Criteria

17.5.9 Noise from construction related works is assessed differently to noise from permanent industrial installations, as it is recognised that construction noise is an inevitable by-product of required works and that the construction works represent a temporary operation.

17.5.10 The Scottish Government TAN, states that for Environmental Impact Assessments (EIA) and for planning purposes BS 5228: 2009 (Parts 1 and 2) are applicable, respectively, as the relevant codes of practice for noise and vibration. Part 1 of the code of practice incorporates the 2005 and 2006 Defra updates on construction plant noise and provides noise level and exposure matrices that have been used on major infrastructure projects across the UK.

17.5.11 BS 5228-1 provides the relevant advice on assessing and predicting noise from construction works. The Standard additionally provides information on construction noise levels from various plant and construction operations and provides recommendations on procedures and mitigation that can be adopted to reduce the impact of construction noise.

17.5.12 Annex E 'Significance of noise effects' of BS 5228-1, provides example criteria for the assessment of potential significance of noise effects. However, a pragmatic approach for assessing the noise effects of construction works is advised, with guidance applying to projects of significant size. The advice for lesser projects is that the effects of construction noise may not need to be assessed, or may only require a general consideration of noise effects, for example, to advise on the appropriate actions that might need to be considered to minimise effects.

17.5.13 For the purposes of determining the potential significance of noise effects BS 5228-1 provides two approaches, the first based on fixed noise limits and the second based on ambient noise change.

17.5.14 The fixed noise limit approach specifies levels of 70 dB(A) / 75 dB(A), as being applicable to normal working hours and dependent on receptor location, with the higher level applicable to a receptor located near a main road or industry. This is noted as being the older and simpler approach and consequently consideration is most commonly given to the second approach, which is based on noise change.

17.5.15 Two methods for establishing the threshold for potential significant effect are provided, both having similar approaches. It is therefore only necessary to provide detail on one of the example methods.

17.5.16 Example method 2 is based on ambient noise change, due to the introduction of construction activities. As the concept of ambient noise change is also used in The Scottish Government TAN: 'Assessment of Noise', it is appropriate to reference this approach, in terms of its application to construction noise.

17.5.17 Construction noise is deemed to produce a potential significant effect if the total noise (construction noise plus pre-construction ambient noise) exceeds the pre-construction ambient noise by 5dB, or more, subject to lower cut-off values of $L_{Aeq,T}$ 65dB, 55dB and 45dB from construction noise alone, for the daytime, evening and night time periods, respectively; and a duration of one month or more.

17.5.18 BS 5228-1 does not provide a scale grading magnitude of noise impacts, however, the BS 5228 defined noise effect criteria of 5dB noise change, subject to lower cut-off values being exceeded, can be used to develop a classification in accordance with the low/medium/high descriptors in Table 17.3. In this example the lower cut off value for the daytime period ($L_{Aeq,T}$ 65dB) has been used. For the evening and night time periods this would be substituted for 55dB and 45dB, respectively.

Table 17.3: Magnitude of construction noise impacts, including 5228-1 defined threshold of potential significant effect

Change in ambient noise level ($L_{Aeq,T}$) and lower cut-off value for CNL (daytime)	Magnitude of Impact	BS 5228-1 defined Noise Effects
Noise change 0dB	No change	Not significant
Noise change <=1dB	Very low	Not significant
Noise change <=5dB	Low	Not significant
Noise change >=5dB and CNL <= 65dB	Medium	Not significant
Noise change >=5dB and CNL >65dB	High	Potentially significant

17.5.19 BS 5228 does not include a sensitivity scale for different categories of receptor, instead stating that the evaluation criteria are generally applicable to the following resources, which in accordance with Table 2.1 (of the TAN) are considered to have equal high sensitivity to noise:

- Residential buildings;
- Hotels and hostels;
- Buildings in religious use;
- Buildings in educational use; and
- Buildings in health and/or community use.

Construction Ground Vibration Criteria

17.5.20 Guidance on potential effects of vibration levels is provided in Annex B of BS 5228-2, with Tables B.1 and B.2 of the Standard providing, respectively, guide values for human response and cosmetic damage to buildings. The guidance is summarised in Table 17.4.

Table 17.4: Effects of vibration, taken from BS 5228-2

Effect on people/building	Vibration level Peak Particle Velocity (mms^{-1})
Vibration might be just perceptible in the most sensitive situations and at most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	0.14
Vibration might be just perceptible in residential environments.	0.3
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.	1.0
Vibration is likely to be intolerable for any more than a very brief exposure to this level.	10.0
Guide values to avoid cosmetic damage to buildings – Residential buildings.	15.0 at 4Hz increasing to 20.0 at 15Hz increasing to 50.0 at 40Hz and above
Guide values to avoid cosmetic damage to buildings – Industrial buildings.	50.0 at 4Hz and above

17.5.21 Note c) to Table B.1 of BS 5228-2 states that single, or infrequent occurrences at the levels indicated in Table 17.4 would not necessarily correspond to the stated effect, in every case.

17.5.22 In line with the above guidance, it is considered that providing appropriate warnings are provided to residents, vibration levels of below 1.0 mms^{-1} would be tolerated and therefore would have a negligible adverse impact. Some degree of adverse impact would occur when vibration (either continuous, or for frequent periods) exceeds Peak Particle Velocity (PPV) 1.0 mms^{-1}.

17.5.23 Whilst the table does not provide guidance as to the potential different effects within the PPV range 1–10mms^{-1} the magnitude of adverse impact would likely increase from small (1-3mms^{-1}), to medium (3-7mms^{-1}) to large (7-10mms^{-1}).

17.5.24 At PPV levels above 10mms^{-1}, the more usual concern is potential building damage and commonly a PPV limit is set at this level to ensure the PPV 15mms^{-1} threshold for cosmetic damage is adequately protected.

Construction Air Overpressure Criteria

17.5.25 Annex G of BS 5228-2 provides information on blast generated air overpressure, which can produce airborne pressure waves at both audible (above 20Hz) and inaudible (below 20Hz) frequencies.

17.5.26 The Standard states that there is no known evidence of air overpressure causing structural damage to buildings, however, it is noted that a poorly mounted pre-stressed window might crack at 150dB (Lin), with most windows cracking at 170dB (Lin). This would suggest avoidance of levels within this range.

Road Traffic Noise during Construction

17.5.27 For the purpose of classifying the magnitude of impact from traffic noise (on new or improved roads), The Scottish Government TAN cites the advice provided in the Design Manual for Roads and Bridges (DMRB, 1992).

17.5.28 The DMRB (in Table 3.1, included in Volume 11, section 3 part 7), provides a classification of magnitude of impact for traffic noise (in the short term), based on change in $L_{A10,18h}$ noise level, which is reproduced here as Table 17.5.

Table 17.5: DMRB classification of magnitude of noise impacts against change in traffic noise level

Noise Change - $L_{A10,18hour}$ (dB)	Magnitude of Impact
0	No change
0.1-0.9	Negligible adverse
1.0-2.9	Minor adverse
3.0-4.9	Moderate adverse
Over 5	Major adverse

17.5.29 The DMRB notes that this classification table can be used for the assessment of noise impact associated with construction traffic on the local road network.

17.5.30 DMRB does not include a methodology for assigning an overall significance of effect in relation to the magnitude of impact. However, this may be determined by reference to the framework defined in the TAN (reproduced as Table 17.6), which assigns a level of significance (of noise effect) based on the sensitivity of NSR's and the magnitude of adverse impact. It may be noted that for the purpose of assessing traffic noise, the magnitude of impact is related to noise change in terms of $L_{A10,18\ hour}$.

Table 17.6: Significance of Noise Effects

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

17.5.31 For the purpose of traffic noise assessment the NSR's would be residential properties and in accordance with Table 2.1 (of the TAN) the sensitivity would be classed in the high category (as highlighted in red font in Table 17.6).

17.5.32 For projects which are likely to produce less significant changes to traffic noise, the DMRB also includes a screening process, identifying the threshold criteria for traffic noise assessment as a noise change of $L_{A10,18\ hour}$ 1dB, requiring an increase in traffic flow of around 25%. This noise change represents the smallest increment in noise increase that is generally regarded as being discernible, in terms of a short term change.

17.5.33 Procedures for calculating road traffic noise are described in The Department of Transport, Welsh Office document: 'Calculation of Road Traffic Noise' (CRTN).

17.6 Baseline Conditions

17.6.1 In order to assess noise from The Proposed Development, in line with both TAN and BS 5228-1 noise assessment guidance, the noise emission needs to be compared with the existing ambient noise environment, at the nearest sensitive residential locations to the site.

17.6.2 As part of the noise assessment process, existing ambient noise levels therefore need to be established, in order to determine any change to these levels due to the specific noise contribution from The Proposed Development.

Noise Sensitive Receptor Positions (NSR's)

17.6.3 A description of the noise sensitive residential receptor positions (NSR's) chosen for the noise impact assessment is provided in Table 17.7. These positions were chosen as being representative of the nearest properties both to The Proposed Development and to the associated construction activities. NSR's were described in the Scoping Report (May 2017)[1] and are consistent with the locations assessed as part of The Consented Development.

[1] Revised Coire Glas Pumped Storage Scheme: Scoping Report (May 2017)

17.6.4 Noise measurements for the purpose of describing the current ambient noise environment were recorded at each receptor position. In the case of NSR 2 and NSR 5, measurements could not be taken directly at the properties concerned, as agreement could not be reached with the householders. Proxy measurement positions were chosen for the purpose of establishing ambient noise levels representative of the actual receptor.

Table 17.7: Description of noise sensitive receptor positions

Position	OS Grid Ref.	Description
Position NSR 1: Corrigour Hotel	226171E 792682N	Corrigour Hotel is situated on the south side of Loch Lochy, set back in an elevated position on the south side of the A82. The measurement position was some 8 m from the front of the hotel, at the side of a parking bay.
Position NSR 2: Kilfinnan Lodges. Proxy measurement position Robertson Farm	227186E 795227N 227411E 795402N	This measurement position was situated on sloping scrub-farmland. Being similarly located, between Great Glen Way and the north side of Loch Lochy, this was chosen as a suitable proxy position for the Kilfinnan Lodges, which are located to the southwest of this measurement position.
Position NSR 3: Cameron Farm House	228438E 796648N	Cameron Farm House is situated on the southeast side of the minor road linking the A82 and Kilfinnan and north of Laggan Loch. The measurement position was situated in an open area 10 m from the south boundary and 30 m from the property, in order to be at the furthest distance from a small stream that runs just to the south of the farm house.
Position NSR 4: No.11 North Laggan	229977E 798589N	No.11 North Laggan is the furthest north of a row of 11 properties known as the 'Swing Bridge Houses'. The property is situated close to the junction of the A82 and Kilfinnan Road. The measurement position was situated in the rear garden of the property facing the minor road and some 6 m from the rear façade of the property.
Position NSR 5: White Bridge House. Proxy position south of White Bridge House	228172E 800920N 228153E 800877N	The house referred to as the White Bridge House is located within land owned by the Forestry Commission. The proxy measurement position was situated on an area of open ground between vegetation, some 50 m to the south of the property and set a similar distance back from the local access track.

