Welsh Government

M4 Corridor around Newport

Environmental Statement Volume 3: Appendix 13.1

Assessment Methodology

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1.1 Introduction

1.1.1 Noise is defined as '*sound which is undesired by the recipient*'. The range of audible sound is from 0 dB to 140 dB. The frequency response of the ear is usually taken to be about 18 Hz (number of oscillations per second) to 18000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in importance by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting that is most widely used and which correlates best with subjective response to noise is the dB(A) weighting. This is an internationally accepted standard for noise measurements.

1.1.2 For variable noise sources such as traffic, a difference of 3 dB in the A-weighted level is just distinguishable. In addition, a doubling of a noise source would increase the overall noise by 3 dB. For example, if one item of machinery results in noise levels of 30 dB at 10 m, then two identical items of machinery adjacent to one another would result in noise levels of 33 dB at 10 m. Equally, if a traffic flow was to double or halve, assuming other parameters stayed the same, speed, HGV content etc, the noise level would increase or decrease by 3 dB respectively. The 'loudness' of a noise is a purely subjective parameter but it is generally accepted that an increase/decrease of 10 dB corresponds to a doubling/halving in perceived loudness.

1.1.3 Examples of typical sound levels are provided in Table 1.1. Note that the tonal and temporal characteristics, along with the context and connotation of the sound will strongly influence how the noise is perceived.

Table 1.1: Example Sound Levels

Noise Source	Sound Level, dB(A)
Threshold of pain	130
Hearing damage (risk over instantaneous exposure)	120
Construction plant at 10 m	90 – 110
Hearing damage (risk over long-term exposure)	80 – 85
Traffic on a busy road at 10 m	70 – 90
Passenger car at 10 m	60 – 80
Normal conversation at 1m	40 – 60
Very calm room	20 – 30
Threshold of hearing	0

1.1.4 Groundborne vibration from construction sources, such as piling or blasting, can be a source of concern for occupants of buildings in the vicinity. The concern can be that the building may suffer some form of cosmetic or structural damage or that ground settlement may arise that could subsequently lead to damage. Research associated with British Standard 7385 (BS 7385) (British Standards Institution, 1990) & (British Standards Institution, 1993), concerned with vibration-induced building damage found that although a large number of case histories were assembled, very few cases of vibration-induced damage were found.

However, structural vibration in buildings can be detected by the occupants and can affect them in many ways: their quality of life can be reduced, as also can their working efficiency, although there is little evidence that whole-body vibration directly affects cognitive processes. It should be noted that there is a major difference between the sensitivity of people feeling vibration and the onset of levels of vibration that damage a structure.

1.1.5 Air overpressure, noise associated with blasting, consists of air transmitted sound pressure waves that move outwards from an exploding charge. A well confined explosives charge creates pressure waves with frequencies that are predominantly less than 20 Hz, with a relatively small amount of energy having frequencies above 20 Hz. The human ear responds to frequencies above 20 Hz but filters out frequencies below 20 Hz. Buildings respond predominantly to frequencies in the range 2 to 20 Hz.

1.1.6 Community noise measurements for health or environmental purposes use sound level meters that filter out frequencies below 20 Hz, and record the filtered sound using the A-weighting. As air overpressure from blasting consists of frequencies that are substantially below 20 Hz, air overpressure levels are measured with a meter that measures frequencies in the range 2 to 250 Hz on a linear, unweighted, scale, dB(lin). As a comparison between the two scales, if a sound level meter set to measure air over-pressure from a well confined blast measured 120 dB(lin), a sound level meter set to measure community noise on the A-weighting scale would measure approximately 95 dB(A).

1.2 Glossary

A-weighting - weighting of the audible frequencies designed to reflect the response of the human ear to noise. The ear is more sensitive to noise at frequencies in the middle of the audible range than it is to either very high or very low frequencies. Noise measurements are often A-weighted (using a dedicated filter) to compensate for the sensitivity of the ear.

Airborne Noise – noise radiated directly from a source, such as a loudspeaker or machine, into the surrounding air.

Ambient noise level – BS 4142 (British Standards Institution, 2014c) defines the ambient noise level as: ‘Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.’ It is sometimes used to mean an environmental noise level defined specifically in terms of the L_{Aeq} noise index. The terms ambient and background may be colloquially synonymous when describing environmental noise levels.

Background noise level – BS 4142 defines the background noise level as: ‘The A-weighted sound pressure level of the residual noise 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’ (i.e. a noise level defined specifically in terms of the L_{A90} noise index). The terms ambient and background may be colloquially synonymous when describing environmental noise levels.

Baseline Noise Levels – The existing noise levels before construction or operation of a development commences.

Broadband – a noise containing a wide range of frequencies (for example, a whooshing noise like a waterfall or out of tune analogue radio).

Decibel – units of sound measurement and noise exposure measurement.

dB(A) – decibels A-weighted or decibel change in an A-weighted level.

Directivity – the uniform/non-uniform directional characteristics of a noise source (as noise may be emitted from the source in different directions with varying intensities and frequencies).

Emission – sound emitted by a sound source such as a stream of traffic.

Equivalent continuous sound pressure level (L_{AeqT}) – is defined in BS 7445 (British Standards Institution, 2003) as the 'value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time'. In more straightforward terms, it is a measure of the noise dose or exposure over a period. It is a unit commonly used to describe construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. It is also the unit best suited to assessing community response.

Façade/Freefield – This applies to the positions for either measurement or prediction. A façade position is one that effectively represents noise levels at a building but is conventionally taken at a position 1 m from the building; this includes reflections from the building. A freefield position is one that is at least 3.5 m from a building where reflection effects are not significant. The difference between a noise level measured at a façade position and a freefield position, assuming that there is a specific noise source that causes reflections, is that levels are around 3 dB higher at the façade, due to the reflection effects.

Frequency (Hz) – the pitch of the sound, measured in Hertz. The tonal quality of a sound is described and measured in terms of the frequency content and is commonly expressed as octave or third octave bands, the latter being the division of the octave bands into three for finer analysis, across the frequency spectrum. The smaller the octave band or third octave band centre frequency number defined in terms of Hz, the lower the sound. For example, 63 Hz is lower than 500 Hz and is perceived as a deeper sound. The attenuation due to air absorption and natural barriers increases with frequency i.e. low frequencies are always the most difficult to control. Frequency ranges for commonly occurring sounds include:

- the low notes on a bass guitar are typically around 40 – 50 Hz;
- the lowest string on a guitar is typically about 80 Hz;
- middle C is about 250 Hz;
- the C above middle C is about 500 Hz;
- cars in a residential area generally around 250 and 500 Hz;
- Greenwich Mean-time signal (pips) is around 1 kHz;
- bird calls are generally around 2 to 5 kHz; and,
- a 'Shhh' noise made by the mouth is mostly around 4 kHz and above.

