Cottam Parkway Railway Station

Noise and Vibration Technical Appendices

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Cottam Parkway Railway Station

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1. Noise and Vibration Assessment Methodology

1.1 Introduction

This appendix outlines the methodology and guidance followed in the assessment of noise and vibration effects for the Cottam Parkway Railway Station Scheme (hereinafter referred as to the 'Scheme').

1.2 Guidance

The assessment has been completed using the following guidance for each element considered:

- Construction noise – DMRB LA 111 Noise and Vibration (DMRB LA 111) (Highways England, 2020) and BS 5228-1: 2009 + A1: 2014 – Code of practice for noise and vibration control on construction and open sites – Part 1: Noise (BS 5228-1) (British Standards Institution, 2014a);
- Construction vibration – DMRB LA 111 (Highways England, 2020) and BS 5228-2: 2009 + A1: 2014 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (BS 5228-2) (British Standards Institution, 2014b);
- Noise Action Plan – Roads (Department for Environment, Food and Rural Affairs, 2019) to identify Noise Important Areas (NIAs) within the study area;
- Operational road traffic noise – Calculation of Road Traffic Noise (CRTN) (Department of Transport and Welsh Office, 1988) and DMRB LA 111 (Highways England, 2020); and,
- Operational railway station noise – ISO 9613-2 Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation (ISO 9613-2) (International Organization for Standardization, 1996).

1.3 Study Areas

1.3.1 Construction Study Areas

The construction study areas have been selected following DMRB LA 111 (Highways England, 2020). DMRB LA 111 reflects the guidance in BS 5228-1 (British Standards Institution, 2014a) which states that calculations of construction noise at distances over 300m may present inaccuracies due to meteorological effects. The study area for construction noise has therefore been set to 300m around the construction works footprint. For construction related vibration, the study area covers a distance of 100 m from construction activities with the potential to generate vibration (for example, vibratory compaction and vibratory piling), in accordance with the guidance provided in DMRB LA 111. These study areas are shown in Appendix 9.1: Figure 9.1. The construction assessment has considered those sensitive receptors located closest to the proposed works to identify any potential impacts.

1.3.2 Operational Noise Study Areas

The study area for the operational noise assessment has been defined in accordance with DMRB LA 111 (Highway England, 2020). On this matter, DMRB LA 111 advises:

'*An operational study area defined as the following can be sufficient for most projects, but it can be reduced or extended to ensure it is proportionate to the risk of likely significant effects:*

1) The area within 600m of new roads or road links physically changed or bypassed by the project;

2) The area within 50m of other road links with potential to experience short term Basic Noise Level (BNL) change of more than 1.0 dB(A) as a result of the project.'

To identify any bypassed routes, forecast traffic data provided by the traffic modelling team for the assessment has been analysed to identify any road links bypassed by the Scheme and which are predicted to experience BNL reductions of 1.0 dB(A) or more in the short-term, i.e. in the baseline year (2024). No bypassed road links were identified.

Therefore, the operational noise study area has been defined as a 600 m boundary around the Scheme. This operational noise study area, for which noise model calculations have been undertaken, is shown in Appendix 9.1: Figure 9.2.

DMRB LA 111 (Highways England, 2020) requires consideration of potential noise impacts on the wider road network beyond the modelled operational noise study area, where changes of 1 dB or more in noise level are predicted in the short-term. Any expected changes beyond the modelled operational noise study area have not been included in the noise modelling exercise but have been calculated using BNL calculations carried out in accordance with CRTN (Department of Transport and Welsh Office, 1988) and have been reported separately to noise model predictions.

1.4 Sensitivity of Receptors

Table 1 provides definitions of the types of noise and vibration sensitive receptor considered in the assessment, extracted from the terms and definitions provided in DMRB LA 111 (Highways England, 2020).

Table 1: Noise and Vibration Sensitive Receptors

Type	Definition
Noise sensitive receptor	Receptors which are potentially sensitive to noise, including dwellings, hospitals, healthcare facilities, community facilities, European Noise Directive (END) quiet areas or potential END quiet areas, international and statutorily designated sites, public rights of way and cultural heritage assets.
Vibration sensitive receptor	Receptors which are potentially sensitive to vibration, including dwellings, hospitals, healthcare facilities, education facilities, community facilities, buildings containing vibration sensitive equipment and cultural heritage assets.

