Noise Scheme of Assessment for Route Section C

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June 2014

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CONTENTS

1 INTRODUCTION

In October 2012, the Secretary of State made the Chiltern Railways (Bicester to Oxford Improvements) Order 2012 (the Order). This Transport and Works Act Order authorises the construction and operation of an improved railway between Bicester and Oxford. The Order is accompanied by a planning direction (or 'deemed planning permission') granted by the Secretary of State, which is subject to a number of conditions.

Certain of the planning conditions require that detailed designs or other information are submitted to, and approved by, the local planning authority, which may be either the Cherwell District Council, or Oxford City Council, or both.

The conditions relating to operational noise comprise 19(1) to 19(14) which require approval of *Schemes of Assessment* of the predicted noise and vibration impacts of Phases 1, 2A and 2B by the relevant local planning authorities. This document forms one such *Scheme of Assessment* and sets out both the methodology that has been used to assess noise from the Order Scheme, identifying the requirements for noise mitigation measures and the effects of operation noise with mitigation.

Planning condition 19(1) requires operational noise monitoring and mitigation to be carried out in accordance with the *Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1)* (The Policy). The requirements for mitigation result from both The Policy and the planning conditions, which operate together to ensure that noise mitigation is appropriately specified.

The scope of this *Scheme of Assessment* covers noise as a result of railway vehicles using the Order Scheme following the principles of The Policy. Vibration from the Order Scheme is addressed in a separate *Scheme of Assessment*.

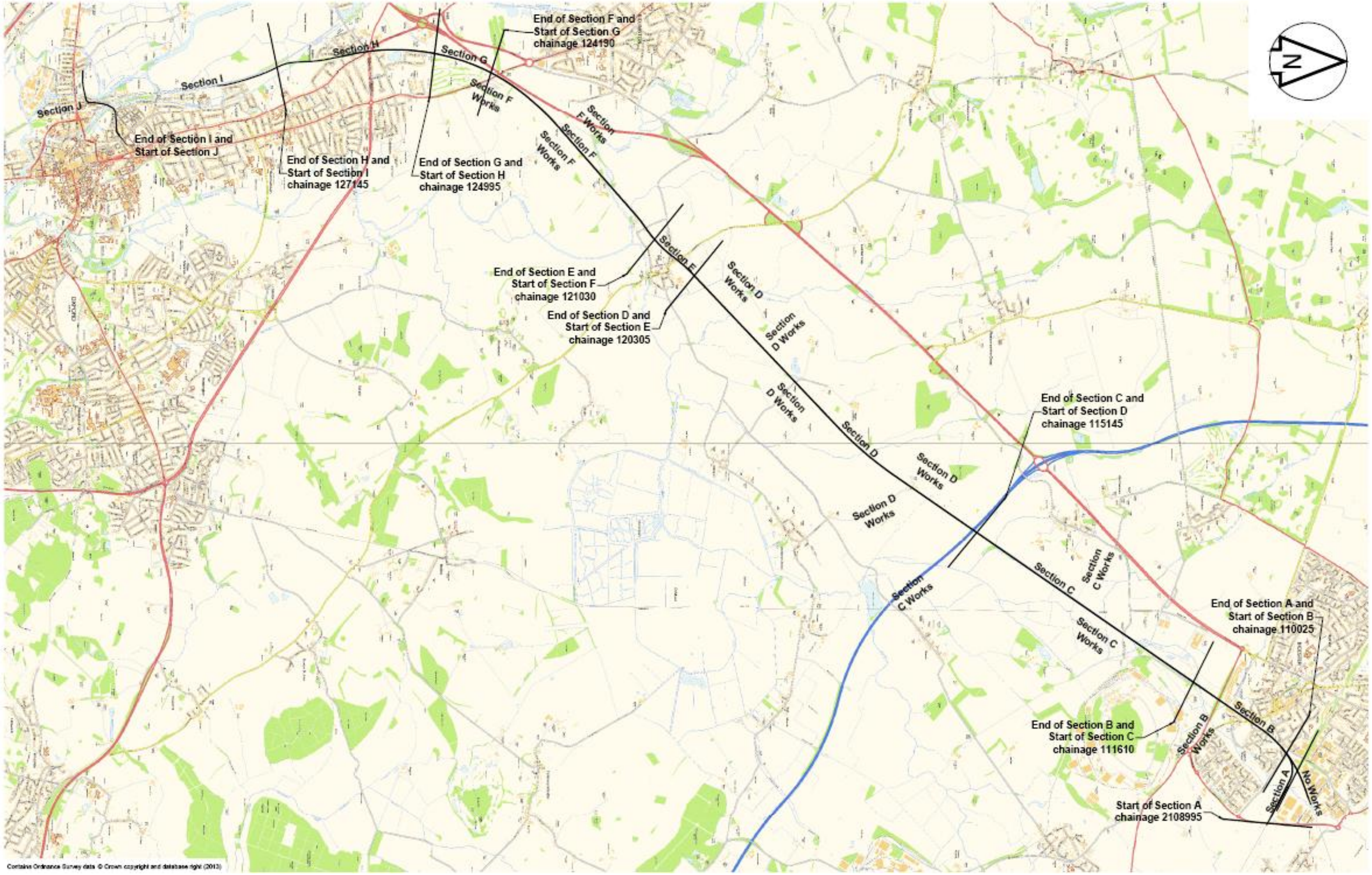
Directional public address systems will be used that minimise the impact on nearby properties whilst maintaining audibility on platforms. The station operator will establish appropriate sound levels for station public address systems and will seek to address complaints, if they are received from occupiers of noise sensitive premises, as far as is reasonably practicable within railway safety requirements.