Harmonic – a signal having a repetitive pattern.

Hz – hertz, the unit of frequency.

Immission – In terms of noise, it is the sound received at the receptor, i.e. residents outside or within a property.

Impulsive noise – any type of single or repeated noise of short duration, e.g. the noise from an explosion or the noise of a power press.

$L_{Aeq,T}$ – see "Equivalent continuous sound pressure level"

$L_{A,max}$ – maximum value of the A-weighted sound pressure level, measured using the fast (F) time weighting, in dB(A).

L_{A10} - This is the noise level that is exceeded for 10% of the measurement period and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

L_{A90} – This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during quieter periods. It is used in the methodology contained within BS 4142 and is sometimes called the 'background noise level'. Horizontal Guidance H3 Part 2 Noise Assessment and Control (Environment Agency, 2004) describes the L_{A90} background noise level as: 'Whilst it is not the absolute lowest level measured in any of the short samples, it gives a clear indication of the underlying noise level, or the level that is almost always there in between intermittent noisy events.'

Loudness – the measure of the subjective impression of the magnitude or strength of a sound.

Noise spectrum – a noise represented by its frequency components.

Octave – the range between two frequencies whose ratio is 2:1

Octave Bands – Groups of frequencies defined by standards where the upper frequency of each band is equal to twice the lower frequency of the next higher band. Octave bands are usually named by their geometric centre frequency. For example, the octave band extending between 44.7 Hz and 89.1 Hz is called the 63 Hz octave band; the octave band extending between 89.1 Hz and 178 Hz is called the 125 Hz octave band. The full complement of octave bands in the audible frequency range is as follows: 31.5; 63; 125; 250; 500; 1,000; 2,000; 4,000; 8,000; and 16,000 Hz.

Peak Particle Velocity (PPV) – Peak particle velocity is defined as 'the maximum instantaneous velocity of a particle at a point during a given time interval', and has been found to be the best single descriptor for correlating with case history data on the occurrence of vibration-induced damage. The PPV is used for the assessment of the vibration effects of construction and demolition including blasting.

Point / Line / Area Source – Noise sources can be modelled as point, line, or area sources. Noise attenuation due to geometric spreading, which is the effect of acoustic energy being spread over an increasing surface with increasing distance from the source, can be different for the different types of source. When the distance from source to receptor is very much greater than the dimensions of

the source, the attenuation due to geometric spreading from all source types is the same as for point sources.

Rating level, $L_{Ar,Tr}$ – BS 4142 defines the rating level as 'The specific noise level plus any adjustment for the characteristic features of the noise.'

Reflection – Sound can be reflected by hard surfaces and reflection effects can affect hence sound levels.

Slow / Fast Time Weighting – The response speed of the detector in a sound level meter. For Slow response, the response speed is 1 second. Slow time weighting is frequently used in environmental sound measurements. Fast response time is 1/8 second (0.125). This is less frequently used, but will detect changes in sound levels more rapidly.

Sound Pressure Level (SPL) – Sound pressure is the dynamic variation of the static pressure of air and is measured in force per unit area. Sound pressure is normally represented on a logarithmic amplitude scale, which gives a better relationship to the human perception of hearing. The sound pressure level is expressed in decibels (dB) and is equal to 20 times the logarithm to the base 10 of the ratio of the sound pressure at the measurement location to a reference sound pressure. The reference sound pressure in air is normally taken to be 20 IPa, which roughly corresponds to the threshold of human hearing.

Sound Power Level (SWL, Lw) – A sound power level is a measure of the total power radiated as noise by a source in all directions. It is a property of the source and is essentially independent of the measuring environment. The sound power level of a source is expressed in decibels (dB) and is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to a reference sound power. The reference sound power in air is normally taken to be 10-12 watt.

SoundPlan – A computer software package that uses a ray-tracing numerical modelling approach to predict acoustic propagation from industrial and/or transport noise sources. The prediction methodologies follow CRTN (Department of Transport and Welsh Office, 1988), national and international standards.

Source Term – The acoustic properties of a source defined as a sound power level or as a sound pressure level under specific measurement conditions. Source terms are sometimes provided as a spectrum.

Specific noise level – BS 4142 defines the specific noise levels as 'The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.'

Tonal – Noise sources sometimes contain pure tone components that can be identified as hums, whistles etc. The presence of these tonal components is sometimes considered to add an extra, annoying quality to the noise.

Vibration Dose Value (VDV) – The effect of building vibration on people inside buildings is assessed by determining their vibration dose. Present knowledge indicates that this is best evaluated with the VDV, as promoted through British Standard 6472 Part 1 (British Standards Institution, 2008a). VDV defines a relationship that yields a consistent assessment of intermittent, occasional and

impulsive vibration, as well as continuous input, and correlates well with subjective response. The way in which people perceive building vibration depends upon various factors, including the vibration frequency and direction. The VDV is given by the fourth root of the integral of the fourth power of the acceleration after it has been frequency weighted.

Ultrasound – Noise with significant energy at frequencies above the range of human hearing is described as ultrasonic, ie. above 20 kHz. Bats rely upon ultrasound in the range 20 kHz to 200 kHz for echolocation; frequency depending on species. Horseshoe bats, for example, emit and receive ultrasound around 82 kHz.

2 Relevant Legislation and Policy

2.1 Introduction

2.1.1 Noise and vibration can have a significant effect on the environment and on the quality of life enjoyed by individuals and communities. In this respect, the planning system promotes sustainable economic growth whilst ensuring that the quality of life is not unreasonably affected.

2.1.2 National standards and planning policy are primarily concerned with noise and vibration effects at residential receptors and vibration effects on structures. Noise and vibration effects at residential receptors for new or modified road schemes, including consequential changes on related roads, are considered primarily in terms of the noise change and change in annoyance due to increases or decreases in road traffic noise. However, in some circumstances, it is also relevant to consider the possibility of health and quality of life effects, such as sleep disturbance.

2.1.3 Vibration effects on buildings and structures may be considered in terms of the potential for damage to occur. However, vibration levels at which even cosmetic damage can occur are relatively high and, generally, these are only generated by blasting or from some other construction activities that would need to occur in very close proximity to buildings. For a reasonably maintained road without speed control measures, such as speed humps, vibration arising during operation is likely to be minimal.

2.1.4 Legislation and national and local policies are described below.

2.2 Legislation

The Environmental Noise Directive

2.2.1 The Assessment and Management of Environmental Noise Directive (2002/49/EC) (END) provides the general European Union policy context under which Wales is implementing policies to manage environmental noise including traffic noise.