Further guidance has also been taken from BS 5228-1 (British Standards Institution, 2014a) which defines noise sensitive premises as '*any occupied premises outside a site used as a dwelling (including gardens), place of worship, educational establishment, hospital or similar institution, or any other property likely to be adversely affected by an increase in noise level*'.

DMRB LA 111 (Highways England, 2020) does not provide a sliding scale of receptor sensitivity; receptors are either classed as sensitive or not sensitive. Noise and vibration sensitive receptors have therefore been defined using the above definitions, and the following data sources:

- OS Mastermap (Ordnance Survey, 2021a);
- OS AddressBase Plus (Ordnance Survey, 2021b); and
- Defra's MAGIC mapping (Department for Environment, Food and Rural Affairs, 2021) database to identify international and statutorily designated sites.

Whilst all noise and vibration sensitive receptors identified within the study areas were included in the assessment, a number of sample representative receptors were selected for discussion, identified as those most likely to experience significant effects arising from either the construction or operation of the Scheme. In total, nine sample representative receptors have been selected for the construction noise and vibration assessment and eight have been selected for the operational road traffic noise assessment, as shown in Table 2 and Table 3 and Figures 9.1 and 9.2 (Appendix 9.1). Only the sample representative receptors within 100m of the site boundary have been included in the construction vibration assessment; these are indicated in Table 2. These sample receptors are considered to have acoustic environments representative of those at other nearby receptors. They are located where people could be particularly sensitive to noise and vibration and include dwellings close to the Scheme as well as along Hoyles Lane, Sidgreaves Lane and Lea Road.

Table 2: Sample Representative Sensitive Receptors for Construction Noise and Vibration Assessment

Receptor Name	OS Grid Reference		Construction Impacts Assessed
	X	Y	
Quaker Lodge, Sidgreaves Lane	349022	431821	Noise and vibration
Clock House, Lea Road	349207	431834	Noise
5 Edgewater Oaks	349237	431688	Noise
Danes Pad, Lea Road	349342	431588	Noise
Yew Tree Lodge, Lea Road	349420	431537	Noise
4 The Shires	349489	431416	Noise and vibration
116 Lea Road	349662	431258	Noise and vibration
Leyland Bridge Barn, Lea Road	349678	431158	Noise and vibration
1 Railway Cottages, Sidgreaves Lane	349096	431336	Noise and vibration

Table 3: Sample Representative Sensitive Receptors for Operational Road Traffic Noise Assessment

Receptor Name	OS Grid Reference	
	X	Y
229 Hoyles Lane	349208	432280
Invercauld, Sidgreaves Lane	348967	432036
Quaker Lodge, Sidgreaves Lane	349022	431821
7 Thornthwaite Road	349664	431872
Danes Pad, Lea Road	349342	431588
4 The Shires	349489	431416
1 Railway Cottage, Sidgreaves Lane	349096	431336
Leyland Bridge Barn, Lea Road	349678	431158

1.5 Construction Noise Assessment Methodology

1.5.1 Construction Noise Approach

There is the potential for temporary noise effects to occur during the construction phase, both at residential properties and other sensitive receptors in the vicinity of the Scheme.

DMRB LA 111 (Highways England, 2020) has been followed for assessing the impacts from construction noise. DMRB LA 111 refers to BS 5228-1 (British Standards Institution, 2014a) as additional guidance to follow when undertaking an impact assessment of construction noise.

BS 5228-1 describes a calculation methodology to determine the impact from construction noise, including the assignment of significance.

Predicted noise levels during the worst-case construction activities have been calculated using the CadnaA noise modelling package. The construction noise levels have been predicted at the façades of the sample noise sensitive properties which are representative of the receptors nearest to the Scheme.

The construction noise predictions have used noise emission data from plant equipment reported in Annexes C and D of BS 5228-1.

A contractor has not yet been appointed for the Scheme and a preliminary construction programme is not available at this stage of the assessment. The predicted noise levels should be considered indicative only and have been based on a series of technical, generally conservative, assumptions, in lieu of specific guidance available at this stage regarding the likely plant and equipment that could be used during construction.