Although mitigation measures for noise from fixed plant are not covered in The Policy, standards are set in the Environmental Statement (ES) [(1)], and these will be implemented during the design process.

(1) Transport and Works Order Application Document CD/1.16, volume 2, chapter 6.

Since the work on the Order Scheme will progress in sections, the planning conditions require *Route Sections* to be defined, and a separate *Scheme of Assessment* is to be undertaken for each *Route Section*. The Order Scheme has been divided into 10 *Route Sections* (labelled A – J). This *Scheme of Assessment* covers *Route Section C*, which runs from south of Bicester, adjacent to the MoD, to the M40 motorway, as defined in the approved discharge of conditions document, *Discharge of Condition 3 - Sections* (Oxford City Council planning reference 13/00918/CND and Cherwell District Council planning reference 13/00106/DISC). The locations of the *Route Sections* are shown in *Figure 1.1*.

Figure 1.1 Route Sections



This document has been structured as follows:

- *Chapter 2* establishes the principles for evaluating noise from the operation of the Order Scheme;
- *Chapter 3* sets out the method used to predict noise from the railway;
- *Chapter 4* presents the existing baseline noise conditions, including additional baseline measurements which were found to be appropriate to inform the mitigation design;
- *Chapter 5* presents the results of the evaluation of noise from the operation of the Order Scheme, and the noise mitigation required; and
- *Chapter 6* describes the monitoring protocol that will be adopted to monitor noise.

A copy of The Policy is provided at *Annex A* for reference and the relevant planning conditions are included in *Annex B*. *Annex C* provides a glossary of acoustic terms. *Annex D* provides supporting information and where necessary, calculations and printouts from recognised computer software, to show how the standards of noise mitigation set out in The Policy will be achieved as required by the planning conditions. *Annex E* sets out details of the baseline noise data to which this document refers.

2 *PRINCIPLES FOR THE EVALUATION OF NOISE FROM THE ORDER SCHEME*

2.1 *INTRODUCTION*

The method for evaluating when noise impacts occur is based on the methodology in the ES (volume 2, chapter 6). The procedures for identifying when noise mitigation will be implemented are defined in The Policy following an approach that is consistent with the ES. Key extracts from The Policy are repeated in the following sections. The paragraph numbering presented in square brackets corresponds to The Policy. The Policy is provided in full at *Annex A*.