Control of Pollution Act

2.2.2 Section 60, Part III of the Control of Pollution Act (HMSO, 1974) refers to the control of noise on construction sites. It provides legislation by which local planning authorities can control noise from construction sites to prevent noise disturbance occurring. In addition, it recommends that guidance provided by British Standard (BS) 5228 be implemented to ensure compliance with Section 60. The Control of Pollution Act provides the local planning authority, in whose area work is going to be undertaken, or is being undertaken, with the power to serve a notice imposing requirements as to the way in which construction works are to be carried out. This notice can specify, the plant or machinery that is or is not to be used, the hours during which the construction work can be carried out, the level of noise and vibration that can be emitted from the premises in question or at any specified point on these premises or that can be emitted during specified hours, or for any change of circumstances.

2.2.3 Section 61, Part III of the Control of Pollution Act refers to prior consent for work on construction sites. It provides a method by which a contractor can apply for consent to undertake construction works in advance. If consent is given, and the stated method and hours of work are complied with, then the local authority cannot take action under Section 60.

2.2.4 Section 71, Part III of the Control of Pollution Act refers to the preparation and approval of codes of practice for minimising noise. The current, June 2014, version of BS 5228 is one such approved code.

2.2.5 Section 72, Part III of the Control of Pollution Act refers to 'best practicable means' (BPM), which is defined as:

'reasonably practicable, having regards among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications'. Whilst 'Means' includes 'the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and acoustic structures.'

2.2.6 If BPM is applied, then it can provide a defence against prosecution by the consenting body.

Environmental Noise (Wales) Regulations 2006

2.2.7 The Environmental Noise (Wales) Regulations 2006 (National Assembly for Wales, 2006) (Statutory Instrument No. 2629 W.225) implements EU Directive 2002/49/EU, known as the END in Wales. This legislation relates to the assessment and management of environmental noise and its implementation is the responsibility of the Welsh Assembly Government.

2.2.8 Under the Regulations, a first round of environmental noise maps of large agglomerations and major roads, railways and airports was completed in 2007. The strategic noise action plans required by the legislation were prepared following completion of the mapping. A further set of action plans have been prepared following the second round of noise mapping in 2012. The first round of noise mapping included the existing M4 motorway as part of the requirements to map major roads exceeding certain traffic thresholds.

2.2.9 The noise action plan for roads in Wales (Welsh Government, 2013) sets out the results of the noise mapping and evaluation of the numbers of people exposed to different levels of noise, noise reduction measures in place at the time of publication and sets out a long-term strategy for reducing noise from road traffic.

Land Compensation Act 1973 and Noise Insulation Regulations 1975 (amended 1988)

2.2.10 The Land Compensation Act 1973 (HMSO, 1973) provide a mechanism for property owners to seek compensation for devaluation of their property. Under Part 1 of the Act, compensation can be claimed by people who own and also occupy property that has been reduced in value by more than £50 by physical factors, including noise, caused by the use of a new or altered road. These claims can be made between one and seven years following the opening of the Scheme and are assessed by the Regulatory Authority.

2.2.11 The highways authority also has a duty under the Noise Insulation Regulations 1975 (amended 1988) (HMSO, 1988) to offer sound insulation for dwellings affected by increased noise from a new road, and discretionary powers in relation to altered roads based upon various conditions.

2.2.12 To qualify for sound insulation, three conditions have to be satisfied:

- the combined highest expected traffic noise level, referred to as the relevant noise level, up to 15-years after the Scheme opens, from the new or altered highway together with other traffic in the vicinity must not be less than 68 dB $L_{A10,18hr}$;
- the relevant noise level is at least 1.0 dB more than the prevailing noise level, i.e. the total traffic noise level existing before the works to construct or improve the highway were begun; and
- the contribution to the increase in the relevant noise level from the new or altered highway must be at least 1.0 dB.

2.2.13 This assessment is based on the noise levels calculated including any mitigation measures forming part of the proposed Scheme.

2.2.14 Noise levels and changes have been predicted using the methodology contained within the publication CRTN (Department of Transport (DOT) and Welsh Office, 1988), which is that approved within the UK for road traffic noise assessments; this will be through use of the road traffic noise modelling software "SoundPlan". TAN 11 also discusses the control and assessment of noise and vibration from construction sites and cites the use of BS 5228 which is now in two parts - BS 5228-1:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites - Part 1: Noise (British Standards Institution, 2014a) and BS 5228-1:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration (British Standards Institution, 2014b).

2.2.15 Under the Noise Insulation Regulations, the highways authority also has discretionary powers to offer insulation against construction noise.

2.3 Policy

2.3.1 This section sets out relevant policy at the national and local level.

National Planning Policy

2.3.2 Planning Policy Wales (Welsh Government, 2016) provides the following introduction to national planning policy with regards to noise (and by implication vibration):

'Noise can affect people's health and well-being and have a direct impact on wildlife and local amenity. Noise levels provide an indicator of local environmental quality. The objective of a policy for noise is to minimise emissions and reduce ambient noise levels to an acceptable standard. Noise Action Plans, drawn up by the Welsh Ministers in relation to Wales under the Environmental Noise Directive, and the Wales Regulations, aim to prevent and reduce environmental noise where necessary and preserve environmental noise quality where it is good. They are a planning consideration in the use and development of land.'

2.3.3 The goal of the Transport Strategy for Wales 'One Wales: Connecting the Nation' is to promote sustainable transport networks that safeguard the environment while strengthening the country's economic and social life. The transport strategy identifies a series of high-level outcomes. Outcome 15 is to '*improve the positive impact of transport on the local environment'* (Welsh Assembly Government, 2008). Indicators of success for this outcome, as related to noise, are stated as:

- "*Number of targeted noise action plans related to transport*" – With reference to "A noise action plan for Wales 2013 – 2018" (Welsh Government, 2013), the M4 is included and described as a major road which was included in the 2012 round of noise mapping. However, whilst various priority areas were identified from the 2007 noise mapping, the M4 through Newport was not included as a priority area.
- "*Proportion of noise sensitive areas with noise protection measures*" – In the context of road traffic, noise protection measures would include barriers, bunds, speed restrictions, low noise road surfaces etc. These measures, as appropriate, are being considered for the Scheme.

2.3.4 National planning guidance on noise is contained within Technical Advice Note (Wales) 11 (TAN 11) (Welsh Government, 1997). This document does not provide any specific guidance relating to the assessment of noise from new or altered roads but does refer to the Noise Insulation Regulations 1975.