1.5.2 Construction Noise Magnitude of Impact

When determining the magnitude of impact, DMRB LA 111 (Highways England, 2020) uses 'effect levels' that have been introduced into English noise policy by the Noise Policy Statement for England 2010 (NPSE) (Department for Environment, Food and Rural Affairs, 2010). The 'effect levels' of Significant Observed Adverse Effect Level (SOAEL) and Lowest Observed Adverse Effect Level (LOAEL) are defined in accordance with the guidance within DMRB LA 111 and are shown in Table 4 which summarises Table 3.12 of DMRB LA 111. Defining the SOAEL and LOAEL requires knowledge of the existing noise levels at the sensitive receptors.

Table 4: Construction Noise LOAEL and SOAEL Values at Residential Receptors

Construction Noise Effect Level	How Effect Level is Defined
LOAEL	Baseline noise level $L_{Aeq,T}$ for day, evening or night-time period.
SOAEL	Threshold level determined as per BS 5228-1 Section E3.2 and Table E.1.

The SOAEL is determined as per Table E.1 of BS 5228-1, which is reproduced in Table 5.

Table 5: Example Threshold of Potential Significant Effect at Dwellings

Assessment Category and Threshold Value Period	Assessment Category and $L_{Aeq,T}$ Threshold Value (dB(A)		
	Category A [A)]	Category B [B)]	Category C [C)]
Night-time (23:00 – 07:00)	45	50	55
Evenings and Weekends [D)]	55	60	65
Daytime (07:00 – 19:00) and Saturday (07:00 – 13:00)	65	70	75
NOTE 1 A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. NOTE 2 If the ambient noise levels exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise. NOTE 3 Applied to residential receptors only.			
A) Category A: threshold values to use when the ambient noise levels (when rounded to the nearest 5 dB) are less than these values. B) Category B: threshold values to use when the ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.			

Assessment Category and Threshold Value Period	Assessment Category and $L_{Aeq,T}$ Threshold Value (dB(A)		
	Category A A)	Category B B)	Category C C)
C) Category C: threshold values to use when the ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values. D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.			

In order to assign the LOAEL and SOAEL, information on the existing noise climate is required. This has not been possible to obtain via noise survey for the following reasons:

- Construction works for the Preston Western Distributor Road (PWDR) was underway at the time of the assessment; therefore, measured baseline noise levels would not be representative of typical baseline conditions due to the potential for atypical construction noise to be measured;
- The baseline scenario for the Scheme construction and operational noise assessment assumes that the PWDR is fully operational; therefore, current noise levels, or noise levels measured during any surveys previously undertaken in the area, will not be representative of opening year baseline conditions as PWDR is not yet completed and open to road traffic; and,
- The coronavirus pandemic has resulted in several issues for conducting baseline noise assessments. During much of the assessment timeframe, the UK Government has imposed a series of differing levels of lockdown and travel restrictions, which has resulted in atypical noise environments for most of the UK due to changes in traffic, likely to render any baseline noise measurements unrepresentative of normal baseline conditions.

Therefore, the predicted noise levels for the Do-Minimum Opening Year scenario have been used to define the baseline in accordance with DMRB LA 111, paragraph 3.9. The noise model predicts noise levels as $L_{A10,18hr}$ whilst the LOAEL values are $L_{Aeq,T}$; therefore, it is necessary to convert the predicted Do-Minimum Opening Year traffic noise levels from $L_{A10,18hr}$ to $L_{Aeq,12hr}$ to obtain the daytime LOAEL. This conversion has been undertaken using Method 3 of Transport Research Laboratory (TRL) Report PR/SE/451/02 Converting the UK traffic noise index $L_{A10,18hr}$ to EU noise indices for noise mapping (TRL PR/SE/451/02) (Transport Research Laboratory, 2000).

The adopted magnitude scale for construction noise is presented in Table 6. This table is taken from DMRB LA 111, Table 3.16.

Table 6: Magnitude of Impact and Construction Noise Descriptions

Magnitude of Impact	Construction Noise Level
Major	Above or equal to SOAEL + 5dB
Moderate	Above or equal to SOAEL and below SOAEL + 5dB
Minor	Above or equal to LOAEL and below SOAEL
Negligible	Below LOAEL

1.5.3 Construction Noise Assessment of Significance

Assessment of significance for construction noise has followed the guidance in DMRB LA 111 (Highways England, 2020), which states, '*Construction noise and construction traffic noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:*

- *10 or more days or nights in any 15 consecutive days or nights; or,*
- *a total number of days exceeding 40 in any 6 consecutive months.'*

1.6 Construction Vibration Assessment Methodology

1.6.1 Construction Vibration Approach

Groundborne vibration from construction works may be perceptible to nearby receptors, which at higher levels can cause annoyance to residents. High vibration levels generally arise from 'heavy' construction works such as piling, deep excavation, or dynamic ground compaction. In extreme cases, cosmetic or structural building damage can occur.