2.2 *PRINCIPLES OF THE NOISE AND VIBRATION MITIGATION POLICY*

[2.1] *The Policy is intended to ensure that noise and vibration mitigation is provided on a fair basis for all landowners and occupiers affected by the Order Scheme.*

[2.2] *The Promoter is committed to using the Best Practicable Means (1) to design the railway so as to avoid significant noise and vibration impacts at existing sensitive receptors (e.g. residential properties, educational buildings and places of worship). The first preference will be to apply necessary noise control measures at source where this is reasonably practicable. These may include rail damping or other infrastructure measures to reduce noise at source. Where this is not reasonably practicable or sufficient to mitigate significant noise impacts, the Promoter will:*

- *where they are effective and reasonably practicable to install, provide noise barriers to mitigate noise between the track and sensitive receptors; and*

- *after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, offer noise insulation to properties where residual noise impacts on sensitive receptors remain high.*

[2.3] *The Promoter will consult with landowners and occupiers who may be affected by noise and vibration to explain the mitigation measures that are proposed.*

The assessment of noise uses technical terms, which are described in Annex A (of The Policy). The provision for noise mitigation will be based on two sets of absolute noise levels (2). The first are 'Noise Impact Threshold' levels, below which noise impacts are never significant. The second set of levels are the 'Noise Insulation Trigger' levels. These are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field (3) noise levels.

(1) Best Practicable Means are defined in Section 72 of the Control of Pollution Act 1974 as those measures which are "reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge, financial considerations and compatibility with safety and safe working conditions"
(2) The standards relate to disturbance of building occupants, and do not relate to specific effects such as speech interference.
(3) Free-field means away from reflective surfaces, except the ground.

Noise Impact Threshold Levels: *Day - $L_{Aeq, (0700-2300\ hours)}$ 55 dB* [1]
Night – $L_{Aeq, (2300-0700\ hours)}$ 45 dB

[2.4] *Where train noise is predicted to be above either of these threshold levels, but where the level is still less than that set out in the Noise Insulation Regulations requiring noise insulation to be provided, the Promoter will provide mitigation measures to reduce the adverse impact of noise. These will vary according to the extent to which the train noise level exceeds the threshold levels and the extent to which overall noise is increased above the existing or ambient noise level, as follows:*

- *exceedances of 3 dB or greater and increases of 3 dB or greater – mitigation at source through rail infrastructure solutions will be implemented where reasonably practicable;*
- *exceedances of greater than 5 and up to 7 dB and increases of greater than 5 dB and up to 7 dB - at source and/or in the form of noise barriers if reasonably practicable and have no other negative effects; and*
- *exceedances of greater than 7dB and increases of greater than 7dB – at source through rail infrastructure solutions and where these cannot be reasonably practicably achieved, noise barriers will be provided, where reasonably practicable.*

These standards are consistent with those applied in the Environmental Statement, where noise mitigation is considered at source for impacts that are greater than 3 dB and in the form of noise barriers for impacts above a minimum of 5 dB. (Noise impacts in the ES are calculated by considering both the exceedance of the threshold criteria and the increase in overall noise, and taking the lower of the two.) The noise benefits of noise barriers are more likely to outweigh any dis-benefits, where the noise increase is above 7 dB. There are certain locations where because of the topography of the railway and adjacent properties, safety or visual impact, barriers cannot be installed or will not be effective.

[2.5] *Noise barriers or other noise attenuating infrastructure solutions will achieve noise reductions in most areas, to near to the existing noise levels. However residual noise impacts may still occur at particular locations. If, after consideration of the effects of noise mitigation measures at source, any of the Noise Insulation Trigger levels is still exceeded, then noise insulation to relevant properties will be offered, provided the corresponding existing or ambient noise level is routinely exceeded by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations. The noise level thresholds at which this will be offered are shown below in terms of free-field noise levels that are equivalent to the façade levels provided for in the Regulations.*

(1) $L_{Aeq,T}$ is the A-weighted equivalent sound level over the period T. A-weighting is a frequency weighting that replicates the frequency response of the ear. $L_{Aeq,T}$ is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. It is recommended parameter for train noise.