2.3.5 The Well-being of Future Generations Act (Wales) 2015 sets out what is meant by sustainable development and requires public bodies to carry out sustainable development and to carry out their activities in accordance with the sustainable development principle.

Local Policy

2.3.6 The Scheme falls within the administrative areas of Monmouthshire County Council and Newport City Council.

Monmouthshire County Council

2.3.7 Monmouthshire County Council published their adopted Local Development Plan in February 2014 (Monmouthshire County Council, 2014).

2.3.8 Policy EP1 of the Local Development Plan seeks to prevent development proposals that would result in unacceptable risk or harm due to air, light, noise or water pollution, contamination or land instability.

'EP1 - Amenity and Environmental Protection: Development […/…] should have regard to the privacy, amenity and health of occupiers of neighbouring properties.

Development proposals that would cause or result in an unacceptable risk /harm to local amenity, health, the character /quality of the countryside or interests of nature conservation, landscape or built heritage importance due to the following will not be permitted, unless it can be demonstrated that measures can be taken to overcome any significant risk.'

Newport City Council

2.3.9 Newport City Council published their adopted Local Development Plan in January 2015 (Newport City Council, 2015). Newport City Council published their

adopted Local Development Plan in January 2015 (Newport City Council, 2015). The Local Development Plan has a number of strategic and general policies relating to noise, summarised below.

- SP14: Transport proposals will be supported where they result in environmental improvements, including noise reduction.
- GP2: Development will be permitted where there will not be a significant adverse effect on local amenity, including in terms of noise, disturbance etc.
- GP4: Development proposals should be designed to avoid or reduce noise pollution.
- GP6: Good quality design will be sought in all forms of development. The aim is to create a safe, accessible, attractive and convenient environment. All development should maintain a high level of pedestrian access, connectivity and be laid out so as to minimise noise pollution.
- GP7: Development will not be permitted which would cause or result in unacceptable harm to health because of land contamination, dust, instability or subsidence, air, heat, noise or light pollution, flooding, water pollution, or any other identified risk to environment, local amenity or public health and safety.

2.3.10 Key elements are reproduced below.

'GP2: General Development Principles - General Amenity

Development will be permitted where, as applicable:

There will not be a significant adverse effect on local amenity, including in terms of noise, disturbance, privacy, overbearing, light, odours and air quality; […/…]'

'GP4: General Development Principles – Highways and Accessibility

Development proposals should: […/…]

iii) be designed to avoid or reduce transport severance, noise and air pollution; […/…]'

2.3.11 Similar requirements for noise to be addressed by design are found in Policy GP6 General Development Principles – Quality of Design:

'*Good quality design will be sought in all forms of development. The aim is to create a safe, accessible, attractive and convenient environment.*'

2.3.12 The Local Development Plan provides more details in the following.

'GP7: General Development Principles – Environmental Protection and Public Health

Development will not be permitted which would cause or result in unacceptable harm to health because of land contamination, dust, instability or subsidence, air, heat, noise or light pollution, flooding, water pollution, or any other identified risk to environment, local amenity or public health and safety.';

2.3.13 And in SP14.

'SP14 Transport Proposals

Transport proposals will be supported where they […/…]

iv) improve the quality of life of residents; […/…]

ix) result in other environmental improvements, including air quality, noise reduction, sustainable drainage and enhanced biodiversity.'

2.4 Relevant Guidance

Department of Transport (Welsh Office 1988) CRTN

2.4.1 Calculation of Road Traffic Noise (CRTN) (Department of Transport/Welsh Office, 1988) provides the Welsh Government's approved methodology for calculating noise from road traffic. The calculations are based on the traffic flow data and the spatial relationship between the receptor and the road. Noise levels are determined using the L_{A10} index, which is the 10th percentile of the A-weighted sound pressure level. The index is normally determined for the 18-hour day (06.00 - 24.00 hours) based on the annual average weekday traffic. CRTN also provides methodologies for noise surveys.

Design Manual for Roads and Bridges (DMRB)

2.4.2 The Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7 (Highways Agency *et al.,* 2011) Noise and Vibration (HD 213/11) provides guidance on assessing the noise and vibration impacts from road schemes. This has been updated in places by Interim Advice Note 185/15 (Highways Agency, 2015) and requires additional analysis based upon more appropriate speed profiles.

2.4.3 The DMRB defines scoping and sets out simple and detailed methods for assessing the impacts of road traffic noise (Highways Agency *et al.*, 2011). Thresholds for significant operational traffic noise effects are a 1 dB(A) change in the short term, assessed for the opening year, and a 3 dB(A) change in the long term, assessed by comparing the change between the opening year and the future assessment year.

2.4.4 The 1 dB and 3 dB thresholds being the onset of a 'minor' impact for short term and long term assessments respectively. These scales should also be applied to night-time noise changes. However, a night-time noise assessment is only necessary for dwellings subject to L_{night}, outside levels exceeding 55 dB. This threshold is the interim target for night-time noise in the WHO Night Noise Guidelines for Europe (World Health Organisation, 2009).

2.4.5 Given the scale of the Scheme, it is considered that a detailed assessment of the noise generated by traffic in the long term is appropriate (see Chapters 3 and 4 of Volume 11, Section 3, Part 7). A simple assessment would normally be appropriate where noise and vibration sensitive receptors (NVSRs) are present but neither of the threshold values (i.e. noise and vibration) are expected to be exceeded. A detailed assessment is appropriate in situations where NVSRs are present and either or both of the threshold values are expected to be exceeded, most commonly with an all new road.

2.4.6 The baseline and future assessment years for construction and operational effects are defined as follows.

- For an assessment of temporary noise and vibration impacts (i.e. from construction or maintenance activities), the baseline year is taken as that immediately prior to the start of works. The future assessment year would be a year during the period of construction/maintenance works.
- For an assessment of permanent noise and vibration impacts, the baseline year is taken as the opening year of the road project. This is considered to be the year which is most representative of the situation immediately before a road project opens to traffic. It is noted that the baseline year used for this assessment could be different to the year used when predicting the Prevailing Noise Level for any calculations undertaken for the relevant Noise Insulation Regulations. The future assessment year for operation is typically the 15th year after the opening year of the road project as that is when traffic flows are generally at their highest but, in some circumstances, this may occur before the 15th year. For this project, it is expected that the greatest traffic flows will generally occur in the 15th year, and this is taken as the future assessment year.

2.4.7 The methodology requires CRTN noise predictions to be made for dwellings and other NVSRs affected by the Scheme, both with and without the Scheme for the opening year and future year. This enables both the short term and long term changes to be evaluated. The latest version of the DMRB Volume 11, Section 3, Part 7 includes separate classifications of impact magnitude for the short term and long term noise changes.