17.6.5 A plan showing The Proposed Development and NSR's is illustrated in Figure 17.1.

17.6.6 Photos of the noise measurement positions at each NSR are included as follows:

Photo 17.1: View of noise monitoring position at NSR 1

Photo 17.2: View of noise monitoring position at proxy position for NSR 2

Photo 17.3: View of noise monitoring position at NSR 3

Photo 17.4: View of weather station at NSR 3

Photo 17.5: View of noise monitoring position at NSR 4

Photo 17.6: View of noise monitoring position at proxy position for NSR 5

Noise Survey Procedure and Instrumentation

17.6.7 Instrumentation used to measure noise levels at each receptor position included the following items. All equipment is calibrated in accordance with manufacturers requirements, using equipment referenced to the British Calibration Service and the National Physical Laboratory:-

NSR1: Carrigour Hotel: Bruel & Kjaer Type 2250-Light (No.2) Sound Level Analyser (s/n 3006952), with type 4952 Microphone (s/n 2922638);

NSR 2: Kilfinnan Lodges: Bruel & Kjaer Type 2250-Light (No.3) Sound Level Analyser (s/n 3006954), with type 4952 Microphone (s/n2922639) ;

NSR 3: Cameron Farm House: Bruel & Kjaer Type 2238-F (No.1) Sound Level Meter (s/n 2285767), with type 4188 Microphone (s/n 2289858);

NSR 4: No.11 North Laggan: Bruel & Kjaer Type 2238-C (No.9) Sound Level Meter (s/n 2774251), with type 4188 Microphone (s/n 2764264); and

NSR 5: White Bridge House: Bruel & Kjaer Type 2238-C (No.6) Sound Level Meter (s/n 2654441), with type 4188 Microphone (s/n 2658552).

Other equipment included:

- Bruel & Kjaer Type 4231 Acoustic Calibrators and all-weather microphone kits.
- Davis Instruments Vantage VUE Weather Station and Envoy 8X Data Logger.

17.6.8 During consultation, The Highland Council recommended carrying out more than one noise measurement at each of the NSR's identified for the study.

17.6.9 Whilst not being specific about the required survey duration at each position, it was considered that the Council's requirement would be best covered by completion of a longer-term survey, using remote noise logging, taking in a weekly period to include both weekday and weekend periods. This would provide more detail regarding the variation to ambient noise levels through the complete daytime (07:00 to 19:00), evening (19:00-23:00) and night (23:00-07:00) periods and allow a more accurate assessment of the central tendencies for each period, to subsequently use as the reference level for the assessment.

17.6.10 The noise survey covered an 8-day period from 12th to 19th October 2017. Noise samples of 15-minute duration were recorded contiguously through the survey period, to provide information on prevailing ambient noise levels over the shorter night time assessment period defined in BS 4142:2014.

17.6.11 As expected for an autumn period in a Highland location, weather conditions were mixed with variable wind conditions through the survey period. A weather station was set up at NSR 3 for the purpose of measuring wind speed and rainfall through the period of the survey, thereby allowing the periods of fine weather with light winds to be established for the purpose of defining the ambient noise under these favourable conditions.

17.6.12 Noise samples were recorded, in terms of the following parameters:

- $L_{Aeq,T}$ the equivalent continuous noise level; and
- $L_{A90,T}$ percentile level.

17.6.13 Briefly, $L_{Aeq,T}$, the equivalent continuous noise level is used as the measure of total ambient noise, or noise from a specific source. $L_{A90,T}$ is defined in BS 4142, as the measure of background noise, when it is applied to the residual noise level (the noise in the absence of the specific noise being assessed).

Noise Survey Results

17.6.14 The bulk noise, wind speed and rainfall measurement data, is included in Appendix 17.1. Separate tables are included for each noise sensitive receptor and for each of the daytime (0700-1900), evening (1900-2300) and night time (2300-0700) periods.

17.6.15 Data is also sorted between the weekday and weekend periods of the survey. Each table includes both the raw data and the calculated central tendencies, to include the mode, mean, mean – 1 standard deviation and log-average values. Prior to the calculation of the central tendencies, the bulk noise data has been filtered to exclude measurements taken under wind speeds of above 3.5m/s and during rainfall.

17.6.16 With the remote monitoring survey producing a significant number of individual noise samples, the bulk noise data is best presented in terms of results charts. To this effect Charts 17.1 to 17.6, illustrate the noise data taken from each NSR position over the 8-day survey period. Wind speed data taken from the weather station installed at NSR 3 is also included in the Charts.

Chart 17.1: Noise measurements at NSR 1 Corrigour Hotel

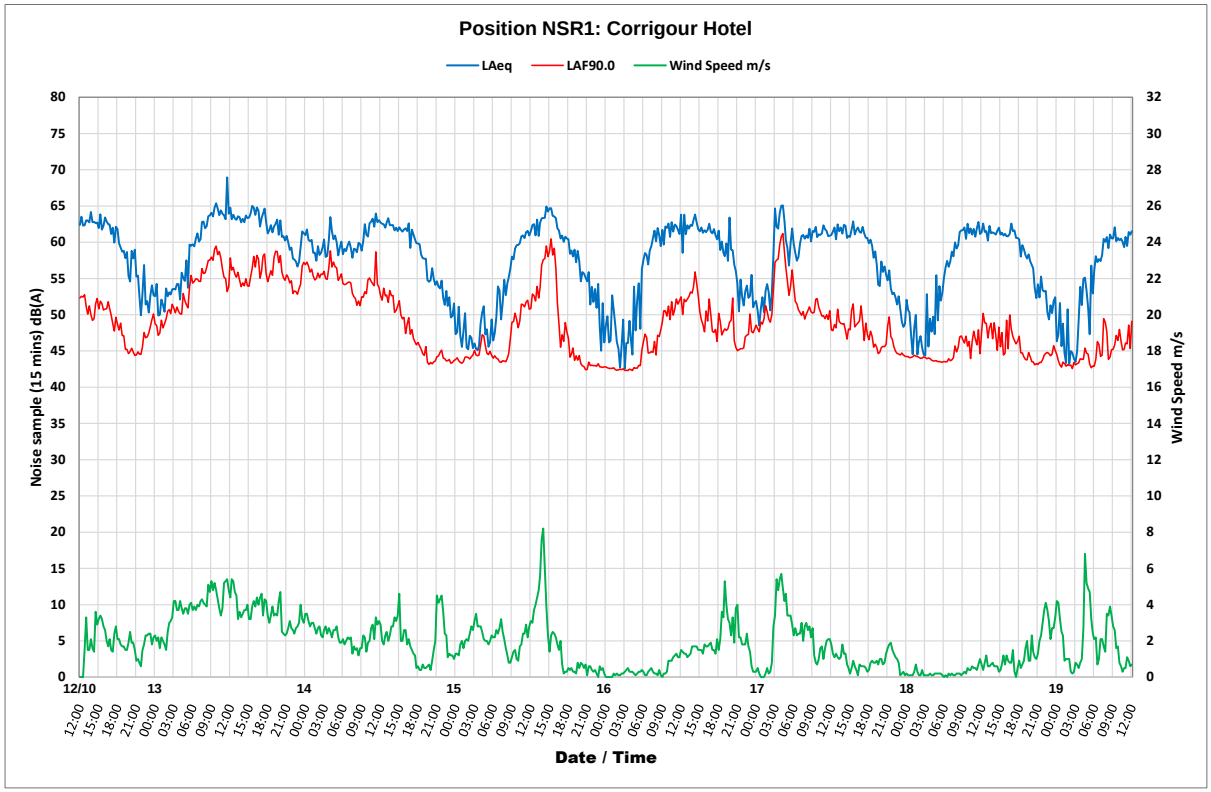


Chart 17.2: Noise measurements at NSR 2 Robertson Farm (proxy position for Kilfinnan Lodges)