Noise Insulation Trigger Levels *Day > $L_{Aeq, (0600-0000\ hours)}$ 66 dB* (1)
Night > $L_{Aeq, (0000-0600\ hours)}$ 61 dB

[2.6] *Even with the mitigation in paragraph 2.5, some of the properties close to the railway may still experience residual noise impacts that may be classed as 'high'. A 'high' impact is the equivalent of a noise impact of greater than +10 dB. If these properties are not already to be provided with insulation under the Noise Insulation Regulations, they will be offered additional mitigation, which is likely to be in the form of noise insulation.*

[2.7] *If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field)at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance, except where ambient maximum noise levels are already above the predicted train noise level. One or two events per night would not be interpreted as regular, but the 8 assumed freight movements each night in Phase 2B are considered to be regular. In those very few locations likely to have such noise effects, additional noise attenuation measures will be taken to include the offer of noise insulation to affected properties. This form of mitigation is particularly effective in addressing night-time noise impacts when noise levels inside buildings are the key factor as regards sleep disturbance. The following additional criterion for noise insulation is therefore being applied.*

Significant impact, need for further mitigation likely to be noise insulation: *Night > L_{Amax} 82 dB* (2)

Section 1.7 of The Policy includes the commitment to refine the mitigation that was developed for the ES following the principles set out in The Policy. It is intended to ensure that the residual noise effects at any location are no worse than those reported in the ES.

Refined noise level predictions were modelled during the public inquiry and the results of this analysis were communicated to third parties who had a specific interest in noise levels. These were reported in the *Note on Refined Noise Modelling and Monitoring* (CRCL/INQ/32). The public inquiry confirmed that it was Chiltern Railways' intention to ensure, where practicable, that residual noise effects at these receptors are no worse than reported.

2.3 *ADDITIONAL MITIGATION REQUIREMENTS IN PLANNING CONDITIONS*

There were no specific commitments made during the public inquiry to provide mitigation in this *Route Section*, or to carry out further baseline monitoring, that is not otherwise covered by The Policy or the planning conditions.

(1) Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations, where it is defined as 0600 hours to midnight. These noise levels are free-field values that are equivalent to the values defined in the Noise Insulation Regulations.
(2) L_{Amax} is a measure of the peak noise level, A-weighted.

3 RAIL NOISE PREDICTION METHODOLOGY

3.1 SELECTION OF ASSESSMENT SCENARIO

This section describes the railway noise prediction methodology that has been used in this *Scheme of Assessment*.

The Policy was developed to allow for a sequence of construction (as described in paragraphs 1.1 to 1.3 of The Policy). In this sequence *Phases 1* and *2A* were expected to be undertaken by Chiltern Railways soon after the Order was granted. Further works, in *Phase 2B*, were expected to take place at a later date, and to be undertaken either by the East West Rail (EWR) Consortium or others on behalf of Network Rail. However, the EWR project is being progressed and it is now intended to carry out all of the works authorised by the Order (ie all of the Phases set out above) during a single combined construction period. Therefore, this *Scheme of Assessment* includes mitigation designed to take account of the combined railway noise from all of the phases of the Order Scheme (*Phase 1*, *2A* and *2B*).

The Order Scheme, as now to be built, includes double track throughout *Route Sections A* to *H*, resulting in tracks in some locations being closer to receptors than would have been the case if only *Phases 1* and *2A* were to be built. This Scheme of Assessment has been based on the assumed train frequencies for *Phase 2B* set out in The Policy, and assesses a 'worst case' in terms of unmitigated noise impact. Until other parts of EWR, between Bicester and Bletchley, have permission and are built, the additional freight and passenger services, assumed for *Phase 2B*, as described in paragraphs 1.8 and 1.9 of The Policy, are unlikely to be operated. The 'worst case' assessed in this *Scheme of Assessment* will not arise until those services are operating.

3.2 METHODOLOGY

Noise sensitive receptors (NSRs) were identified in the ES to represent properties likely to be worst affected by noise from the Order Scheme. Subsequently, additional receptors were included which represented third parties who had a specific interest in noise levels during the public inquiry. Noise levels at these receptors have been predicted according to the methodology in the CRN (1) for L_{Aeq} noise levels, whilst the Nordic Method (2) has been used to calculate maximum noise levels. Details of the train types and service information that have been used in the prediction of noise levels are presented in *Annex D*.

(1) Calculation of Railway Noise 1995. The DoT

(2) Nord 2000 New Nordic Prediction Method for Rail Traffic Noise, H J Jonasson and S Storeheier, 2001.

Although the results of this assessment have only been presented numerically for the NSRs outlined above, all NSRs have been considered when determining noise mitigation. *Figure 5.1* in *Section* 5 presents all noise mitigation measures in this *Route Section* as well as residual noise levels contours.