2.4.8 The DMRB sets out the approach to simple and detailed assessments. At the simple stage, the following two comparisons are made in order to determine the impact of the Scheme in the short term, and the long term.

- Do-Minimum (without Scheme) scenario in the baseline year against Do-Something (with Scheme) scenario in the baseline year (short term).
- Do-Minimum scenario in the baseline year against Do-Something scenario in the future assessment year (long term).

2.4.9 At the detailed stage, the following three comparisons are made in order to better understand the impact of the Scheme.

- Do-minimum scenario in the baseline year against Do-Minimum scenario in the future assessment year.
- Do-minimum scenario in the baseline year against Do-Something scenario in the baseline year.
- Do-minimum scenario in the baseline year against Do-Something scenario in the future assessment year.

2.4.10 The assessment of noise and vibration has been based on the Scheme with permanent acoustic mitigation in place (i.e. as part of the highway engineering design). In Wales, however, it is a requirement of DMRB Volume 11, Section 3, Part 7, paragraph 3.12, page 3/2 that an assessment of noise and vibration should also be undertaken without mitigation in place. The assessment periods reflect the detail of traffic data available.

2.4.11 For a detailed assessment, Annex 1 of DMRB Volume 11, Section 3, Part 7 provides a methodology for tabulating the noise changes based on the predicted noise levels for the various scenarios. A parallel assessment of change in noise

nuisance has also been carried out. This methodology draws upon a number of studies that determined the percentage of people bothered by road traffic noise and are referred to in Annex 6 of the document.

2.4.12 The guidance for assessing temporary construction impacts in DMRB Volume 11, Section 3, Part 7 requires the identification of key construction operations likely to be the most significant; assessment of the extent and duration of such impacts taking account of proposed mitigation and expected restrictions likely to be agreed with the local authorities. Chapter 2 of DMRB Volume 11, Section 3, Part 7 refers to the legal control mechanisms set out in Control of Pollution Act 1974 and the guidance in BS 5228 (British Standards Institution, 2009) on prediction of construction noise and vibration levels and mitigation techniques.

British Standards

British Standard 5228 'Code of practice for noise and vibration control on construction and open sites', Parts 1 and 2, 2009 (as revised 2014)

2.4.13 British Standard (BS) 5228 is a two part standard which comprises:

- BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise' (British Standards Institution, 2014a); and
- BS 5228-2:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration' (British Standards Institution, 2014b).

2.4.14 The Standard provides guidance, information and procedures on the control of noise and vibration from demolition and construction sites. There are no set standards for the definition of the significance of construction noise effects. However, for noise, example criteria are provided in Part 1 (British Standards Institution, 2014a) Annex E and for vibration, example criteria are provided in Part 2 (British Standards Institution, 2014b) Annex B. The assessment of whether changes in noise levels due to construction activity constitute significant effects are dependent on the absolute levels of ambient and construction noise, as well as the magnitude, duration, time of occurrence and frequency of the noise change.

2.4.15 Part 1 of the Standard (British Standards Institution, 2014a) provides basic information and recommendations for methods of noise control relating to construction and open sites where work activities/operations generate significant noise levels. It includes sections on: community relations; noise and persons on site, neighbourhood nuisance; project supervision; and control of noise. However, annexes include: information on legislative background; noise sources, remedies and their effectiveness (mitigation options); current and historic sound level data on site equipment and site activities; significance of noise effects; calculation procedures estimating sound emissions from sites and sound level monitoring; types of piling; and air overpressure.

2.4.16 Part 2 of the Standard (British Standards Institution, 2014b) provides basic information and recommendations for basic methods of vibration control relating to construction and open sites where work activities/operations generate significant vibration levels. It includes sections on: community relations; vibration and persons on site; neighbourhood nuisance; project supervision; control of

vibration and measurement. BS 5228-2:2009+A1:2014 refers to BS ISO 4866:2010 (British Standards Institution, 2010b); BS 7385-2:1993 (British Standards Institution, 1993); and BS 6472:2008 (Parts 1 and 2) (British Standards Institution, 2008a) and (British Standards Institution, 2008b) for further advice on the significance of vibration.

2.4.17 Table 2.1 provides the vibration limits contained within the Standard (British Standards Institution, 2014b) above which cosmetic damage could occur. Minor damage is possible at vibration magnitudes that are greater than twice those given in Table 2.2 and major damage to a structure may occur at values greater than four times the tabulated values. The limits are the same as are found in BS 7385-2:1993 (British Standards Institution 1993), which would be applicable for effects beyond the construction phase.

Table 2.1: Threshold Vibration Values for the Evaluation of Cosmetic Building Damage (BS 5228-2:2009+A1:2014)

Building Classification	Frequency Range of Vibration (Hz)	PPV mm/s	
		Transient Vibration	Continuous Vibration
Unreinforced or light framed structures Residential or light commercial type buildings	4 Hz to 15 Hz	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz
	15 Hz and above	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	4 Hz and above	50 mm/s	25 mm/s

Based on Table B.1 of BS 5228-2:2009+A1:2014

British Standard 4866:2010 'Mechanical Vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures'

2.4.18 Construction and industrial plant and machinery can generate groundborne vibration that is perceptible to occupants of nearby buildings. The primary cause of community concern generally relates to building damage, although concerns are often expressed at levels of vibration significantly lower than that likely to cause damage.

2.4.19 BS 4866:2010 (British Standards Institution, 2010) provides guidance on the measurement of vibration in buildings including methodologies, measurement instrumentation, location and fixing of transducers and data evaluation. Annexes also provide advice on classifying buildings with regard to their likely sensitivity; estimating peak stress from peak particle velocity; and random data. A bibliography is also provided. The Standard supersedes BS 7385-1:1990 'Evaluation and measurement of vibration in buildings - Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings' (British Standards Institution, 1990).

2.4.20 Assessment of the potential for cosmetic or structural damage is provided within BS 7385-2:1993 (British Standards Institution, 1993). Guidance on vibration from piling activities is contained within Part 2 of BS 5228 (British Standards Institution, 2014b). Guidance relating to the human response to vibration in buildings is contained within BS 6472-1:2008 (British Standards Institution, 2008).

British Standard 7385-2:1993 'Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from groundborne vibration'

2.4.21 BS 7385-2:1993 (British Standards Institution, 1993) provides guidance on the levels of vibration above which buildings could suffer damage. It identifies the factors that influence the vibration response of buildings and describes the basic procedure for carrying out measurements. It also states that there is a particular difference between the sensitivity of people feeling vibration and the onset of levels of vibration that damage structures and that levels of vibration at which adverse comment from people is likely are below levels of vibration which damage buildings, except at lower frequencies. The standard is applicable to vibration from both construction and operation of the Scheme.