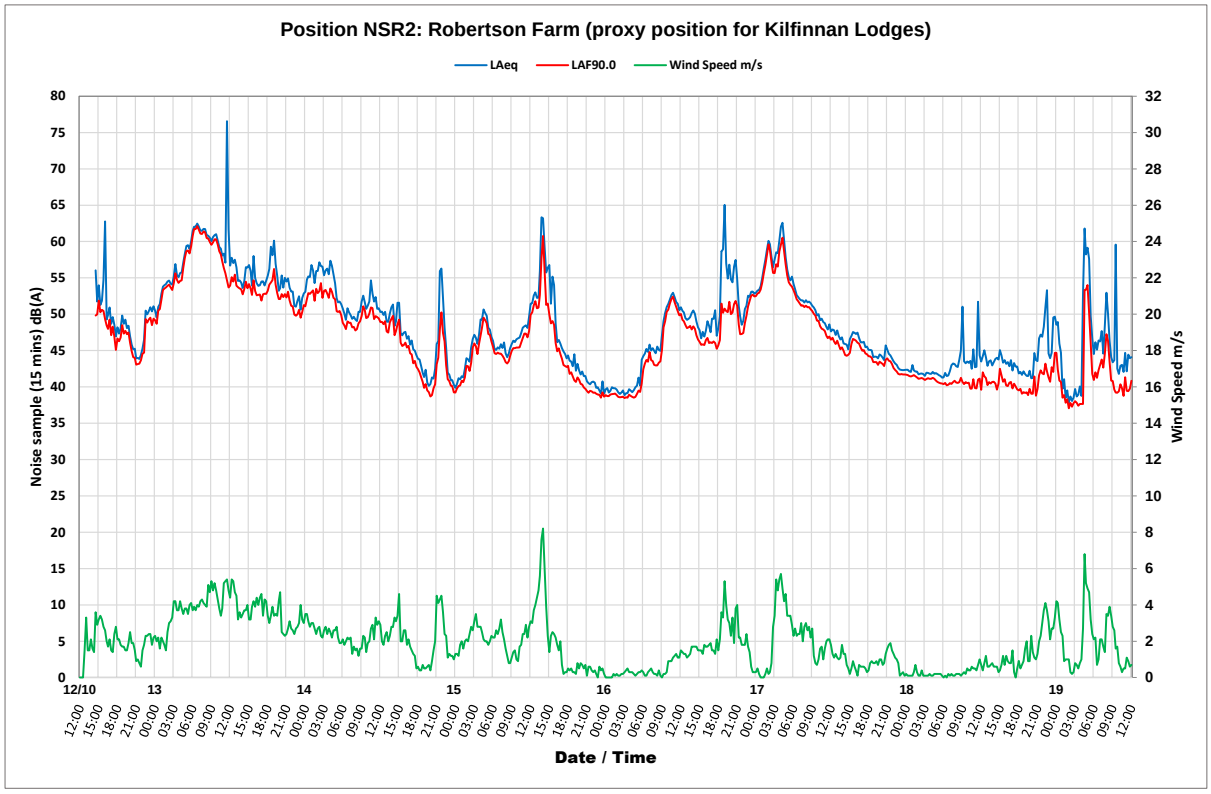


Chart 17.3: Noise measurements at NSR 3 Cameron Farm House

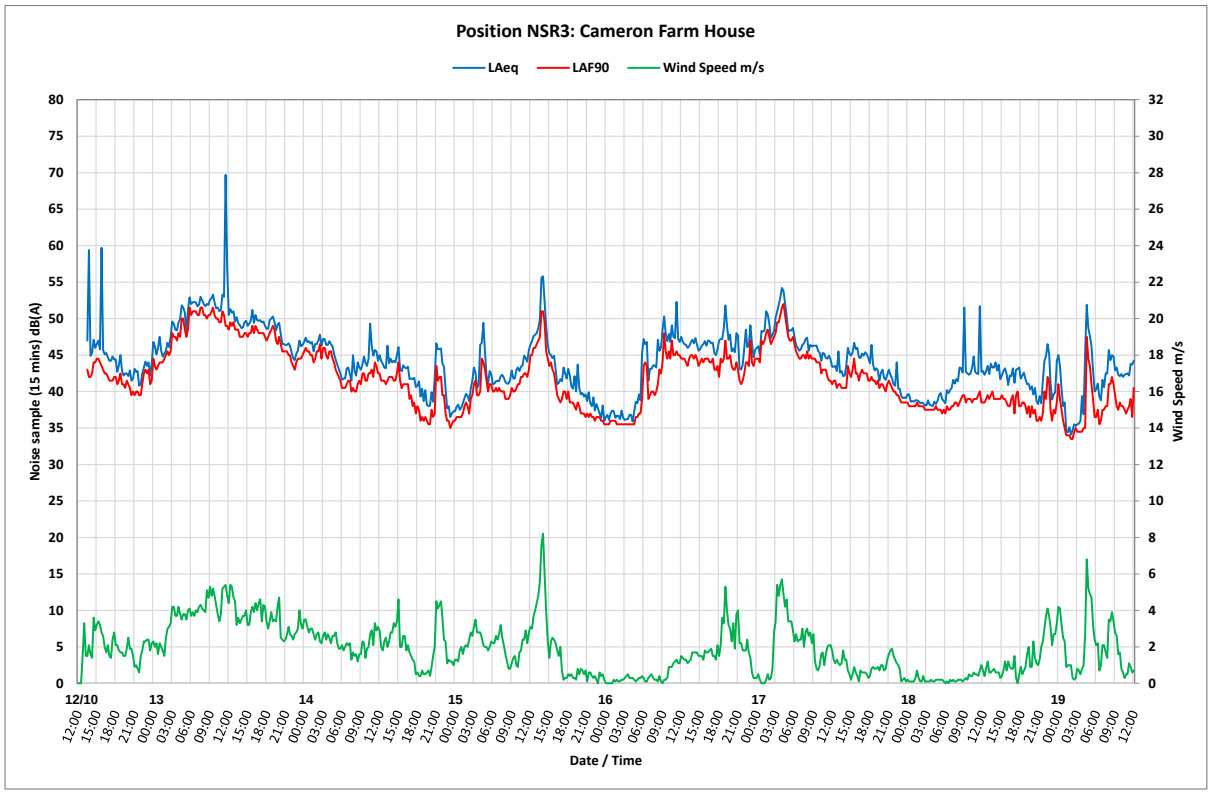


Chart 17.4: Noise measurements at NSR 4 No.11 North Laggan (swing bridge houses)

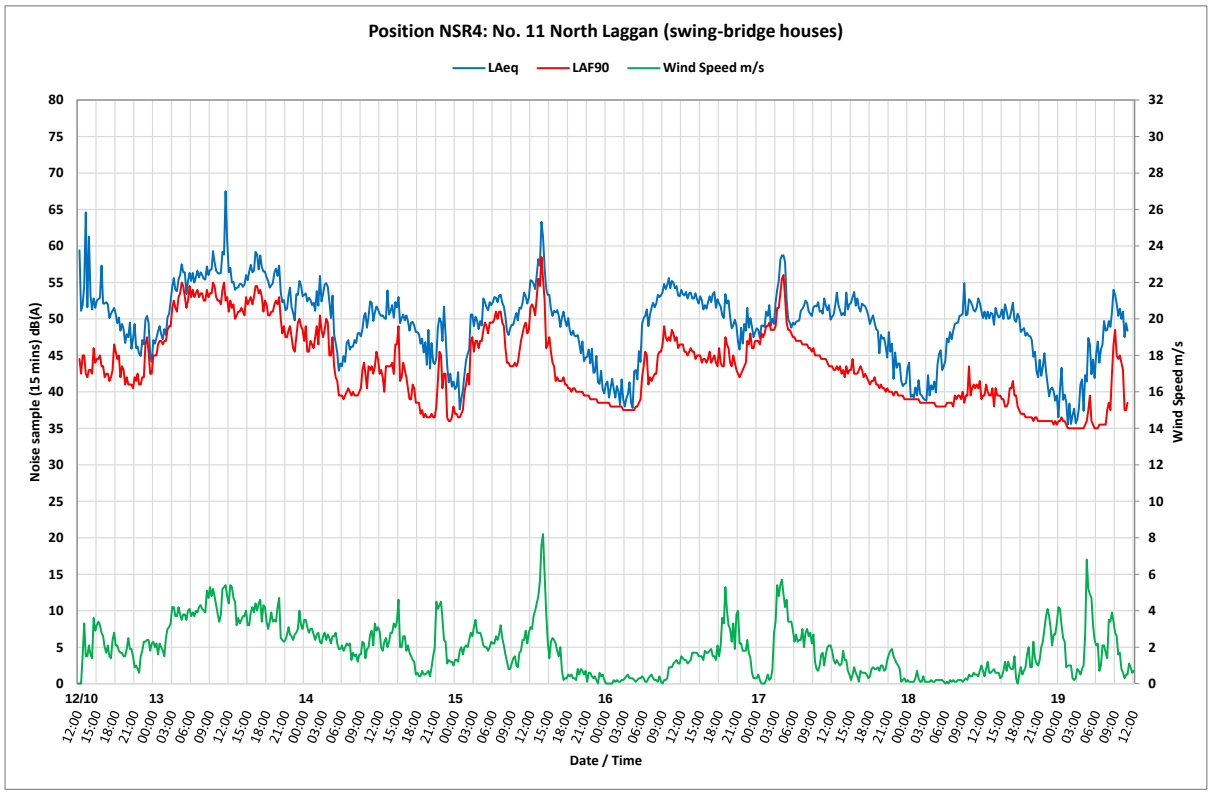
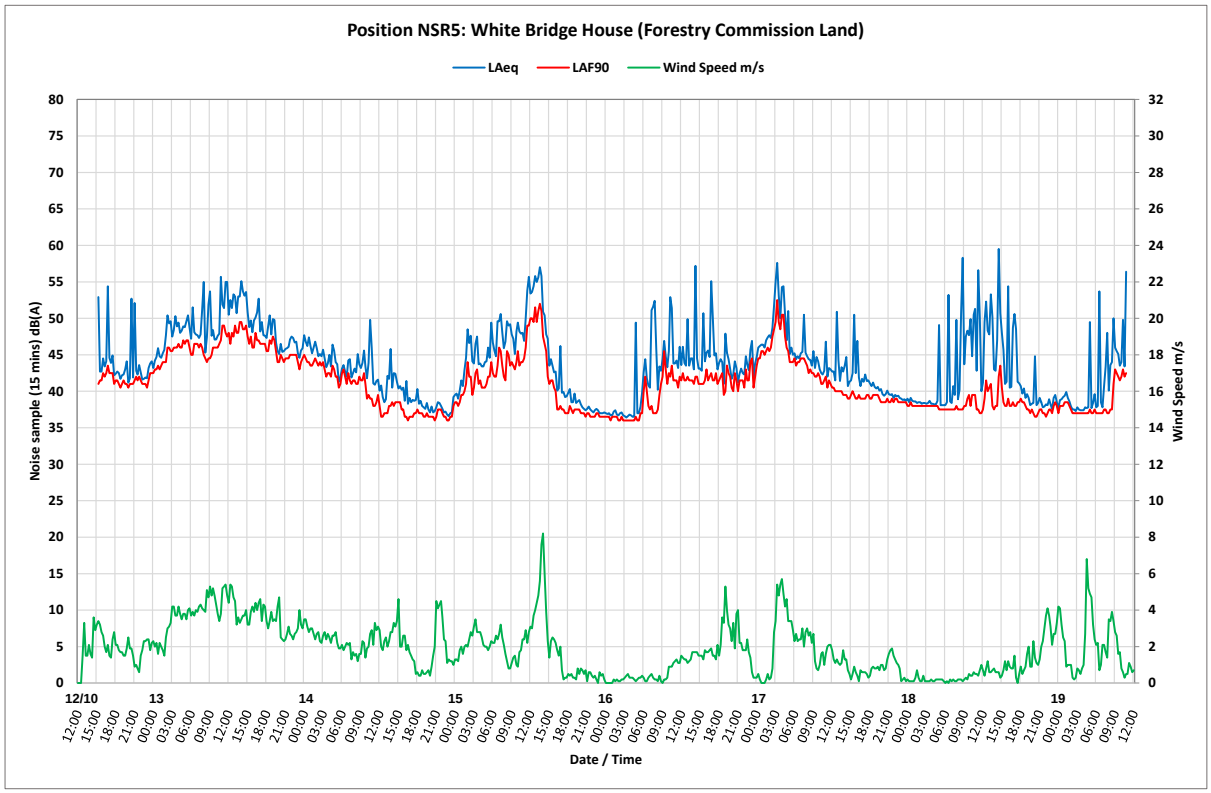


Chart 17.5: Noise measurements at NSR 5 Forestry Commission Land (proxy position for White Bridge House)



17.6.17 The qualifying data has then been used to establish central tendency values, including mode, mean, mean – 1 standard deviation and log-average values. However, care needs be taken in referencing the modal value, as there can be multiple modes and in some noise environments the value can be unrepresentative. The log-mean value is only applicable to the $L_{Aeq,T}$ data, as the $L_{A90,T}$ statistical data cannot be averaged in this way. Also, the log average value places greater weight to the samples with higher values, so can typically be between 3-5dB higher than the arithmetic mean.

17.6.18 The arithmetic mean of the qualifying $L_{Aeq,15min}$ and $L_{A90,15min}$ measurement samples best describes the current noise environment at each of the receptor positions. Accordingly, Table 17.8 presents these values, applicable to the daytime, evening and night time periods and separately for the weekday and weekend periods.

Table 17.8: Mean ambient $L_{Aeq,T}$ and background $L_{A90,T}$ noise levels at each NSR Position.

Receptor Position	Mean $L_{Aeq,15\ min}$						Mean $L_{A90,15\ min}$					
	Day(07-19)		Eve(19-23)		Night(23-07)		Day(07-19)		Eve(19-23)		Night(23-07)	
	w/d	w/e	w/d	w/e	w/d	w/e	w/d	w/e	w/d	w/e	w/d	w/e
NSR 1: Corrigour Hotel	61	61	56	55	51	53 (47)	49	51	48	43	45	49 (43)
NSR 2: Kilfinnan Lodges	47	48	48	42	44	49 (42)	45	47	46	40	43	47 (42)
NSR 3: Cameron Farm Hs	45	43	43	40	40	42 (39)	42	41	41	37	39	41 (38)
NSR 4: 11 North Laggan	52	50	48	46	43	48 (43)	43	43	42	39	40	44 (39)
NSR 5: White Bridge Hs	45	44	42	38	40	44 (40)	41	40	41	37	39	42 (39)

17.6.19 During the weekend night time periods, wind speeds were consistently at a level of between 2 – 3.5m/s. Whilst not being sufficiently high to exclude the data, the effect of having only a small data set applicable to the lower wind speeds was to raise the mean value to above both the weekday night time values and night time evening levels.

17.6.20 With the mean value for the weekend night time period being potentially unrepresentative, the value of the 'mean minus 1 standard deviation' has been included (in brackets) in Table 17.8 as this value demonstrates better consistency with mean values for other period, at all NSR's.

Discussion of Noise Survey Results

17.6.21 The main general points to note from a review of the noise measurement results are:

- Daytime ambient $L_{Aeq,15min}$ and background $L_{A90,15min}$ noise levels do not vary significantly between weekday and weekend periods. This would be expected, as road traffic and general environmental noise sources such as running water (streams), vegetation (tree and foliage rustle) do not vary between these periods;

- Ambient $L_{Aeq,15min}$ noise levels are highest at positions NSR 1 and NSR 4, as these positions are closest to the A82 and therefore exposed to higher levels of traffic noise; and

- At all positions, except NSR 1, where traffic noise is most dominant, the higher noise levels are produced during the periods of higher winds above 3.5m/s. However, all these higher sound levels have been excluded from the mean values indicated.

17.6.22 Table 17.9 provides a more detailed review of the mean daytime ambient noise levels at each position, with a description of main contributing noise sources.