An initial assessment of eligibility for noise insulation under the Noise Insulation Regulations (1) (NIR or the Regulations) has been carried out. This has been based on noise from trains in accordance with the Regulations. Noise levels have been predicted according to the methodology in the CRN, using the time periods specified in the Regulations (the day-time period is defined as the period of 18 hours between 06.00 and midnight, the night-time period means the period of six hours between midnight and 06.00). Train service levels have been adjusted accordingly.

3.3 *MODEL INPUTS*

The Policy requires that noise and vibration mitigation will be designed based on the assumptions in paragraphs 1.8 and 1.9 of The Policy (see *Annex A*) regarding the numbers and timing of train movements. These and the other assumptions that have been used, for example in relation to types of rolling stock and train lengths, are the same as those used in the ES, except for the exclusion of an assumed Cross Country passenger service that is no longer planned.

Speed profiles and other input data have been used to model the worst case likely noise levels. The source information and assumptions that were assumed for the modelling are discussed in detail in *Annex D*.

3.4 *ASSESSMENT OF SPEECH COMMUNICATIONS*

As required by planning condition 19(3), an assessment of speech communications has been carried out for users of the "large riding school" and "small riding school" at Wendlebury Gate Stables, and the paddock opposite Bramlow, nearby. The assessment has been carried out according to the Speech Interference Level (SIL) assessment method described in Annex E of the British Standard, *Ergonomics Assessment of Speech Communications* (2).

As set out in planning condition 19(3), the assessment has been based on a native female speaker facing the rider under instruction for alert situations where short known words are used and the wind speed is less than 5 metres per second. A correction factor of -5 dB has been used to convert the standard for male voices to female voices.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (as amended 1998).
(2) BS EN ISO 9921:2003 Ergonomics Assessment of Speech Communications

An optimisation process has been undertaken to determine the preferred barrier height and length. As with other route sections the maximum height of barriers is 2.5 m above rail. The barrier length has been considered as follows:

- There are constraints on the locations where a barrier can be provided including (i) the fact that the barrier cannot extend across the proposed turnout and spur onto the MOD sidings, and (ii) the designs for the replacement bridges have been settled (OX40, a concrete bridge, at ch. 112571.5 m – 112547 m and OX40a, a brick bridge at ch. 113020 m – 113050 m) and these designs do not allow for barriers to be supported across these bridges.

- The effect of the noise reduction from a barrier south of OX40a was found to be insignificant, and therefore it is recommended that this section of barrier is not provided. The rest of the barrier, however, does provide a reduction in overall train noise, and this is a positive and practicable attempt to reduce the time during which speech interference would occur. A barrier 2.5 m above rail height has been adopted in the Scheme of Assessment for this route section between the MOD sidings and OX40a.

Since the overall noise from the train at the Wendlebury Gate Stables is made up of noise from the locomotive and approximately 30 wagons all of which are screened to differing extents as the train passes WGS, modelling has been carried out to establish the combined noise from the locomotive and wagons. These predictions have then been used to plot a time history of the noise from the train as it passes the Stables. These predictions have been repeated to illustrate the effect of the proposed noise barrier compared to the unmitigated situation. Predictions from passenger trains would give rise to a less critical situation over a shorter period of time.

Maximum train noise levels have been predicted using the Nordic Method. Details are presented in *Annex D*.

4 *EXISTING BASELINE NOISE*

4.1 *SUMMARY OF MEASURED DATA*

4.1.1 *Introduction*

The Policy includes standards that take into account the change in existing noise levels, consequently an understanding of the baseline noise environment is required to assess the need for noise mitigation. The sources of baseline noise data that have been used in this *Scheme of Assessment* are described in this section.

The baseline noise levels assumed in this *Scheme of Assessment* are summarised at the end of this section. The detailed baseline noise measurement results are included in *Annex E*.

4.1.2 *Environmental Statement Baseline Monitoring*

Representative NSR locations in the *Route Section* covered by this *Scheme of Assessment* were identified in the ES (volume 2, chapter 6) as follows:

- ES 6 Alchester House, Langford Lane.