2.4.22 BS 7385-2:1993 provides the following guidance with reference to other structures:

- important buildings that are difficult to repair (for example listed buildings) may require special consideration on a case-by-case basis. A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive; and
- structures below ground level (for example underground water pumping stations or water and gas pipelines) are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition.

British Standard 6472-1:2008 'Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting'

2.4.23 The human body is an excellent detector of vibration, which can become perceptible at levels that are substantially lower than those required to cause even cosmetic building damage. The way in which people perceive vibration in buildings depends upon various factors, including the vibration duration, frequency, direction and activity.

2.4.24 The standard (British Standard Institution, 2008a) indicates that how people inside a building respond to vibration from sources within and outwith the building, with the exception of blasting, is best evaluated with the Vibration Dose Value (VDV). VDV defines a relationship that yields a consistent assessment of intermittent, occasional and impulsive vibration, as well as continuous input, and correlates well with subjective response. The VDV is given by the fourth root of the time integral of the fourth power of the acceleration after it has been frequency weighted. BS 6472-1:2008 provides separate weighting curves related to human response for vibration in the vertical and the horizontal directions.

2.4.25 The VDV is evaluated at the point of entry to the subject. If direct measurement is not possible, for example, on a building that has not yet been built, then BS 6472-1:2008 states that it will be necessary to estimate the vibration environment to be expected within the building. Appendix D of BS 6472-1:2008 contains guidance on the estimation of building vibration response.

2.4.26 The VDVs associated with various probabilities of adverse comment within residential buildings are provided in Table 1 of the Standard, as reproduced in Table 2.2 below. For offices and workshops, BS 6472-1:2008 states that multiplying factors of 2 and 4, respectively, should be applied to the values provided in Table 1 of the Standard. The criteria are presented as ranges due to the widely differing susceptibility to vibration evident among members of the population and also their differing expectations of the vibration environment. BS 6472-1:2008 states that adverse comment is not expected for VDVs below the ranges in Table 2.3 below.

Table 2.2: Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings

Place	Low probability of adverse comment[1] ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable[2] ($m/s^{1.75}$)
Residential buildings 16 hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

1) Below these ranges adverse comment is not expected
2) Above these ranges adverse comment is very likely
Based on Table 1 of BS 6472-1:2008

British Standard 6472-2:2008 'Guide to evaluation of human exposure to vibration in buildings – Part 2 Blast-induced vibration'

2.4.27 The human body is an excellent detector of vibration, which can become perceptible at levels that are substantially lower than those required to cause even cosmetic building damage. The way in which people perceive vibration in buildings depends upon various factors, including the vibration duration, frequency, direction and activity.

2.4.28 BS 6472-2:2008 (British Standards Institution, 2008b) deals with the particular problems associated with periodic blasting within range of inhabited buildings. For blasting, the current practice is to measure the peak particle velocity (PPV) and BS 6472-2:2008 suggests satisfactory vibration magnitudes in terms of PPV.

2.4.29 BS 6472-2:2008 also provides guidance on human exposure to blast-induced vibration in buildings and is primarily applicable to blasting associated with mineral extraction, although the criteria are also appropriate for demolition. For blasting, current practice is to measure PPV using velocity transducers (geophones). Usually, measurements should be made outside the building on a well-founded hard surface as close to the building as possible. The Standard sets external vibration levels so as to achieve satisfactory internal levels and are provided in Table 2.3.

Table 2.3: Maximum satisfactory magnitudes of vibration with respect to human response for up to three blast vibration events per day

Place	Time	Satisfactory magnitude, PPV (mm/s)
Residential	Day	6.0 to 10.0
	Night	2.0
	Other times	4.5
Offices	Any time	14.0
Workshops	Any time	14.0

2.4.30 For the purpose of blasting, daytime is considered to be 08:00 to 18:00 hours Monday to Friday and 08:00 to 13:00 hours Saturday. Routine blasting would not normally be considered on Sundays or Public Holidays. Other times cover the period outside of the working day but exclude night time, which is defined as 23:00 to 07:00 hours. The satisfactory magnitudes are the same for the working day and the rest of the day unless stated otherwise. For more than three blast vibration events per day, the satisfactory magnitudes are reduced by applying a multiplication factor that depends upon the number of blast vibration events per day, the blast vibration duration and the type of floor of the affected building(s).

2.4.31 The propagation of blast-vibration through the ground is site specific and depends upon the local geology. The Standard describes a method for the prediction of vibration propagation based upon measurements at various distances of a number of blasts and production of a site-specific scaled distance graph. This permits calculation of vibration at various distances from the site for a given maximum instantaneous charge weight.

2.4.32 Whenever blasting is carried out, energy is transmitted from the blast site in the form of airborne pressure waves. The majority of the airborne energy is carried at frequencies below 20 Hz and hence is inaudible to the human ear but can be sensed as concussion or pressure. It is the combination of the sound and concussion that is known as air overpressure. Air overpressure can excite secondary vibrations at audible frequencies in buildings and it is often this effect that gives rise to adverse comments from the occupiers. However, the highest levels normally measured in the United Kingdom are generally less than 1% of the levels known to cause structural damage. Accurate prediction of air overpressure is almost impossible due to the variable effects of the prevailing weather conditions and the large distances often involved. The Standard does not suggest maximum satisfactory levels of air overpressure.

2.4.33 With regards to human response to vibration and air overpressure associated with blasting, BS 6472-2:2008 (British Standards Institution 2008b) states that:

'Within residential areas people exhibit wide variations of vibration tolerance. Specific values are dependent upon social and cultural factors, psychological attitudes and expected degree of intrusion.' (in the notes to Table 1)

and,

'Experience shows that the fear of property damage has a more significant effect on human response than the effect of the vibration on the person directly, although discussion of this matter is beyond the scope of this British Standard.' (as a note to the first paragraph in Section 6.1)

2.4.34 With regard to air overpressure, levels measured at properties near quarries in the United Kingdom are generally around 120 dB(lin), which is 30 dB below or only 3% of the limit for cracking pre-stressed poorly mounted windows. This is therefore the limit mostly adopted to prevent excess air overpressure effects.

3 Assessment Methodology

3.1 Introduction

3.1.1 This noise and vibration assessment has considered the significance of effects on NVSRs of operational changes in road traffic associated with the Scheme on noise change and absolute levels and noise nuisance, including an assessment of the effectiveness of proposed mitigation measures. This assessment of operational effects has included consideration of effects arising on the existing road network (including the existing M4) and on the new section of motorway.