Table 17.9: Mean daytime ambient $L_{Aeq,T}$ levels and description of noise sources

Receptor Position	Mean $L_{Aeq,15\ min}$			Description of ambient noise sources
	Day	Eve.	Night	
NSR 1: Corrigour Hotel	61	56	51	The main contributor to ambient noise levels across all periods is from steady traffic on the nearby A82. A typical traffic noise profile, with levels reducing in the evening and night time with reducing traffic flow, is exhibited at this location. Lower noise contributions include vegetation noise (tree rustle) from the nearby trees and continuous running water from the nearby hillside stream, which limits the lowest night time background noise to $L_{A90,T}$ 43dB.
NSR 2: Kilfinnan Lodges Proxy position Robertson Farm	47	48	44	As a more remote location, the main contribution to ambient noise levels across all periods comes from a mix of general environmental sources. Intermittent sources include animals, vegetation (tree and foliage rustle) and occasional local vehicles. More constant noise comes from running water from nearby small streams, draining rain-water from the hill to Loch Lochy and also distant traffic on the A82 (800 m) on the opposite (south) side of the loch. Noise from running water provides the limit to the lowest night time background noise to $L_{A90,T}$ 42dB.
NSR 3: Cameron Farm Hs	45	43	40	Being a more remote location, the main contribution to ambient noise levels across all periods comes from a mix of general environmental sources. Intermittent sources include animals, vegetation (tree and grass rustle) and occasional local vehicles. More constant noise comes from running water from a nearby small stream, draining rain-water from the hill to Loch Lochy and also distant traffic on the A82 (500 m) on the opposite (south) side of the loch. Noise from running water provides the limit to the lowest night time background noise to $L_{A90,T}$ 38dB.
NSR 4: 11 North Laggan	52	48	43	The main contributor to ambient noise levels across all periods is from steady traffic on the nearby A82. A typical traffic noise profile, with levels reducing in the evening and night time with reducing traffic flow, is exhibited at this location. Smaller noise contributions include vegetation noise from the nearby trees and continuous water flow noise from the nearby hillside stream, which limits the lowest night time background noise to $L_{A90,T}$ 40dB.
NSR 5: White Bridge Hs. Proxy position south of property	45	42	40	A remote location within a cleared area between foliage. Intermittent sources include occasional passing traffic on the nearby forest track and vegetation (tree and grass rustle). More continuous river-flow noise comes River Garry, including a section of nearby rapids, which runs to the east of this position. This running water provides the limit to the lowest night time background noise to $L_{A90,T}$ .39dB.

17.6.23 As described in Table 17.9, the main contributing elements to environmental noise in this region are from natural sources, such as running water, vegetation (tree and foliage rustle) and from animal sounds. The only anthropogenic noise is from transportation sources and

mainly steady road traffic on the busy A82, which provides the main link route from Fort Augustus to Inverness and towns and communities in between.

17.6.24 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, and in particular on the A82.

17.7 Potential Noise & Vibration Impacts

17.7.1 For The Proposed Development the following noise and vibration impacts have been identified for review and assessment:

- Continuous noise produced during operation of The Proposed Development (Operational Noise);
- Temporary noise produced during construction of The Proposed Development (Construction Noise);
- Temporary vibration produced during construction of The Proposed Development (Construction Vibration); and
- Temporary noise from additional construction road traffic using public roads (Traffic Noise).

Operational Noise

17.7.2 Noise from the operation of The Proposed Development has been scoped out of a quantitative assessment, as the reversible pump-turbines, motor generators, transformers and other associated equipment would be located within an underground cavern power station, with the bulk of the mountain and the long underground access tunnel (circa 1 km) reducing noise breakout to the surface to a minimum.

17.7.3 The tailrace tunnels and two screened inlet/outlet structures would be below minimum water level, to channel water in and out of Loch Lochy. There would therefore be no risk of noise travelling along the tailrace from the pump-turbines and breaking out to atmosphere.

17.7.4 In further consideration of the large distance between the cavern power station and the closest NSR position (2.2 km), a qualitative assessment would indicate that the potential for adverse noise impact, due to operational noise, would be negligible.

17.7.5 Once operational, it is estimated that an average of 20 staff would be employed at the facility on a permanent basis, requiring daily access. There would additionally be occasional (weekly) visits to the upper reservoir area for inspection and maintenance purposes. The vehicle movements generated by these activities would be low, and therefore the potential for adverse noise impact would again be negligible.

Construction Noise

17.7.6 For the purpose of demonstrating potential impact from construction works, a qualitative assessment, to include prediction of noise levels resulting from the following activities, has been completed.

- Upgrade and construction of existing access tracks / roads: forecast for completion between years 1-2;
- Site establishment works: forecast for completion between years 1-2;
- Jetty works: forecast for completion between years 3-6; and
- Lower control works (screened inlet / outlet structures): forecast for completion between years 3-6.

Prediction of Construction Noise

17.7.7 For the purpose of this assessment, noise predictions have been completed for each of the above work activities and to the NSR's identified in Table 17.7, using procedures, together with construction equipment noise data, included in BS 5228-1.

17.7.8 For the upgrade of access roads/tracks and construction of a new temporary haul road, predictions have been 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 10 m distance, has been referenced from Annex C of the Standard. At this stage, detail of the plant requirements for road construction and upgrade works are not finalised. For the purpose of the predictions a typical plant operating scenario for such road works has been assumed, as illustrated in Plate 17.1.

17.7.9 For the site establishment works, jetty and lower control works, predictions have been based on the BS 5228-1 plant sound power method, using the operating plant noise levels given in Annex C, with a +28dB(A) correction applied to the $L_{Aeq,T}$ values at 10 m distance. Whilst some plant would be mobile, this would be within a limited area work zone, so for the purpose of the predictions such plant would be classified as 'quasi-stationary'.

17.7.10 A proprietary computer noise model, the Bruel and Kjaer, 'Predictor' has been used to calculate noise propagation corrections, to procedures defined in ISO 9613. The model calculates noise levels around a site simultaneously and allows the reporting of the results visually through the construction of noise contours on an OS plan. This enhances the information provided by simple predictions made to specific receptor positions, as forecast noise levels can be reviewed across the complete region covered by the noise map.

17.7.11 The following set-up parameters have been used in the computer noise model:

- Ground Factor = 0.8 (mainly soft ground), 0 (for Loch Lochy, which is reflective);
- Downwind conditions (C=0);
- Temperature = 10°C;
- Humidity = 60%;
- Receiver height = 1.5 m; and
- Noise source height: typically 2 m.

17.7.12 It may be noted that the noise model has been built upon scaled OS mapping that includes land height contours, at 10 m distance intervals. Accordingly, the noise model takes full account of terrain screening.

17.7.13 For the purpose of the predictions it has been assumed that all the plant items, with associated numbers of each, could be operating together and continuously for the complete working day (07:00-19:00). The predictions therefore reflect the worst-case scenario, with no applied on-time correction.

17.7.14 Predictions made to ISO 9613 are applicable to the worst-case noise propagation condition, where all receptors are downwind from the noise source. Noise levels experienced under other wind directions are likely to be lower than those predicted for the downwind condition.

17.7.15 A temporary haul road is proposed to connect the lower reservoir works area to the upper reservoir, providing an opportunity to supplement rock quarried within the upper reservoir, with suitable tunnel spoil from the underground works, for dam construction. As noted in Chapter 7: Spoil Management, the viability of constructing this temporary haul road would be dependent on the scale of the project (i.e. 1500 MW or less), and the outcome of the final Spoil Management Plan. However, its use is included in this assessment for completeness. For the prediction of additional noise due to dump truck movements along the haul road, the method described in Section F.2.5.2 of BS 5228-1 has been used, referencing the following expression:

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

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
- a_v is the angle of view of the haul road from the receptor position.

17.7.16 The basis for all the noise predictions is the noise data applicable to the items of construction plant and equipment that have been identified, at this stage, as typically being required for undertaking each of the planned work activities. The noise data applicable to the plant operation has been taken from the reference tables included in Annex C of BS 5228-1. The plant list with accompanying noise data is reproduced in Table 17.10.

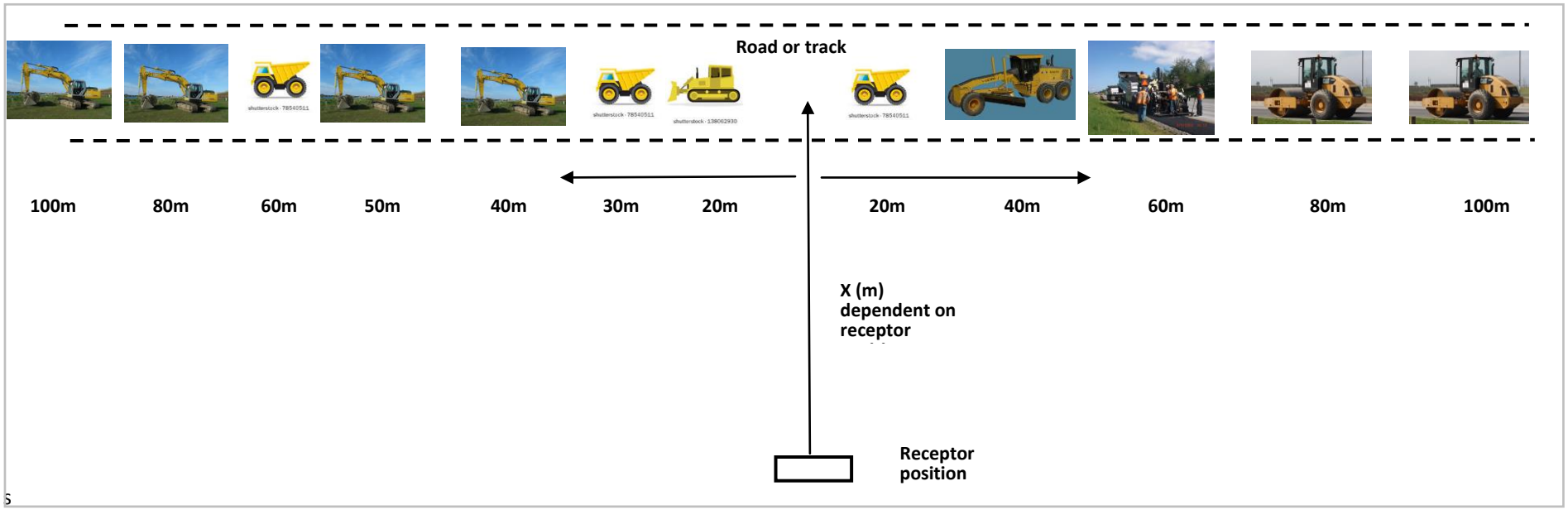
Table 17.10: Equipment and plant noise data taken from BS 5228-1 Annex C

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
Site Establishment Works	Bulldozer CAT D6T	1	C.5.15	83	83	81	76	77	82	70	65	58
	Excavator CAT 336F (35t)	2	C.5.18	80	76	79	75	75	76	73	70	65
	Excavator CAT 320F (20t)	2	C.2.19	77	95	84	79	73	70	68	64	57
	CAT Grader 14M	1	C6.31	86	88	87	83	79	84	78	74	65
	ADT Dump Truck CAT 745C	3	C.5.17	81	85	88	77	75	77	74	69	63
	Vibratory Compactor CAT CS56B	1	C.5.22	81	92	83	75	79	77	70	67	61
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
Jetty works	Drill rig FlexiROC T35	2	C.6.35	86	85	93	78	79	80	79	76	74
	Excavator CAT 336F (35t)	2	C.5.18	80	76	79	75	75	76	73	70	65
	ADT Dump Truck CAT 745C	2	C.5.17	81	85	88	77	75	77	74	69	63
	Crawler Crane Piling rig (50t)	1	C.3.29	70	81	77	69	67	62	60	61	51
	Bulldozer CAT D6T	1	C.5.15	83	83	81	76	77	82	70	65	58
	CAT Grader 14M	1	C6.31	86	88	87	83	79	84	78	74	65
	Vibratory Compactor CAT CS56B	1	C.5.22	81	92	83	75	79	77	70	67	61
Lower Control Works: (screened inlet/outlet structures).	Drill rig FlexiROC T35	3	C.6.35	86	85	93	78	79	80	79	76	74
	Shotcrete jumbo	2	C.9.2	92	94	95	90	91	87	85	80	73
	Rock drills	3	C.9.1	90	86	92	85	88	84	83	78	77
	Shovel CAT 992K (wheeled Loader)	1	C.9.7	88	88	93	84	84	83	81	79	69
	ADT Dump Truck CAT 745C	3	C.5.17	81	85	88	77	75	77	74	69	63
	Excavator CAT 352F (50t)317kW	1	C.6.4	80	86	90	78	74	75	70	62	60
	Crawler crane (50t)	4	C.4.46	67	78	69	67	64	62	57	49	40