DMRB LA 111 (Highways England, 2020) has been followed for assessing the impacts from construction vibration. DMRB LA 111 refers to BS 5228-2 (British Standards Institution, 2014b) as additional guidance to follow when undertaking an impact assessment of construction vibration.

BS 5228-2 contains guidance on vibration levels in structures from construction works. It provides a prediction methodology for mechanised construction works, such as compaction and piling works. The standard also presents guidance for the control of vibration from construction works. These calculation methods rely on detailed information, including the type and number of plant being used, their location and correction factors for operational state, and the probability that the vibration level might be exceeded.

1.6.2 Construction Vibration Magnitude of Impact

The magnitude of impact scale for vibration is presented in Table 7. This has been derived from BS 5228-2 (British Standards Institution, 2014b), Table B.1. For the human response to vibration, a value of LOAEL and SOAEL has been assigned in accordance with the values provided in Tables 3.31 and 3.33 of DMRB LA 111 (Highways England, 2020).

Table 7: Construction Vibration Magnitude and Effect Levels

Magnitude of Impact	Vibration Level, Peak Particle Velocity (PPV) mm/s (Effect Level)	Human Response
Major	≥10	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.
Moderate	Above or equal to 1.0 (SOAEL) and below 10	It is likely that vibration of this level in residential environments would cause complaint but can be tolerated if prior warning and explanation has been given to residents.
Minor	Above or equal to 0.3 (LOAEL) and below 1.0 (SOAEL)	Vibration might be just perceptible in residential environments.
Negligible	Above or equal to 0.14 and below 0.3 (LOAEL)	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
	<0.14	Vibration is below levels of perception.

1.6.3 Construction Vibration Assessment of Significance

Assessment of significance for construction vibration has followed the guidance in DMRB LA 111 (Highways England, 2020), which states, '*Construction vibration shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:*

- *10 or more days or nights in any 15 consecutive days or nights; or,*

- *a total number of days exceeding 40 in any 6 consecutive months.'*

1.6.4 Construction Vibration Building Structure Response

For building structure response, BS 5228-2 (British Standards Institution, 2014b) reproduces the advice given in BS 7385-2: 1993 (British Standards Institution, 1993). The response of a building to ground-borne vibration is affected by the type of foundation, underlying ground conditions, the building construction, and the state of repair of the building. Table 8 reproduces the guidance detail on building classification and guide values for cosmetic building damage.

Table 8: Guidance on the effects of Vibration Levels on Building Structures from BS 5228-2: 2009 + A1: 2014

Line	Type of Building	PPV in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	**4 Hz to 15 Hz**
1	Reinforced or framed structures	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
	Industrial and heavy commercial buildings		
2	Un-reinforced or light framed structures	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
	Residential or light commercial buildings		
Note 1 – Values referred to are at the base of the building Note 2 – For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.			

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 7, with major damage at values greater than four times the values in the table. BS 7385-2 also notes that the probability of cosmetic damage tends towards zero at 12.5 mm/s PPV.

1.6.5 Sources of Vibration Considered

Vibratory Compaction

Sensitive receptors for vibration compaction have been selected from the closest sensitive properties. For vibratory compaction, BS 5228-2 details the following empirical equations for deriving likely ground-borne vibration levels:

- $v_{res}=k_s \sqrt{n_d}\,\{A/(x+L_d)\}^{1.5}$ (Steady state – continuous activity)
- $v_{res}=k_t \sqrt{n_d}\,\{A^{1.5}/(x+L_d)^{1.3}\}$ (Start up and run down – intermittent activity)

Where:

- v_{res} is the resultant PPV in millimetres per second;
- k_s and k_t are scaling factors for the probability of the predicted value being exceeded;
- n_d is the number of vibrating drums;
- A is the maximum amplitude of drum vibration in millimetres;
- x is the distance measured along the ground surface in metres; and,
- L_d is the vibrating roller drum width in metres.