3.1.2 The assessment has also evaluated the significance of temporary noise and vibration effects on NVSRs associated with the construction of the Scheme. It is noted that construction activities are primarily associated with the proposed new section of motorway. Works required for the Complementary Measures are limited and would generally occur within the footprint of the existing road network.

3.2 Receptor Sensitivity

3.2.1 Within the study area, the following types of receptors have been considered:

- residential properties;
- recreational uses; and
- other sensitive receptors (such as schools, nursing homes, hospitals etc).

3.2.2 The sensitivity or value of each receptor has been described using the terms high, medium or low, taking into account the guidance set out in the DMRB Volume 11, Section 2, Part 5 HA 205/08 (Highways Agency *et al.,* 2008).

3.2.3 For residential properties within the study area, sensitivity has been valued as 'medium'; this is generally the case for residential receptors. This balances their high importance against their low rarity.

3.2.4 Recreational users on Public Rights of Way (PRoW), cycle routes and other facilities are also valued as ‘low’ or 'medium' sensitivity, depending on the anticipated duration of exposure and availability of alternate quieter areas, unless particular circumstance indicates otherwise.

3.2.5 Other sensitive receptors (such as schools, nursing homes, hospitals etc.) have been valued as 'medium' sensitivity, unless particular circumstances indicate otherwise. Examples of receptors that might be considered as high sensitivity include recording studios and vibration-sensitive manufacturing processes such as microelectronics facilities.

3.2.6 The approach to determining sensitivity is summarised in Table 3.1 below.

Table 3.1: Acoustic Receptor Sensitivity

Typical Criteria	Sensitivity
Users of PRoW; Other permitted recreational trails and users of recreational facilities where the purpose of that recreation is enjoyment of the countryside.	Low / Medium
Residential properties; and Other sensitive receptors (such as schools, nursing homes, hospitals etc), unless particular circumstances indicate otherwise.	Medium
Sensitive receptors with particular circumstances - none as yet identified.	High

3.3 Magnitude of Impact

3.3.1 The magnitude of an impact is identified using the terms major, moderate, minor, negligible and no change. The DMRB defines 'impact' as follows:

'Change that is caused by an action; for example land clearing (action) during construction which results in habitat loss (impact)' (Highways Agency *et al.,* 2008)

3.3.2 The magnitude of an impact relates to the scale/size/extent of an impact and is independent of the sensitivity of the receptor. Where the topic section of the DMRB does not provide topic specific definitions, the guidance set out in Table 2.2 of HA205/08 is taken into account. For ease of reference this is set out below in Table 3.2.

Table 3.2: Criteria and DMRB Definitions of Impact Magnitude

Magnitude of Impact	Typical Criteria Descriptors
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse).
	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Moderate	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse).
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse).
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse).
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).

Magnitude of Impact	Typical Criteria Descriptors
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Noise

Construction Phase

3.3.3 The most significant potential impacts during construction are likely to arise from direct construction noise arising from plant and activities where these are within around 150 metres of NVSRs. Out of these, works at bridges, cuttings, major earthmoving areas etc. may be the most significant as these may last for an extended duration at specific locations and may need to occur outside normal daytime working hours. Other activities, such as embankment construction, unless this includes a haul road, laying the new road surface etc. would be transitory along the length of the new section of motorway, so particular NVSRs are only affected for a relatively short duration.

3.3.4 Noise from construction traffic is not expected to result in widespread significant impacts but may affect receptors particularly close to parts of the existing highway network.

3.3.5 The Magor area is underlain by limestone and sandstone and is likely to require a combination of open cut excavation and controlled blasting. It is intended that the blasting would be carried out once a day under controlled conditions during the period of major earthworks. Local residents and businesses would be given advanced warning of when the blasting would take place. In addition, blasting may be required in the demolition of the existing Pound Hill Overbridge.

3.3.6 The criteria for assessing noise impact from the road construction works have been based on Example Method 2 contained within Annex E of BS 5228-1 (British Standards Institution, 2014a). This indicates that:

'Noise levels generated by site activities are deemed to be potentially significant if the total noise (pre-construction ambient plus site noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ from site noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant effect.'

Table 3.3: Construction Noise Levels - Lower Cut-off Criteria for Adverse Impact Magnitude

Assessment Category and Threshold Value Period (LAeq)	Threshold Value in Decibels (dB) [1]			
	No change / Negligible	Minor	Moderate	Major
Night-time (23.00 to 07.00 hours)	<40	40 - 45	45 – 55	>55
Evenings (19.00 to 23.00 hours weekdays). Weekends (13.00 to 23.00 hours Saturdays and 07.00 to 23.00 hours Sundays)	<50	50 - 55	55 – 65	>65

Assessment Category	Threshold Value in Decibels (dB) [1]			
Daytime (07.00 to 19.00 hours) and Saturdays (07.00 to 13.00 hours)	<60	60 - 65	65 - 75	>75

1) Subject to duration criteria, and where ambient noise levels are low.

3.3.7 The calculation method of BS 5228-1 (British Standards Institution, 2014a) takes account of the duration of an activity per hour, the 'on-time'; and the attenuation of sound due to the effects of distance, ground attenuation and barrier effects.

3.3.8 The assessment has been based on reasonably expected construction phases, plant items and on-times based on the information provided within BS 5228-1 (British Standards Institution, 2014a) and in Chapter 3 of this ES.

3.3.9 For works away from the existing M4, i.e. for the new section of motorway away from the junctions with the existing M4, baseline noise levels are generally low and result in the adoption of the cut-off levels given in Table 3.3 above; i.e. the most stringent levels. For works in closer proximity to the existing motorway, higher levels of construction noise should be acceptable without significant effects arising, based upon the methodology above.

3.3.10 Where predicted construction noise levels are up to 5 dB below the levels assessed as per paragraph 3.3.6 above or of short duration, this has been considered to be 'no change' or negligible adverse impact. For works of significant duration (of one month or more, unless works of a shorter duration are likely to result in significant effect), where levels are between -5 dB below and equal to the criteria from paragraph 3.3.6 above, this has been considered a minor adverse impact; where the criteria calculated are exceeded by up to 10 dB, this has been considered a moderate adverse impact. Noise levels greater than 10 dB above the criteria have been considered a major adverse impact depending on the context and duration of the works.

3.3.11 Table 3.4 has been used in the assessment of noise impact associated with construction traffic on the local road network and from temporary diversion routes resulting from construction of the Scheme (see Chapter 3 of this ES). Although for a given noise change, the DMRB indicates a greater magnitude of impact in the short term compared to the long term, the temporary nature of construction works decreases the rating of impacts.