Table 17.10: Equipment and plant noise data taken from BS 5228-1 Annex C - continued

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
Concrete aggregate processing & materials handling	Bulldozer CAT D6T	1	C.5.15	83	83	81	76	77	82	70	65	58
	Excavator CAT 336F (35t)	2	C.5.18	80	76	79	75	75	76	73	70	65
	Excavator CAT 320F (20t)	2	C.2.19	77	85	84	79	73	70	68	64	57
	CAT Grader 14M	1	C6.31	86	88	87	83	79	84	78	74	65
	ADT Dump Truck CAT 745C	3	C.5.17	81	85	88	77	75	77	74	69	63
	Vibratory Compactor CAT CS56B	1	C.5.22	81	92	83	75	79	77	70	67	61
Transportation of spoil to upper dam via temporary haul road	Shovel CAT 992K (wheeled Loader)	1	C.9.7	88	88	93	84	84	83	81	79	69
	CAT 777F Dump Truck 700kW / 100t	4	C.6.14	89	89	94	89	85	83	81	76	71

Plate17.1: Example plant operating scenario for new road / road upgrade work



Construction Noise Prediction Results

17.7.17 The prediction of noise resulting from the road upgrade and new road construction works are provided in Tables 17.11 to 17.16.

Table 17.11: Prediction table for construction of new temporary haul road. NSR 1: Corrigour Hotel

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	1200	-50	-	+3	33	100	0	33
Excavator (35t) No.2	80	1200	-50	-	+3	33	100	0	33
ADT Dump Truck No.1	81	1200	-50	-	+3	34	100	0	34
Excavator (20t). No.1	77	1200	-50	-	+3	30	100	0	30
Excavator (20t) No.2	77	1200	-50	-	+3	30	100	0	30
ADT Dump Truck No.2	81	1200	-50	-	+3	34	100	0	34
Bulldozer CAT D6T	83	1200	-50	-	+3	36	100	0	36
ADT Dump Truck No.3	81	1200	-50	-	+3	34	100	0	34
CAT Grader 14M	86	1200	-50	-	+3	39	100	0	39
Asphalt paver	77	1200	-50	-	+3	30	100	0	30
Vibratory Compactor 1	81	1200	-50	-	+3	34	100	0	34
Vibratory Compactor 2	81	1200	-50	-	+3	34	100	0	34
Total						**45**			**45**

Table 17.12: Prediction table for upgrade of public access road. NSR 2: Kilfinnan Lodges

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	101	-23	-5	+3	55	100	0	55
Excavator (35t) No.2	80	82	-21	-5	+3	57	100	0	57
ADT Dump Truck No.1	81	62	-18	-5	+3	61	100	0	61
Excavator (20t). No.1	77	52	-16	-5	+3	59	100	0	59
Excavator (20t) No.2	77	43	-14	-5	+3	61	100	0	61
ADT Dump Truck No.2	81	34	-11	-5	+3	68	100	0	68
Bulldozer CAT D6T	83	26	-8	-5	+3	73	100	0	73
ADT Dump Truck No.3	81	26	-8	-5	+3	71	100	0	71
CAT Grader 14M	86	43	-14	-5	+3	70	100	0	70
Asphalt paver	77	62	-18	-5	+3	57	100	0	57
Vibratory Compactor 1	81	82	-21	-5	+3	58	100	0	58
Vibratory Compactor 2	81	101	-23	-5	+3	56	100	0	56
Total						**77**			**77**

Table 17.13: Prediction table for construction of new temporary haul road. NSR 2: Kilfinnan Lodges

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	412	-38	-5	+3	40	100	0	40
Excavator (35t) No.2	80	408	-38	-5	+3	40	100	0	40
ADT Dump Truck No.1	81	404	-38	-5	+3	41	100	0	41
Excavator (20t). No.1	77	403	-38	-5	+3	37	100	0	37
Excavator (20t) No.2	77	402	-38	-5	+3	37	100	0	37
ADT Dump Truck No.2	81	401	-38	-5	+3	41	100	0	41
Bulldozer CAT D6T	83	400	-38	-5	+3	43	100	0	43
ADT Dump Truck No.3	81	400	-38	-5	+3	41	100	0	41
CAT Grader 14M	86	402	-38	-5	+3	46	100	0	46
Asphalt paver	77	404	-38	-5	+3	37	100	0	37
Vibratory Compactor 1	81	408	-38	-5	+3	41	100	0	41
Vibratory Compactor 2	81	412	-38	-5	+3	41	100	0	41
Total						**52**			**52**

Table 17.14 Prediction table for upgrade of public access road. NSR 3: Cameron Farm House.

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	101	-24	-5	+3	54	100	0	54
Excavator (35t) No.2	80	82	-21	-5	+3	57	100	0	57
ADT Dump Truck No.1	81	62	-19	-5	+3	60	100	0	60
Excavator (20t). No.1	77	52	-17	-5	+3	58	100	0	58
Excavator (20t) No.2	77	43	-16	-5	+3	59	100	0	59
ADT Dump Truck No.2	81	34	-14	-5	+3	65	100	0	65
Bulldozer CAT D6T	83	26	-12	-5	+3	69	100	0	69
ADT Dump Truck No.3	81	26	-12	-5	+3	67	100	0	67
CAT Grader 14M	86	43	-16	-5	+3	68	100	0	68
Asphalt paver	77	62	-19	-5	+3	56	100	0	56
Vibratory Compactor 1	81	82	-21	-5	+3	58	100	0	58
Vibratory Compactor 2	81	101	24	-5	+3	55	100	0	55
Total						**74**			**74**

Table 17.15: Prediction table for upgrade of public access road. NSR 4: 11 North Laggan

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	102	-23	-	+3	60	100	0	60
Excavator (35t) No.2	80	82	-21	-	+3	62	100	0	62
ADT Dump Truck No.1	81	63	-18	-	+3	66	100	0	66
Excavator (20t). No.1	77	53	-16	-	+3	64	100	0	64
Excavator (20t) No.2	77	44	-14	-	+3	66	100	0	66
ADT Dump Truck No.2	81	35	-12	-	+3	72	100	0	72
Bulldozer CAT D6T	83	27	-9	-	+3	77	100	0	77
Total						**79**			**79**
ADT Dump Truck No.3	81	27	-9	-	+3	75	100	0	75
CAT Grader 14M	86	44	-14	-	+3	75	100	0	75
Asphalt paver	77	63	-18	-	+3	62	100	0	62
Vibratory Compactor 1	81	82	-21	-	+3	63	100	0	63
Vibratory Compactor 2	81	102	-23	-	+3	61	100	0	61
Total						**78**			**78**

Table 17.16: Prediction table for upgrade of existing forestry track. NSR 4: White Bridge House

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	106	-24	-	+3	59	100	0	59
Excavator (35t) No.2	80	87	-22	-	+3	61	100	0	61
ADT Dump Truck No.1	81	69	-19	-	+3	65	100	0	65
Excavator (20t). No.1	77	61	-18	-	+3	62	100	0	62
Excavator (20t) No.2	77	53	-16	-	+3	64	100	0	64
ADT Dump Truck No.2	81	46	-15	-	+3	69	100	0	69
Bulldozer CAT D6T	83	40	-13	-	+3	73	100	0	73
ADT Dump Truck No.3	81	40	-13	-	+3	71	100	0	71
CAT Grader 14M	86	53	-16	-	+3	73	100	0	73
Asphalt paver	77	69	-19	-	+3	61	100	0	61
Vibratory Compactor 1	81	87	-22	-	+3	62	100	0	62
Vibratory Compactor 2	81	106	-24	-	+3	60	100	0	60
Total						**79**			**79**

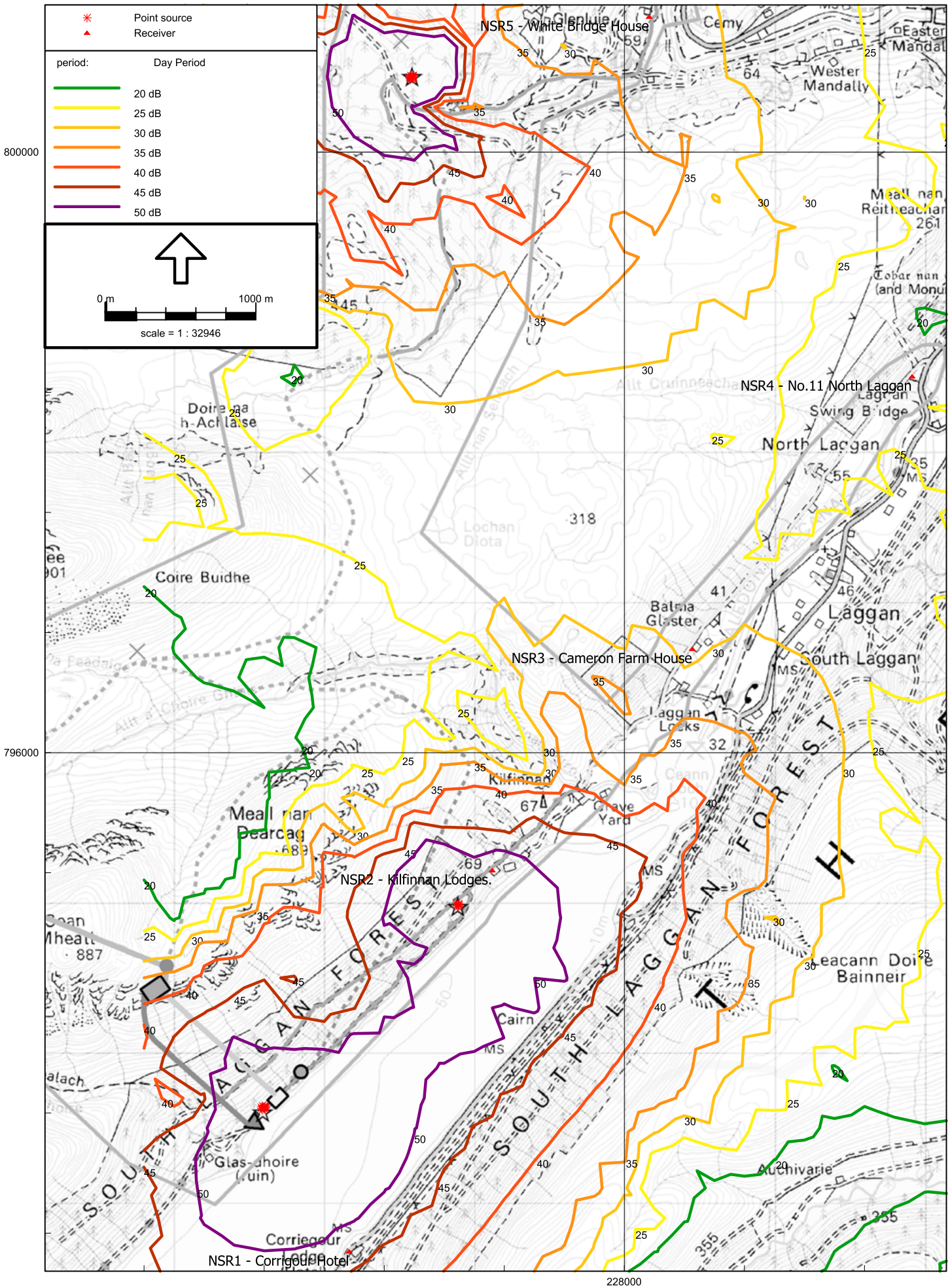
17.7.18 The prediction detail and assumptions made relating to noise resulting from the movements of dump trucks transporting rock from the lower reservoir works to the upper dam, along the new temporary haul road, are provided in Table 17.17. Reference needs to be made to the expression provided in paragraph 17.7.15, in order to calculate the resultant noise levels at each NSR position. Predictions are not included for positions NSR 4 and 5, as these are located in excess of 4 km from the closest part of the temporary haul road and outside of potential impact range.