In addition, one NSR, identified subsequently during the public inquiry (representing a third party with a specific interest in noise levels), falls within this *Route Section*; PI 2 Elm Tree Farm, Wendlebury.

Baseline noise levels have been measured and reported in the ES, at 23 Noise Monitoring Locations (NMLs) along the Order Scheme route, in order to assess the existing noise environment. Noise surveys were carried out between June 2nd and September 11th, 2009. Monitoring locations were chosen to identify the existing noise climate in areas likely to be most affected by the Order Scheme.

Figures 6.1a to *6.1q* of the ES show the NMLs. The following NML lies within this *Route Section*:

- NML(ES) 4 (Langford Lane Crossing).

This monitoring location and the NSRs at which noise has been assessed are identified in *Figure 5.1*.

4.1.3 *Subsequent Baseline Monitoring for the Public Inquiry*

Since publication of the ES, additional long-term, unattended monitoring has been carried out at several locations along the route. These surveys have been used to increase the baseline coverage in some areas, notably in Islip and in the Wolvercote area of north Oxford, where the topography and road locations may result in significant differences in existing noise levels. In other areas along the Order Scheme route, monitoring has been carried out in order to increase the level of detail. The results were reported in the Proof of Evidence of Michael Fraser at the public inquiry (1).

The additional noise monitoring was carried out in June and August 2010, at the following locations:

- Whimbrel Close, Bicester;
- Mill Street, Islip;
- Lakeside, Oxford;
- Blenheim Drive, Oxford; and
- Stone Meadow, Oxford.

None of these measurement locations lie within this *Route Section*.

4.2 *BASELINE NOISE LEVELS ADOPTED FOR THE ASSESSMENT*

4.2.1 *Non-Statutory Provisions*

Ambient noise levels were found to vary from time to time, and in general the lowest ambient L_{Aeq} levels have been used to ensure a worst case assessment. The adopted baseline noise levels at NSRs are summarised in *Table 4.1*. This table identifies the NMLs at which noise measurements were taken, and the predicted train noise that has been added.

Table 4.1 Baseline Noise Levels Assumed for Scheme of Assessment – $L_{Aeq, period}$ (Free-field)

Receptor	Noise Level without Trains, dB		NML Used	Noise Level with Baseline Trains, dB	
	$L_{Aeq, day}$	$L_{Aeq, night}$		$L_{Aeq, day}$	$L_{Aeq, night}$
ES 6 Alchester House, Langford Lane	40	44	*NML(ES) 4*	49	48
PI 2 Elm Tree Farm, Wendlebury	40	44	*NML(ES) 4*	40 (1)	44 (1)

1) This receptor is situated over 500 m from the existing railway and train noise is predicted not to significantly influence the baseline noise level.

(1) Proof of Evidence of Michael Fraser (Noise and Vibration) CRCL/P/9/B).

4.2.2 *Statutory Provisions*

An initial assessment of eligibility for noise insulation under the NIR has been carried out. This assessment uses the time periods specified in the Regulations. The day-time period is defined as the period of 18 hours between 06.00 and midnight, while the night-time period means the six hours between midnight and 06.00.

The Regulations give a specific term for existing noise i.e. 'prevailing noise level', which is defined as the level of noise caused by the movement of trains on railways immediately before the start of construction. One of the steps in determining eligibility under the Regulations is to determine that noise from the Order Scheme exceeds the prevailing noise level by at least 1 dB(A).

The prevailing noise level has been predicted for NSRs in this *Route Section*, based on existing service levels as set out in *Annex D*. The results are presented in *Table 4.2*.

Table 4.2 Predicted Prevailing Noise Level (Free-field)

Receptor	**Predicted Prevailing Noise Level (Free-field), dB(A)**	
	$L_{Aeq,day}$	$L_{Aeq,night}$
ES 6 Alchester House, Langford Lane	48	47
PI 2 Elm Tree Farm, Wendlebury	28	25

5 RESULTS OF THE EVALUATION OF NOISE FROM THE OPERATION OF THE ORDER SCHEME AND THE NOISE MITIGATION REQUIRED

5.1 INTRODUCTION

Planning condition 19(11) requires that:

The submitted schemes of assessment shall include a list of properties assessed and the results of the assessment at each.

In accordance with the condition, this section contains the list of properties that have been assessed and the results of the assessment at each location.