Steady state continuous vibratory activity can be defined as vibratory stimulus that is maintained through a sequence of cycles where the cyclic variation in amplitude is repeated many times over.

Intermittent activity (start-up and run down), where the plant has a distinct start-up cycle, can result in the machine vibrating at the natural frequency of the ground structure at some point in the start-up and run-down phase. At these frequencies maximum amplitudes of vibration can result for short durations as the machine passes through the natural frequency of the ground structure.

For this assessment, it has been assumed, based on the data sheet for a Bomag BW 216 PD-5, that the vibratory roller would have one vibrating drum, a drum width of 2.13m and a maximum amplitude of drum vibration of 1.7mm in the higher vibration setting and 0.9mm in the lower vibration setting.

Piling

There are no sensitive human receptors located within 100m of the area of Lancaster Canal where sheet piling is anticipated. There are also no sensitive human receptors located within 100 m of the Scheme's bridge over Lancaster Canal where piling may be chosen by the contractor as the method of constructing the foundations.

However, there is a designated canal bridge, Quaker's Bridge, located approximately 30 m east of the Scheme's bridge over Lancaster Canal. The potential for damage to the canal bridge due to the sheet piling or potential foundation piling has been considered in the assessment.

Both percussive and vibratory sheet piling have been considered in this vibration assessment. BS 5228-2 details the following empirical equations for deriving likely ground-borne vibration levels:

- $v_{res}=k_p \{\sqrt{W} / r^{1.3}\}$ (Percussive piling)
- $v_{res}=k_v / x^{\delta}$ (Vibratory piling)

Where:

- v_{res} is the resultant PPV in millimetres per second;
- k_p is a scaling factors for the ground conditions;
- k_v is a scaling factor for the probability of the predicted value being exceeded;
- W is the nominal hammer energy, in joules;
- r is the slope distance from the pile toe or tunnel crown, in metres;
- x is the distance measured along the ground surface in metres; and,
- δ is 1.3 for all operations, 1.2 for start up and run down and 1.4 for steady state operations.

1.7 Operational Road Traffic Noise Assessment Methodology

1.7.1 Operational Road Traffic Noise Approach

The assessment of operational road traffic noise has followed the assessment methodology in DMRB LA 111 (Highways England, 2020). Noise levels have been calculated at all residential dwellings and other sensitive receptors (refer to Table 1) within the defined study area for the Scheme.

Noise levels at 1,078 noise sensitive receptors have been calculated using CadnaA noise modelling software, which incorporates the methodology contained in CRTN (Department of Transport and Welsh Office, 1988) and DMRB LA 111. CRTN is a technical memorandum produced by the Department of Transport and Welsh Office, which provides a method of predicting road traffic noise in the United Kingdom.

CRTN noise level predictions take account of the following variables:

- typical weekday volumes of traffic during the 18-hour period from 06:00 to midnight (18-hour annual average weekday traffic (AAWT) flows);
- percentage of HGVs (defined as any vehicle with an unladen weight greater than 3.5 tonnes);
- pivoted traffic model speeds, derived in accordance with the requirements of DMRB LA 111;
- road gradient;
- local topography;
- nature of the ground cover between the road and the receptor;
- shielding effects of any intervening structures, including allowances for limited angles of view from the road and any reflection effects from relevant surfaces; and,
- road surfacing type and surface correction.

It is assumed that the road surface on all of the existing highway network within the study area, including Preston Western Distributor which will be operational by the opening year of the Scheme, is conventional hot rolled asphalt (HRA).

Physical features such as building outlines, existing road alignments and widths, and ground surface characteristics were imported into the CadnaA noise models from the Ordnance Survey (OS) MasterMap Topography Layer digital mapping. Terrain heights are derived from filtered (bare earth) LiDAR data which have been used to generate contour lines at 1 m vertical intervals.

Consideration has also been given to night-time noise levels for all assessment receptors. Method 3 contained in TRL Report PR/SE/451/02 (Transport Research Laboratory, 2000) has been used to derive the night-time level $L_{night,outside}$ based on predicted $L_{A10,18hr}$ road traffic noise levels.