Table 17.17: Prediction table for temporary haul road vehicle movements

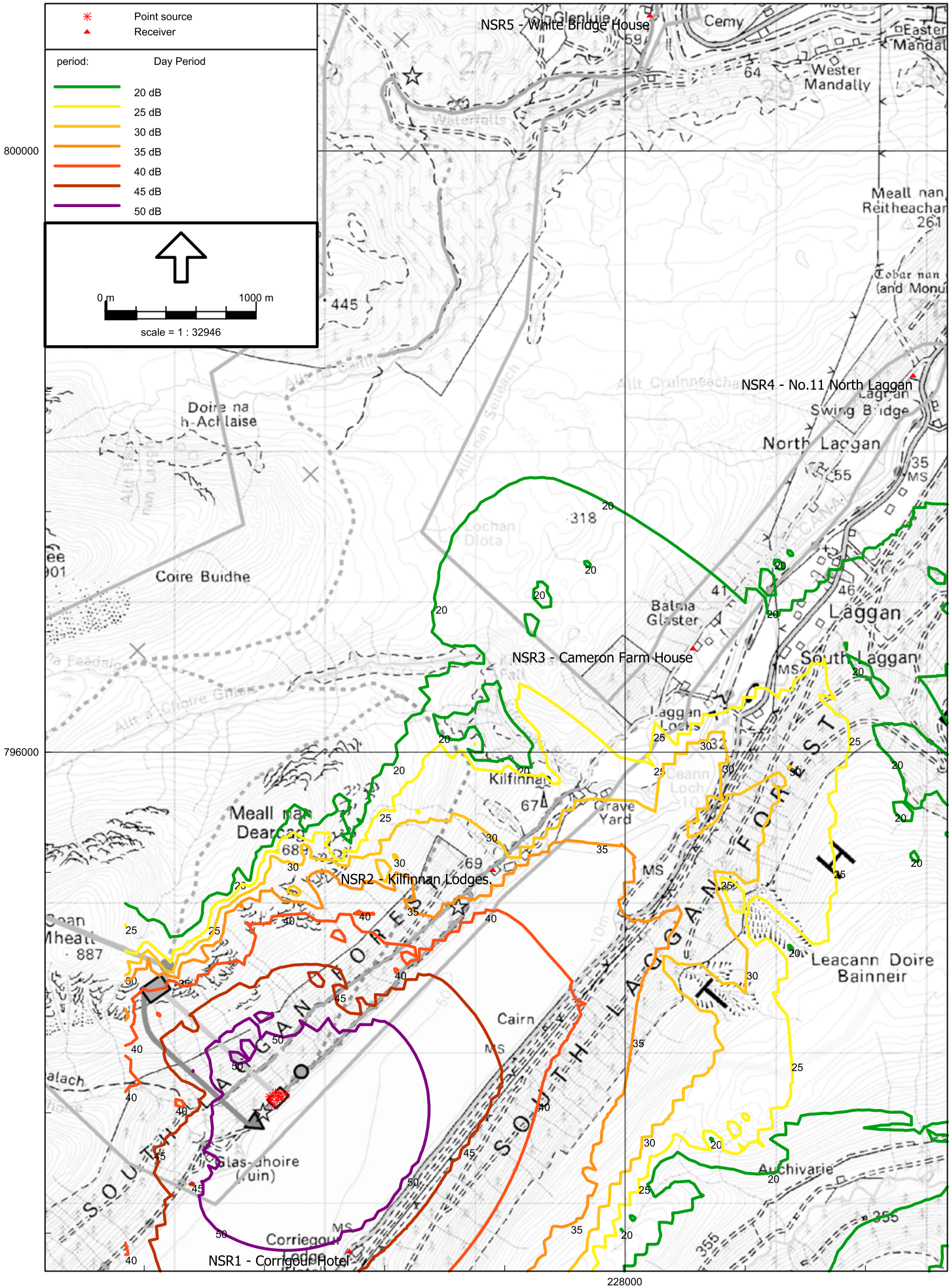
Receptor Position		L_{wA} dB	Q	V	D	View	Adjustments (dB)		Result $L_{Aeq,T}$
			Veh./h	Km/h	Dist. (m)	a_v °	Screen	Ref.n	
NSR 1:	Corrigour Hotel	117	8	25	1200	45	-	+3	45
NSR 2:	Kilfinnan Lodges	117	8	25	400	90	-5	+3	48
NSR 3:	Cameron Farm House	117	8	25	1800	45	-5	+3	38

17.7.19 The noise maps, showing the predicted noise contours resulting from the site establishment and lower control works are included in Plates 17.1 to 17.3.

Plate 17.2: Predicted Noise Levels from Site Establishment Works (Cumulative)

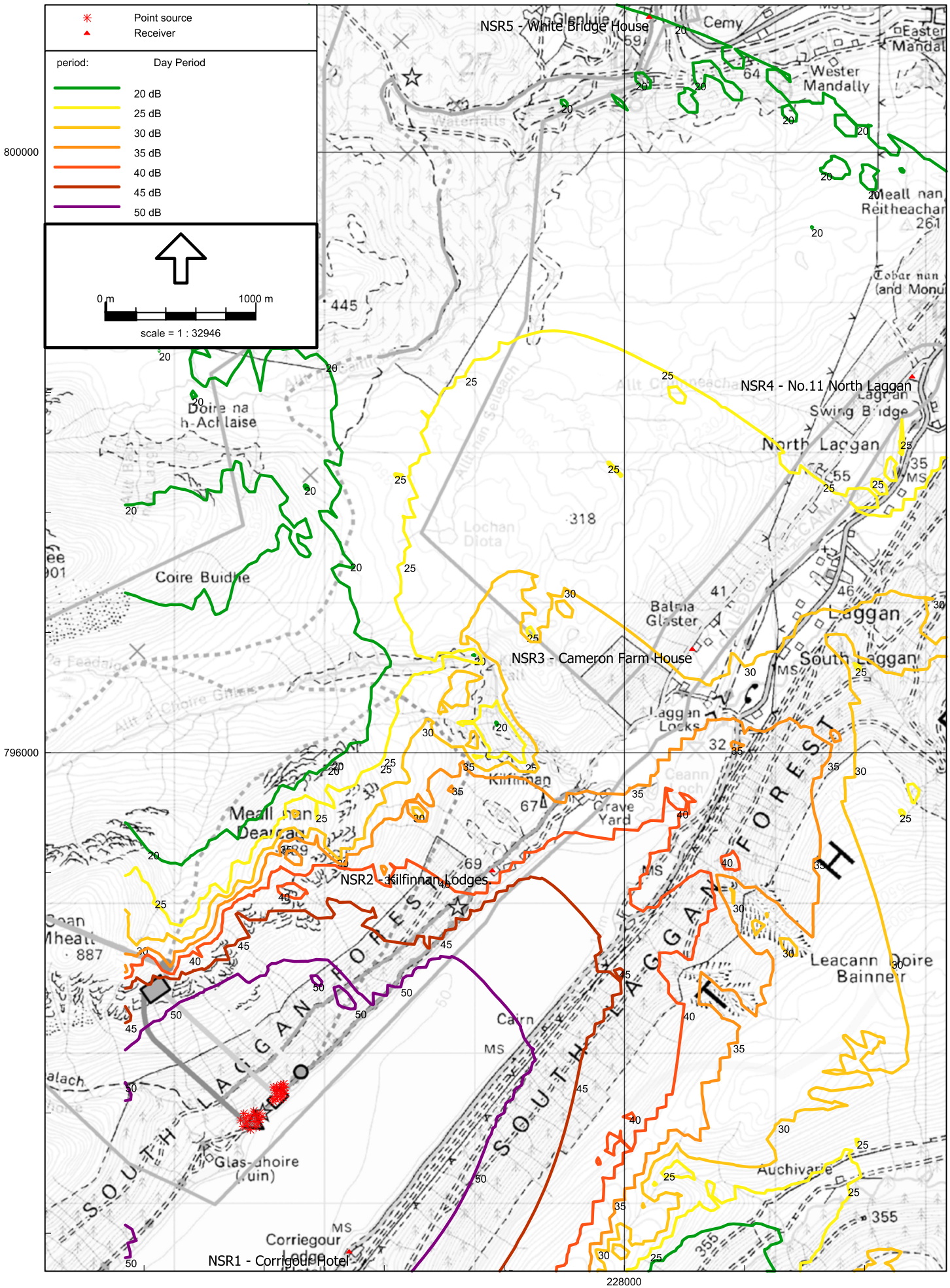


Industrial noise - ISO 9613.1/2, [version of 17278 - Coire Glas Pumped Storage Scheme - Site Establishment Works - Cumulative Impact of all 3 Sites [Rev 2]] , Predictor V11.00
OS License number: 100034870



Industrial noise - ISO 9613.1/2, [version of 17278 - Coire Glas Pumped Storage Scheme - Jetty Works] , Predictor V11.00
OS License number: 100034870

Plate 17.4: Predicted Noise Levels. Lower Control Works (screened inlet /outlet structures + concrete aggregate processing



Industrial noise - ISO 9613.1/2, [version of 17278 - Coire Glas Pumped Storage Scheme - Inlet / Outlet Works + Concrete Aggregate Processing] , Predictor V11.00
OS License number: 100034870

17.7.20 The predicted noise levels from each of the construction activities at each receptor location, are summarised in Table 17.18.

Table 17.18: Summary of predicted construction noise levels $L_{Aeq,T}$.

Receptor Position	Upgrade of access roads / haul road construction	Site Establishment Works	Jetty Works	Lower Control Works: (Inlet/Outlet Structures)	Haul Road Vehicle Movements
NSR 1: Corrigour Hotel	45[1]	48	48	56	45
NSR 2: Kilfinnan Lodges	77 (52)[2]	55	31	38	48
NSR 3: Cameron Farm Hs.	74	28	22	29	38
NSR 4: No.11 N. Laggan	78	22	15	23	-
NSR 5: White Bridge Hs.	79	31	13	20	-

Note 1: For NSR 1 the value represents the predicted level from new temporary haul road construction

Note 2: For NSR 2 the value in brackets in column 2 'upgrade of access roads', represents the predicted level from new haul road construction

17.7.21 The predictions indicate that the highest noise levels and therefore greater potential for adverse impact would result from the works associated with the upgrade and construction of access roads/tracks. This is due to the close proximity of the access roads to the receptor positions located to the side of these roads.

17.7.22 Whilst vehicle movements along the temporary haul road, associated with transporting spoil from the lower reservoir works to the dam, would be concurrent with the lower control works, the predictions show that there is at least an 8dB margin between the contributions from each activity at each receptor. This means that the cumulative level would only be 0.6dB higher than the higher individual contribution, so need not be given separate consideration.

Construction Vibration

17.7.23 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.

17.7.24 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 110 m, which would tie in with the expectation that prediction of vibration to large distances would have limited accuracy.