Table 3.4: Classification of Magnitude of Temporary Construction Traffic Noise Impacts

Noise Change $L_{A10, 18h}$	Magnitude of Impact
0 dB	No change
0.1– 2.9 dB	Negligible
3.0 – 4.9 dB	Minor
5.0 – 9.9 dB	Moderate
10.0+ dB	Major

(Source: Table 3.1 Highways Agency *et al.,* 2011)

Operational Phase

13.1.1 Traffic noise and disturbance would increase for some properties affected by the new section of motorway. However, many receptors situated in close proximity to the existing heavily trafficked M4 motorway would be likely to experience some

decrease in traffic noise and disturbance. The detailed assessment of noise and noise disturbance changes has been undertaken to indicate where both beneficial and adverse changes would occur for the Scheme.

13.1.2 The magnitude of traffic noise impact from a road scheme can be classified. The DMRB Volume 11, Section 3, Part 7 (Highways Agency *et al.,* 2011) provides a classification for the magnitude of impact.

13.1.3 A change in road traffic noise of 1 dB in the short term (e.g. when a scheme is opened) is the smallest that is considered perceptible. In the long term, a 3 dB change is considered perceptible. The magnitude of impact is, therefore, considered different in the short term and the long term. The classification of magnitude of impacts used for traffic noise is given in Table 3.5 (short term) and Table 3.6 (long term). These impacts relate to changes in noise due to the permanent operation of the Scheme (not construction traffic).

Table 3.5: Classification of Magnitude of Noise Impacts in the Short Term

Noise Change $L_{A10, 18h}$	Magnitude of Impact
0 dB	No change
0.1 – 0.9 dB	Negligible
1.0 – 2.9 dB	Minor
3.0 – 4.9 dB	Moderate
5.0+ dB	Major

(Source: Table 3.1 Highways Agency *et al.,* 2011)

Table 3.6: Classification of Magnitude of Noise Impacts in the Long Term

Noise Change $L_{A10, 18h}$	Magnitude of Impact
0 dB	No change
0.1– 2.9 dB	Negligible
3.0 – 4.9 dB	Minor
5.0 – 9.9 dB	Moderate
10+ dB	Major

(Source: Table 3.2 Highways Agency *et al.,* 2011)

13.1.4 These descriptors of impact magnitude are consistent with the terminology used elsewhere in the DMRB. For example, Volume 11, Section 3, Part 2 (HA 208/07) (Highways Agency *et al.* 2007) sets out noise impact descriptors for Historic Landscape (Table 3.7). These can be used as descriptions for the above noise changes.

Table 3.7: DMRB Definitions of Impact Magnitude – Noise on Historic Landscape

Magnitude of Impact	Typical Descriptors
Major	Gross change of noise or change to sound quality
Moderate	Noticeable differences in noise or sound quality
Minor	Limited changes to noise levels or sound quality
Negligible	Very slight changes in noise levels or sound quality
No Change	No audible changes

Vibration

Construction Phase

13.1.5 The most significant potential impacts are likely to arise from direct construction vibration from plant and activities where these are within around 150 metres of NVSRs. Out of these, piling and earthworks at bridges or cuttings may be the most significant as these may last for a significant duration at specific locations and may occur outside normal daytime working hours. Construction vibration is unlikely to be significant, except possibly at a small number of receptors.

13.1.6 Vibration from construction traffic is not expected to result in widespread significant impacts but may affect receptors particularly close to parts of the existing highway network or haul roads.

13.1.7 Criteria for assessing whether or not effects of construction vibration are likely to be significant relative to the potential for damage to buildings are based on the levels given in Table B.2 of BS 5228-2 (British Standards Institution, 2014b) as interpreted reproduced below in Table 3.8.

Table 3.8: Threshold Vibration Values for the Evaluation of Cosmetic Building Damage (BS 5228-2:2009+A1:2014)

Building Classification	Frequency Range of Vibration (Hz)	PPV mm/s	
		Transient Vibration	Continuous Vibration
Unreinforced or light framed structures Residential or light commercial type buildings	4 Hz to 15 Hz	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz
	15 Hz and above	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	4 Hz and above	50	25

Operational Phase

3.3.12 Vibration effects on buildings and structures may be considered in terms of their potential to cause damage. However, vibration levels at which even cosmetic damage can occur are relatively high and, generally, these are only generated by blasting or some construction activities in very close proximity to buildings. For a reasonably maintained road without speed control measures, such as speed humps, vibration arising during operation is likely to be minimal. As set out in Section 13.2 above, the DMRB states that peak particle velocity in close proximity to roads rarely exceeds 2 mm/s and is typically below 1 mm/s.

3.3.13 The effects of groundborne vibration associated with motorways are generally minimal and below perception due to the distances between the carriageways and residential receptors and the good quality road surfaces. Therefore, a quantitative assessment of this aspect has been scoped out.

3.4 Significance of Effect

3.4.1 The DMRB Volume 11 Section 2 Part 7 (HA 218/08) defines 'effect' as follows:

'Term used to express the consequence of an impact (expressed as 'significance of effect'), which is determined by correlating the magnitude of the impact to the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria. For example, land clearing during construction results in habitat loss (impact), the effect of which is the significance of the habitat loss on the ecological resource'.

3.4.2 Therefore, both sensitivity/value and impact magnitude are taken into account in determining the significance of effect. The section defines the approach taken to determining significance based on the following.

- Reference to regulations or standards.
- Reference to best practice guidance.
- Reference to policy objectives.
- Reference to criteria.
- Outcomes of consultation to date.
- Professional judgement based on local / regional / specialist experience.

3.4.3 With regards to noise and vibration, the assessment of significance is based on the guidance provided in DMRB, Volume 11, Section 2, Part 5 (HA 205/08) (Highways Agency *et al.,* 2008). The significance of effect is described using the terms very large, large, moderate, slight and neutral, depending on the environmental sensitivity and the magnitude of impact.

Table 3.10: Approach to Evaluating Significance of Effect

Value/ Sensitivity	Magnitude of Impact				
	No Change	**Negligible**	**Minor**	**Moderate**	**Major**
Low	Neutral	Neutral or Slight	Neutral or Slight	Slight	Slight or Moderate
Medium	Neutral	Neutral or Slight	Slight	Moderate	Moderate or Large
High	Neutral	Slight	Slight or Moderate	Moderate or Large	Large or Very large

3.4.4 Where the topic section of the DMRB does not provide topic specific definitions, the guidance set out in Table 2.3 of HA205/08 has been taken into account. For ease of reference this is set out below as Table 3.11.

Table 3.11: DMRB Descriptors of Significance of Effect Categories

Significance category	Typical Descriptors of Effect
Very large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

4 References

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