In accordance with DMRB LA 111, this assessment considers noise level changes at sensitive receptors with the following comparisons made for both daytime and night-time assessments:

- Do-Something short-term comparison: Do-Minimum scenario in the baseline year (2024) against Do-Something scenario in the baseline year (2024);
- Do-Something long-term comparison: Do-Minimum scenario in the baseline year (2024) against Do-Something scenario in the future assessment year (2039); and,
- Do-Minimum long-term comparison: Do-Minimum scenario in the baseline year (2024) against Do-Minimum scenario in the future assessment year (2039).

1.7.2 Operational Road Traffic Noise Magnitude of Impact

Section 3 of DMRB LA 111 (Highways England, 2020) provides guidance on determining magnitude of impacts for road traffic noise. Magnitude of impact is considered for both the short-term and long-term. The classification of noise impact magnitude is set out in Table 9 and Table 10 reproduced from Table 3.54a and Table 3.54b of DMRB LA 111.

Table 9: Operational Road Traffic Noise Magnitude of Impact – Short-term

Short-term Magnitude	Short-term Noise Change (dB $L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 5.0
Moderate	3.0 to 4.9
Minor	1.0 to 2.9
Negligible	Less than 1.0

Table 10: Operational Road Traffic Noise Magnitude of Impact – Long-term

Long-term Magnitude	Long-term Noise Change (dB $L_{A10,18hr}$ or L_{night})
Major	Greater than or equal to 10.0
Moderate	5.0 to 9.9
Minor	3.0 to 4.9
Negligible	Less than 3.0

Calculations have been performed for all noise sensitive receptors within the study area for the short-term, long-term, daytime and night-time periods, and reported based on Tables 3.55a and 3.55b in DMRB LA 111.

DMRB LA 111 states that the façade used to calculate noise change shall be chosen as the façade with the greatest magnitude of noise change, or where equal on more than one façade, the façade chosen should be that with the greatest magnitude of noise change and highest Do-Something noise level. No guidance is given as to the scenario to assess for the greatest magnitude of noise change; therefore, this has been interpreted for this assessment as the short-term noise change.

For each noise sensitive building, noise level predictions have been made at the ground floor (1.5m above ground level) for all building façades and at the first floor (4m above ground level) for all building façades with two or more storeys. The prediction point meeting the above criteria has been reported for each noise sensitive receptor.

NPSE provides further guidance on the effects of noise, introducing the observed adverse effect level categories. DMRB LA 111 states that the LOAEL and SOAEL shall be set for all noise sensitive receptors within the study area, for time periods when they are in use.

LOAEL and SOAEL considered in this assessment are defined in Table 11 below, which is reproduced from Table 3.49.1 of DMRB LA 111. These LOAEL and SOAEL are considered to apply to both dwellings and other noise sensitive receptors for the purpose of this assessment.

Table 11: Operational Noise LOAEL and SOAEL for all Receptors

Time Period	LOAEL	SOAEL
Day (06:00–24:00)	55dB $L_{A10,18hr}$ (façade)	68dB $L_{A10,18hr}$ (façade)
Night (23:00–07:00)	40dB $L_{night,outside}$ (free-field)	55dB $L_{night,outside}$ (free-field)

1.7.3 Operational Road Traffic Noise Assessment of Significance

DMRB LA 111 (Highways England, 2020) states that the initial assessment of likely significant effects on noise sensitive buildings shall be determined using Table 12, which is reproduced from Table 3.58 of DMRB LA 111.

Table 12: Initial Assessment of Operational Noise Significance

Significance	Short-term Magnitude of Change
Significant	Major
Significant	Moderate
Not significant	Minor
Not significant	Negligible

Following the initial determination of significance based on the short-term magnitude of change, DMRB LA 111 states:

'*Where the magnitude of change in the short-term is negligible at noise sensitive buildings, it shall be concluded that the noise change will not cause changes to behaviours or response to noise and, as such, will not give rise to a likely significant effect.*

For noise sensitive receptors where the magnitude of change in the short-term is minor, moderate or major at noise sensitive buildings, Table 3.60 shall be used, together with the output of Table 3.58 to determine final significance.'

Following the initial determination of significance, the final determination of significance of effect has been determined using the guidance contained in Table 13, which is reproduced from Table 3.60 of DMRB LA 111.