17.7.25 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.

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

17.7.27 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 (1.1 km to the closest sensitive receptor position), the resulting vibration PPV levels would be below 1mms^{-1}, and consequently the potential impact would be negligible.

17.7.28 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; and
- Blasting activities associated with construction of tunnels and the cavern power station.

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

17.7.30 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.

17.7.31 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.

17.7.32 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.

17.7.33 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 17.4). The methodology for the vibration testing programme would be provided in the Final Construction Noise & Vibration Management Plan (CNVMP), when more detail on the design of the blasting activities are known.

Blast Generated Air Overpressure

17.7.34 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.

17.7.35 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.

17.7.36 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. Potential adverse impact resulting from air-overpressure produced by blasting operations would therefore be avoided by employing good blast design.

17.7.37 Additionally, monitoring of air-overpressure during blasting activities would be completed in conjunction with ground vibration measurements, using the same seismograph instrumentation. Detail of the monitoring programme would be included in the CNVMP, when more detail on the design of the blasting programme is known.

Road Traffic Noise

17.7.38 For the purpose of demonstrating potential impact from road traffic noise, a qualitative assessment, to include prediction of noise levels resulting from changes to traffic flows during the construction phase of The Proposed Development, has been completed.

Prediction of Road Traffic Noise during Construction

17.7.39 For the purpose of assessing road traffic change, during the construction phase of The Proposed Development, projected daily 18-hour (0600-0000) average 'with and without' peak development traffic flows (assumed Year 2026, as included in Chapter 16: Traffic and Transport), on roads that would be used to access the site, have been produced based on the 24 hour and 20 hour data included in Chapter 16: Traffic and Transport. This information is provided in Table 17.19.

17.7.40 It may be noted that it is necessary to use 18-hour (0600-0000) traffic flow data in order to calculate traffic noise in terms of the $L_{A10,18\ hour}$ index, as required by CRTN. The noise change in terms of $L_{A10,18\ hour}$ is used (in DMRB) to classify the magnitude of noise impacts.

Table 17.19: Peak Traffic Flows (2026) current and projected (during construction) 18-hour traffic flows.

Road Section	2026 baseline		Development traffic 2026		Total 2026		% Increase (Impact)	
	All	HGV's	All	HGV's	All	HGV's	All	HGV's
A82: North of Invergarry	2578	731	200	182	2778	913	8	25
A87: Invergarry (near the proposed northern site access junction)	1934	419	94	64	2028	483	5	15
A82: Site Access at the junction with Kilfinnan Road)	3722	981	324	282	4046	1263	9	29
Kilfinnan Road (site access road	69	19	294	264	363	283	426	1389
A82 to the south of Spean Bridge	5558	1223	143	119	5701	1342	3	10
A86 to the east of Spean Bridge	2163	554	27	27	2190	581	1	5

17.7.41 The effect of changes in road traffic flows, upon resulting noise levels, only becomes discernible (and significant) when levels rise by more than + 1dB, representing an increase

in traffic flow of 25%. From Table 17.19, the increase to traffic on the main A-roads providing access to the development site would be well below 25% and therefore not significant. However, the 426% increase in total traffic flow on Kilfinnan Road would be significant, requiring further assessment of resulting noise change.

17.7.42 More detailed traffic noise predictions, relating to projected increased traffic during the construction phase of The Proposed Development, have been made in accordance with 'Calculation of Road Traffic Noise' (CRTN), issued by the Department of Transport Welsh Office.

17.7.43 Road traffic noise calculations are based on 18-hour traffic flows with the traffic noise projections covering the following circumstances:

- Scenario A: Baseline (2026) 18-hour mean traffic flow; and
- Scenario B: Baseline (2026) traffic, including projected (2026) construction traffic.

17.7.44 The effect of changes in traffic noise are evaluated along road sections where there are residential receptors. Whilst it is not practicable to predict the received noise level on an individual property basis, it is the relative increase in traffic noise which is most important to the assessment, so the precise prediction distance from the road is not critical.

17.7.45 Consequently, predictions have been provided (Table 17.20) in terms of $L_{A10,18\ hour}$ at a reference position 10 m from the edge of the nearside carriageway, 1.5 m above ground in the free-field. Average 18-hour traffic speeds on each road section have been taken from the traffic survey.

Table 17.20: $L_{A10,18hr}$ current and projected (during construction) traffic noise calculations.

Road Section	Scenario	Average 18hr daytime flow			$L_{A10,18\ hour}$
		vehicles	Heavy	% heavy	BNL (10m)[1]
A82: North of Invergarry	A	2578	731	28	65.8
	B	2778	913	33	66.8
	Change	+200	+182	+5	+1.0
A87: Invergarry	A	1934	419	22	63.2
	B	2028	483	24	63.7
	Change	+94	+64	+2	+0.5
A82: Site access junction South of Invergarry	A	3722	981	26	67.5
	B	4046	1263	31	68.4
	Change	+324	+282	+5	+0.9
Kilfinnan Road (access road)	A	69[2]	19	28	50.7
	B	363[2]	283	78	62.0
	Change	+294	+264	+50	+11.3
A82: Spean Bridge	A	5558	1223	22	68.3
	B	5701	1342	24	68.8
	Change	+143	+119	+2	+0.5
A86: Roybridge	A	2163	554	26	64.5
	B	2190	581	27	64.7
	Change	+27	+27	+1	+0.2

Notes 1) BNL is the basic noise level calculated at 10m from the nearside carriageway edge, in the free-field

2) Traffic flows on Kilfinnan Road are less than 1000 vehicles/18-hours, so, in accordance with CRTN the 'low-flow' correction is not applicable and the predicted noise levels are therefore unreliable.

17.7.46 As shown in Table 17.20, the additional traffic generated during the construction phase of The Proposed Development would provide only a small (<1dB) increase in $L_{A10,18\ hour}$ noise level from the main A-roads providing access to the development site, with this providing a negligible adverse impact.

17.7.47 Both 'with and without' development traffic flows on the Kilfinnan Road are low and below 1000 vehicles/18 hour day, rendering the predicted levels (in accordance with CRTN) unreliable. However, the high percentage increase in traffic on Kilfinnan Road (426% total, 1389% HGV), together with the large increase in noise ($L_{A10,18\ hour}$ >5dB), would indicate a potential major adverse impact.

17.8 Mitigation

Operational Noise

17.8.1 In the case of operational noise, mitigation is integral to the design of the cavern power station, as the reversible pump-turbines, motor generators, transformers and other associated equipment would be located underground, with the bulk of the mountain and the long underground access tunnel (1 km) reducing noise breakout to the surface to a minimum.

Construction Noise and Vibration

17.8.2 Construction noise and vibration would primarily be managed through a CNVMP, which would be formally agreed with The Highland Council (The Planning Authority), prior to construction work commencing.

17.8.3 Once clearer detail of the construction plant and processes are known, the appointed main contractor would develop and submit, for approval by The Highland Council, the 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.

17.8.4 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 17.2.

Traffic Noise

17.8.5 Traffic during the construction and operation of The Proposed Development would utilise existing public roads and forestry tracks, where possible. The Caledonian Canal System would also be used as far as practicable in the delivery of various equipment and materials, as well as in the disposal of tunnel spoil, thereby reducing heavy vehicle road use for this process.

17.8.6 Furthermore, the creation of a temporary 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.

17.8.7 More detail regarding the options for the transportation and re-use of spoil is described in Chapter 7: Spoil Management.

17.9 Monitoring

17.9.1 Monitoring of noise during construction works would be covered in a section included in the CNVMP (see Appendix 17.2). It is expected that monitoring of noise would only be carried out in response to a specific complaint.

17.9.2 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.

17.10 Evaluation of Residual Effects

17.10.1 This section provides, as appropriate to each impact, a quantitative or qualitative assessment of the residual effects of noise associated with The Proposed Development, with the mitigation measures described in Section 17.8 included in the scheme.

Operational Noise

17.10.2 The main items of noise generating equipment associated with the operation of the cavern power station would be located underground, with the bulk of the mountain and the long underground access tunnel (1 km) reducing noise breakout to the surface to a minimum.

17.10.3 With further consideration given to the large distance between the cavern power station and the closest noise sensitive receptor position (2.2 km), the potential for adverse impact, due to operational noise, would be Negligible, with the residual noise effect being not significant.

Construction Noise

17.10.4 As described in Chapter 3: Description of Development, normal construction shifts would generally apply for the surface works, subject to some variation to suit the work in hand and weather conditions, to be agreed with The Highland Council.

17.10.5 For the purpose of assessing noise impact, the predicted noise levels from each of the construction activities have been used to establish the produced ambient noise change, taken over the BS 5228-1 daytime assessment period, defined as 07:00-19:00 weekdays and 07:00-13:00 Saturdays.

17.10.6 Any surface works outside these normal daytime construction hours would be subject to agreement with The Highland Council and, where requested by the Council, to a separate

assessment of noise covering the specific activity proposed and the proposed time of this activity.

17.10.7 Table 17.21 provides a summary of the predicted construction noise levels, together with the resulting ambient noise change.

Table 17.21: Summary of construction noise levels and produced ambient noise ($L_{Aeq,T}$) change.

Receptor Position	Upgrade and construction of access roads				Site Establishment Works				Jetty Works				Lower Control Works (Inlet/Outlet structures)				Haul Road Vehicle Movements			
	CNL	EAN	TAN	ANC	CNL	EAN	TAN	ANC	CNL	EAN	TAN	ANC	CNL	EAN	TAN	ANC	CNL	EAN	TAN	ANC
NSR 1: Corrigour Hotel	45	61	61.1	0.1	48	61	61.2	0.2	48	61	61.2	0.2	56	61	62.2	1.2	45	61	61.1	0.1
NSR 2: Kilfinnan Lodges	77	47	77.0	30	55	47	55.6	8.6	31	47	47.1	0.1	38	47	47.5	0.5	48	47	50.5	3.5
NSR 3: Cameron Farm Hs.	74	45	74.0	29	28	45	45.1	0.1	22	45	45.0	0	29	45	45.1	0.1	38	45	45.8	0.8
NSR 4: No.11 N. Laggan	78	52	78.0	26	22	52	52.0	0	15	52	52.0	0	23	52	52.0	0	-	52	52.0	0
NSR 5: White Bridge Hs.	79	45	79.0	34	31	45	45.2	0.2	13	45	45.0	0	20	45	45.0	0	-	45	45.0	0

Key to table:
CNL: Construction Noise Level. $L_{Aeq,T}$
EAN: Existing Ambient Noise. $L_{Aeq,T}$
TAN Total Ambient Noise (construction noise + existing ambient noise). $L_{Aeq,T}$
ANC: Ambient Noise Change (total ambient noise – existing ambient noise). $L_{Aeq,T}$

17.10.8 In accordance with the Table 17.3 impact classification, Table 17.22 defines the impact magnitude for each construction activity at each NSR position. Where noise impact is classified as High (noise change >=5dB and CNL >65dB) this is highlighted in red font, where noise impact is classified as Medium (noise change >=5dB and CNL <65dB), this is highlighted in amber font and where noise impact has been classed as at least Low (noise change <5dB) this is highlighted in green font.

Table 17.22: Magnitude of noise impacts for each construction activity.