Table 13: Determining Final Operational Significance on Noise Sensitive Buildings

Local Circumstance	Influence of Significance Judgement
Noise level change (is the magnitude of change close to the minor/moderate boundary?)	1) Noise level changes within 1 dB of the top of the 'minor' range can indicate that it is more appropriate to determine a likely significant effect. Noise level changes within 1 dB of the bottom of a 'moderate' range can indicate that it is more appropriate to consider a change is not a likely significant effect.
Differing magnitude of impact in the long-term to magnitude of impact in the short-term	1) Where the long-term impact is predicted to be greater than the short-term impact, it can be appropriate to conclude that a minor change in the short term is a likely significant effect. Where the long-term impact is predicted to be less than the short term it can be appropriate to conclude that a moderate or major change in the short term is not significant. 2) A similar change in the long term and non-project noise change can indicate that the change is not due to the project and not an indication of a likely significant effect.
Absolute noise level with reference to LOAEL and SOAEL (by design this includes sensitivity of receptor)	1) A noise change where all do-something absolute noise levels are below SOAEL requires no modification of the initial assessment. 2) Where any do-something absolute noise levels are above the SOAEL, a noise change in the short term of 1.0 dB or over results in a likely significant effect.
Location of noise sensitive parts of a receptor	1) If the sensitive parts of a receptor are protected from the noise source, it can be appropriate to conclude a moderate or major magnitude change in the short term and/or long term is not a likely significant effect. 2) Conversely, if the sensitive parts of the receptor are exposed to the noise source, it can be more appropriate to conclude a minor change in the short term and/or long term is a likely significant effect. 3) It is only necessary to look in detail at individual receptors in terms of this circumstance where the decision on whether the noise change gives rise to a significant environmental effect is marginal.
Acoustic context	1) If a project changes the acoustic character of an area, it can be appropriate to conclude a minor magnitude of change in the short-term and/or long-term is a likely significant effect.

Local Circumstance	Influence of Significance Judgement
Likely perception of change by residents	1) If the project results in obvious changes to the landscape or setting of a receptor, it is likely that noise level changes will be more acutely perceived by the noise sensitive receptors. In these cases it can be appropriate to conclude that a minor change in the short term and/or long term is a likely significant effect. 2) Conversely, if the project results in no obvious changes for the landscape, particularly if the road is not visible from the receptor, it can be appropriate to conclude that a moderate change in the short term and/or long term is not a likely significant effect.
Note 1 – In relation to the location of sensitive parts of the receptor, an example of a situation where sensitive parts of a receptor would be protected from the noise source would include a house with no, or very few, windows of sensitive rooms facing the road, and its outdoor spaces are protected from the road by buildings. Note 2 – In relation to the location of sensitive parts of the receptor, an example of a situation where sensitive parts of a receptor would be exposed to the noise source would include a house with most windows of sensitive rooms facing the road, and/or outdoor spaces facing the road.	

An initial assessment of significance has been undertaken for all noise sensitive receptors, and the criteria in Table 12 have been used to determine the final significant effects which are shown in Figure 9.4 and described in section 9.7 of Chapter 9: Noise and Vibration.

1.7.4 Noise Insulation Regulations Assessment

An indicative assessment has been undertaken following the procedure outlined in the Noise Insulation Regulations 1975. For a property to qualify for improvement under the Noise Insulation Regulations, the property must meet all of the following four primary conditions:

- be within 300 m of the Scheme;
- show a relevant noise level of at least 68 dB $L_{A10,18hr}$ (façade) – the relevant noise level is the predicted noise level with the Scheme in place in either the Do-Something 2024 or Do-Something 2039 scenarios;
- show a noise increase between the relevant noise level and the prevailing noise level of at least 1 dB(A) – the prevailing noise level is the predicted noise level in the Do-Minimum 2024 scenario; and,
- the contribution to the increase in the relevant noise level from the Scheme must be at least 1 dB(A).

These criteria have been applied to all noise sensitive receptors to determine indicative eligibility for Noise Insulation Regulations qualification. It should, however, be noted that a final Noise Insulation Regulations assessment would be performed once the Scheme is operational using the as-built design and traffic flow data at the time.

1.8 Operational Railway Station Noise Calculation Methodology

Noise levels have been calculated for railway station operational activities using the CadnaA noise modelling software in accordance with ISO 9613-2 (International Organization for Standardization, 1996). The prediction of noise within the CadnaA model aims to represent operational noise levels that could occur within a worst-case period for daytime and night-time operation. The assessment periods for operation are 1 hour during daytime (07:00 – 23:00) and 15 minutes during night-time (23:00 – 07:00) operation.

The following activities allow for a worst-case assessment and have been modelled for both daytime and night-time periods:

- Long line public address system (LLPA) speakers;

- Buses arriving and departing;
- Cars arriving and departing;
- Buses idling; and,
- Cars idling and car doors slamming.

At this stage it is not known where the LLPA speakers will be located. For the purposes of this assessment, it has been assumed that there is one located at either end and one in the middle of each of the two platforms, for a total of six speakers. Speakers have been modelled at a height of 2 m. Based on measurements undertaken near a LLPA speaker for another scheme, the speakers have been modelled with a sound power level of 83.9 dB(A) and it has been assumed they would be in operation 5 % of the time during the daytime and night-time.

In order to present a worst case scenario, traffic information provided by the traffic engineers indicates that the peak daytime average hourly traffic flow occurs between 16:00 – 19:00 hours with an average of 52 car movements (36 cars arriving and 16 vehicles leaving the car park) per hour. Bus provision for the Scheme is not included in the traffic information so the number of bus movements is not known. For the purposes of the assessment, eight bus movements (four buses arriving and four buses leaving the car park) per hour has been assumed.

The traffic data indicates that night-time average hourly traffic flow (between 19:00 – 07:00 hours) is eight car movements (four cars arriving and four cars leaving the car park) per hour. To be conservative it has been assumed that these car movements all occur with the 15-minute night-time assessment period. For the purposes of the assessment, two bus movements (one bus arriving and one bus leaving the car park) has been assumed per 15 minutes.

The modelling work assumes that vehicular activity would be evenly distributed across the areas of use, defined by the car park and station forecourt layout. Car noise sources are split between the west and east car parks in accordance with the number of spaces in each car park – resulting in 35 and 17 car sources for the west and east car parks, respectively, during daytime and five and three car sources, respectively, during night-time. Stationary car sources are distributed evenly across the area of the car parks and moving sources follow the route cars would take around the car parks. Bus stationary sources are located where buses would park and bus moving sources follow the route buses would take in the station forecourt.

All vehicle noise sources have been modelled at a height of 1 m above ground, to account for a worst-case vehicle combined engine and exhaust height. The majority of effective source positions for the noise emissions are likely to be closer to the ground and therefore would potentially benefit from greater ground and screening attenuation than currently assumed.

The assessment of car alarms has not been included in the operational station noise assessment. Car alarm sound is considered to be atypical and is likely to be an infrequent event which is not representative of normal operation of the car park.

The activities and assumed sources associated with the car park operation are presented in Table 14. Each activity occurs during both daytime and night-time periods unless specified.

Table 14: Car Park Activity List with Associated Sources and Sound Power Levels

Activity	Source	% On-time	No. Plant	dB L_{wA}	Corrected dB L_{wA}	Activity dB L_{wA}
Car Parks – Day	Car Door Slam	1	52	89	86	87
	Car Idle	5	52	76	80	
Car Parks – Night	Car Door Slam	1	8	89	78	79
	Car Idle	5	8	76	72	
Car Movement	Car Movement	*	1	90	90	90
Bus Idle – Day	Bus Idle	10	8	76	75	75
Bus Idle – Night	Bus Idle	40	2	76	75	75
Bus Movement	Bus Movement	*	1	106	106	106

*Sound power level for one vehicle pass-by. The number of vehicle movements in each scenario has been incorporated in the noise model.

The octave band sound power levels associated with each activity assumed in the operation noise assessment are presented in Table 15.

Table 15: Octave Band Sound Power Levels for each Car Park Activity

Activity	Linear Octave Band Sound Power Levels, dB by 1/1 Centre Band Frequency, Hz								dB L_{wA}
	63	125	250	500	1000	2000	4000	8000	
Car Parks – Day	87	84	80	83	82	81	78	70	87
Car Parks – Night	79	76	71	74	74	73	70	62	79
Car Movement	102	97	92	85	83	79	77	70	90
Bus Idle – Day	82	71	72	77	76	70	65	59	79
Bus Idle – Night	82	71	72	77	76	70	65	59	79
Bus Movement	108	110	103	102	103	97	82	87	106

1.9 References

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