Pos.n	Upgrade and construction of access roads		Site Establishment Works		Jetty Works		Lower Control Works (Inlet/Outlet Works)		Haul Road Vehicle Movements	
	ANC	Impact	ANC	Impact	ANC	Impact	ANC	Impact	ANC	Impact
NSR 1	0.1	Very low	0.2	Very low	0.2	Very Low	1.2	Low	0.1	Very Low
NSR 2	30	High	8.6	Medium	0.1	Very Low	0.5	Very Low	3.5	Low
NSR 3	29	High	0.1	Very low	0	Very Low	0.1	Very Low	0.8	Very Low
NSR 4	26	High	0	No change	0	No change	0	No Change	0	No change
NSR 5	34	High	0.2	Very low	0	No change	0	No Change	0	No change

17.10.9 In accordance with the BS 5228-1 defined potential significant effect criteria (noise change >=5dB and CNL >65dB), where the noise impact classification is High, noise effects are considered potentially significant. This applies to the following construction activities:

- Upgrade and construction of access roads. NSR 2, NSR 3, NSR 4, NSR 5.

17.10.10 Where a potential significant effect is indicated, consideration needs to be given to several additional factors, for the evaluation of the overall magnitude of noise effects, which for construction noise are:

- Sensitivity of receptors;
- Number of receptors affected;
- Whether the activity is permanent or temporary;
- Duration of the activity (short term, medium term, long-term); and
- Period of works (working hours).

17.10.11 The BS 5228-1 significant effect criteria is applicable to a range of resources (as noted in Section 17.5.19), which are considered to have equal high sensitivity to construction noise. These include residential buildings and hotels.

17.10.12 All construction activities included in the assessment would be classed as temporary, with the duration of the individual activities ranging from short term to long term.

17.10.13 For the upgrade of the access roads, the only activity where a potential significant effect is indicated, construction works would only be short term. Such road works would be progressive along the road concerned and the worst-case scenario assessed, of the road

works centred on the individual property concerned (see Plate 17.1), is only likely to present itself for a period of a few days.

17.10.14 Thereafter, the works would progress further along the road, with noise diminishing significantly with distance from the individual property. To demonstrate this, Table 17.23 presents a scenario where the road working convoy of vehicles and associated operations has progressed a sufficient distance along the road, so that the noise level at the property concerned has reduced to the point where this does not exceed the significant effect threshold of $L_{Aeq,T}$ 65dB (daytime).

Table 17.23: Upgrade of access road. Iterative prediction of construction noise to meet $L_{Aeq,T}$ 65dB

Plant Type	$L_{Aeq,T}$ at 10m	Dist. (m)	Adjustments (dB)			Resultant	on-time		Activity
			Dist.	Screen	Refl.n	$L_{Aeq,T}$ dB	%	dB	$L_{Aeq,T}$
BS5228-1. Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step7	8	10	Step 11
Excavator (35t) No.1	80	340	36	-	+3	47	100	0	47
Excavator (35t) No.2	80	320	36	-	+3	47	100	0	47
ADT Dump Truck No.1	81	300	35	-	+3	49	100	0	49
Excavator (20t). No.1	77	280	34	-	+3	46	100	0	46
Excavator (20t) No.2	77	260	33	-	+3	47	100	0	47
ADT Dump Truck No.2	81	240	33	-	+3	51	100	0	51
Bulldozer CAT D6T	83	220	32	-	+3	54	100	0	54
ADT Dump Truck No.3	81	200	31	-	+3	53	100	0	53
CAT Grader 14M	86	180	29	-	+3	60	100	0	60
Asphalt paver	77	160	28	-	+3	52	100	0	52
Vibratory Compactor	81	140	27	-	+3	57	100	0	57
Vibratory Compactor	81	120	25	-	+3	59	100	0	59
Total						65			65

17.10.15 The prediction shows that the road working convoy of vehicles would need to be at least 120 m (closest plant item), from the house concerned for the noise level to fall to below the $L_{Aeq,T}$ 65dB(A) significant effect threshold. Conversely, for roadworks undertaken within 120 m of a property the noise effect would be potentially significant.

17.10.16 At this stage it is not possible to estimate the rate of progression of the road construction, or road upgrade works, in terms of metres/day. However, it would be reasonable to assume that works completed within the noted distance from properties would be for a period of several weeks, rather than several months i.e. be classed as short term.

17.10.17 In further consideration that works would be completed during normal daytime working hours (07:00-19:00) and that there are only a small number of properties located within 120m of the access roads, the overall significance of effect would be considered as Low.

Construction Vibration

17.10.18 A qualitative assessment of potential vibration produced by construction activities has indicated that, due to the large separation distances to the closest NSR positions, the resulting ground vibration levels would be below 1mms^{-1} PPV. Consequently, the potential vibration impact would be Negligible, with the residual effect being not significant.

17.10.19 Providing the mitigation and monitoring proposals outlined in Sections 17.8 and 17.9 are adopted and incorporated into the CNVMP, to be agreed with The Highland Council, potential adverse impact from ground vibration and air-overpressure resulting from blasting activities would be avoided, resulting in the residual effect being not significant.

Road Traffic Noise

17.10.20 The additional traffic generated during the construction phase of The Proposed Development would provide only a small increase in noise from the main A-roads providing access to the development site, with the significance of the noise effect being Slight.

17.10.21 Due to the much higher percentage increase in traffic on Kilfinnan Road, the larger increase in noise ($L_{A10,18\ hour T}$ >5dB), would provide a Major adverse impact. In accordance with the TAN 'significance of noise effects' matrix, a major adverse impact at a residential receptor with associated high sensitivity would indicate a potential Large/Very Large significance of effect.

17.10.22 However, taking account of the following additional factors, relating to construction traffic using Kilfinnan Road, it is considered that the overall significance of noise effect would be large, rather than very large:

- Whilst the noise change is high at 11%, the absolute level of 62dB $L_{A10,18\ hour}$ at a reference position 10 m from the nearside carriageway, is only at a moderate level, as total (with construction) traffic flows are still low (363 vehicles/18 hour). Putting this in context, a traffic noise level of >=68dB $L_{A10,18\ hour}$, at the façade of a property, is defined as one of the qualifying criteria for entitlement to noise insulation treatment, under the Noise Insulation (Scotland) Regulations (1975). It should be noted that these Regulations apply to new road, or road upgrade (extra carriageway) schemes and not to general road surface improvements and are applied by the highway authority;
- There are only a small number of individual properties located along and set back from Kilfinnan Road; and
- Construction traffic on the Kilfinnan Road would be mainly during normal daytime hours (07:00-19:00).

17.11 Cumulative Effects

17.11.1 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.

17.11.2 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.

17.11.3 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.

17.11.4 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.

17.11.5 Giving consideration to these points, the favourable siting of the cavern power station, underground and at large distance from the closest receptors, would result in an insignificant specific noise level at receptors and no change to existing ambient noise levels. Accordingly, operational noise from the cavern power station would be unlikely to contribute to the specific noise resulting from any other potential developments planned in the area.

17.11.6 It has been demonstrated (Table 17.21) that noise levels produced by the longer-term lower control works would also be below current daytime ambient noise levels, resulting in only a very small change to this level (between 0.1 – 1.2dB). The low noise contribution from the longer-term construction works would be unlikely to contribute significantly to cumulative noise resulting from any other potential developments planned in the area.

17.11.7 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 works and some site establishment works, that would be undertaken in closer proximity to the noise sensitive receptor positions. 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.

17.12 Conclusions

17.12.1 A noise impact assessment (NIA), to include either a qualitative, or quantitative, assessment appropriate to each identified potential impact, has been completed for the purpose of describing the likely effects on the receptors identified as being most sensitive to noise produced by The Proposed Development.

17.12.2 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:

- 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, prior to construction work commencing. As a general principal, consideration would be given in the CNVMP for adopting the ‘best practicable means’ to noise and vibration control;

- The Caledonian Canal System would be used as far as practicable in the delivery of various equipment and materials, as well as in the disposal of tunnel spoil, thereby reducing heavy vehicle road use for this process. Furthermore, the creation of a temporary 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; and
- The control of operational noise would be integral to the design of the cavern power station, as all the main items of generation equipment would be located underground, with the bulk of the mountain and the long underground access tunnel (1 km) reducing noise breakout to the surface to a minimum.

17.12.3 The residual effects of noise associated with The Proposed Development, with the mitigation measures included in the scheme, can be summarised as follows:

- For the temporary / long-term Lower Reservoir Works, noise and vibration effects would be not significant;
- For the temporary / medium-term Site Establishment Works, noise and vibration effects would be not significant;
- For the temporary / short-term access road works, noise effects would be potentially significant, however, as the works would impact on a small number of individual properties for only a short period, the overall effect would be Low;
- With regard to the temporary increase in traffic noise, due to additional traffic generated during the construction phase of The Proposed Development, the significance of the noise effect, relating to traffic using the main A-roads providing access to the development site, would be Slight;
- Due to the much higher percentage increase in traffic on the minor public road from the A82 to Kilfinnan Road, the significance of the noise effect would be Large; and
- For the permanent operation of the cavern power station, the noise and vibration effects would be not significant.

17.13 Statement of Significance

17.13.1 Table 17.24 provides a summary of the effects and mitigation applicable to the noise and vibration impact of The Proposed Development.

Table 17.24: Summary of Noise Impact, Mitigation and Residual Effects

Description of potential noise impact	Magnitude of Adverse Impact			Summary of design mitigation and/or enhancement measures	Significance of Residual Noise Effects		
	Impact	P/T	ST/MT/ LT		Noise effect	P/T	ST/MT/ LT
Operational Noise	Negligible	P	LT	Design mitigation includes for favourable siting of Cavern Power Station underground and large distance from closest receptors	**Not significant**	P	LT
Construction Noise							
Road Upgrade works	High	T	ST	Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Low effect**, as road works would only impact on a small number of individual properties for a short period.	T	ST
Site Establishment Works	Low / Medium	T	MT	Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**, as within BS5228-1 potential significant effect criteria	T	ST/MT
Lower Control Works: Jetty Works	Very Low	T	LT	Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**, as within BS5228-1 potential significant effect criteria	T	LT
Lower Control Works: Inlet/Outlet Works	Very Low	T	LT	Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**, as within BS5228-1 potential significant effect criteria	T	LT
Haul Road Vehicle Movements	Very Low	T	LT	Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**, as within BS5228-1 potential significant effect criteria	T	LT
Construction Vibration							
Mechanised Equipment	Very Low	T	LT	Large separation distance to closest sensitive receptor position. Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**	T	LT
Blasting and associated air-overpressure	Low	T	LT	Large separation distance to closest sensitive receptor position. Works completed in accordance with the guidelines provided in BS5228-1:2009 and in accordance with CNVMP, to be agreed with The Highland Council.	**Not significant**	T	LT

`	Magnitude of Adverse Impact			Summary of design mitigation and/or enhancement measures	Significance of Residual Noise Effects		
	Impact	P/T	ST/MT/ LT		Noise effect	P/T	ST/MT/ LT
Road Traffic Noise							
A82 North of Invergarry	Negligible	T	LT	Noise from road traffic on public roads would be minimised by, where possible, using the Caledonian Canal System for the removal of tunnel spoil and for the transport of heavy plant and equipment. All excavated rock would be either re-used on site, or removed by barge, or road for use elsewhere.	Slight effect	T	LT
A82 Site Access	Negligible	T	LT		Slight effect	T	LT
A87 Invergarry	Negligible	T	LT		Slight effect	T	LT
Kilfinnan Road (Access)	Major	T	LT		Large effect	T	LT
A82 Spean Bridge	Negligible	T	LT		Slight effect	T	LT
A86 Roybridge	Negligible	T	LT		Slight effect	T	LT

Key to table: P/T = Permanent or Temporary, ST/MT/LT = Short Term, Medium Term or Long Term

Note: Impact descriptions are as defined in the relevant assessment guideline

17.14 References

The Scottish Government (March 2009). Technical Advice Note: Assessment of Noise.

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

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

The Scottish Government (March 2011). Planning Advice Note (PAN 1/2011).

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The Design Manual for Roads and Bridges (1992). Volume 11: Environmental Assessment.

The Department of Transport (1988), Welsh Office document: 'Calculation of Road Traffic Noise' (CRTN).

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