The results are reported in *Table 5.1* and *Table 5.3* and more detailed results are shown in *Annex D*.

Planning Condition 19(3) requires that:

The schemes of assessment of the predicted noise impacts of Phase 1 and 2A and of Phase 2B on the Individual Section or Sections that abut Wendlebury Gate Stables shall also identify measures that should be taken to ensure, insofar as reasonably practicable, that the noise caused by individual passing trains, using the railway, does not significantly impede voice communication over a distance of 30 metres within either the "large riding school" or the "small riding school" at those Stables, or within the paddock opposite Bramlow. For direct voice communications (i.e. without electro- acoustic assistance), the term "not significantly impede" shall be taken to mean that the speech intelligibility shall be at least "fair" at an increased (i.e. "loud") vocal effort as defined in BS EN ISO 9921:2003 Ergonomics Assessment of Speech Communications. The assessment method used shall be the Speech Interference Level as described in Annex E to that Standard. The assessment shall be based on a native female speaker facing the rider under instruction and the standard to be achieved will be for alert situations where short known words are used and the wind speed is less than 5 metres per second. A correction factor of -5dB shall be used to convert the standard for male voices to female voices. If personal communications or sound reinforcement systems are proposed, the assessment methodology shall be subject to the approval of the independent expert appointed in accordance with Condition 19.9. This part of the condition shall not apply if, at the time of assessment, the Stables are no longer a licensed riding establishment under the Riding Establishments Act 1964.

In accordance with the condition, this section presents the mitigation that will be offered and the predicted effect of the mitigation. The results are reported in *Table 5.1* and *Table 5.4* and more detailed results are shown in *Annex D*.

5.2 *PRACTICABILITY AND SELECTION OF NOISE MITIGATION*

5.2.1 *Noise Control using Track and Wheel Based Measures to Reduce Noise at Source*

Track designs with an acoustic plenum (1) under the track and a low upstand, which have been used on light rail and tram schemes, were considered, but advice from the scheme engineers suggested that these were not appropriate for a high-speed or heavy haul railway.

Reductions in noise can be achieved by mitigating noise from vehicles at source and wheel dampers have been considered for this purpose. A test was carried out to consider the potential benefits of this noise control measure, the details of which are provided in *Annex D*. The results showed that under optimum conditions (for wheel dampers to be most effective), a reduction of less than 1 dB could be expected in the night time period (the time period critical to the assessment of impacts). Although Chiltern Railways could adopt such measures on their trains, neither they nor Network Rail could insist that other train operators using the line adopt such measures. On this basis, wheel dampers have been excluded as a practicable mitigation measure.

Track discontinuities on switches and crossings can result in elevated noise levels at nearby receptors. To minimise these, the design team has looked into the use of low noise designs such as 'lift over' crossings. However, the team's experience and research into such systems has shown that while these exist for light rail, they are not available for use on heavy rail schemes.

Rail dampers have been applied to railways in other countries, but they are not 'type approved' for use on the UK railway network on the relatively high speed sections of track which are required for this project. Tata Steel has provided details of the only application in the UK of its Silent Track product, which is in a central London environment. Technical details of the performance of this product are provided in *Annex D*. Type approval requires substantial technical appraisal by Network Rail and there is no guarantee that such approval would be granted for application on this Scheme in time for it to be used. On this basis, the use of rail dampers will not be pursued as a practicable mitigation measure on this and other *Route Sections.*

5.2.2 *Noise Barriers*

After considering noise control measures at source, the use of noise barriers to reduce significant noise impacts, as far as reasonably practicable, has been determined for locations where noise mitigation is required. Network Rail advises that there are constraints on the height to which barriers can be built and maintained, in a rail environment, which are summarised in *Box 5.1*. Noise barriers will be installed as close to the nearest running rail as is permitted by Network Rail, normally at a distance of 2.6 metres. Where

(1) An airspace which works as an acoustic silencer.

barriers are proposed, they will normally be built to a height of 2.5 m, relative to rail height. Where lower heights have to be provided, this is set out in *Table* 5.1.

Box 5.1 Constraints on the Practicability of Noise Barriers

Health and Safety

Under the Construction, Design and Management Regulation (2007) and the European Common Safety Method, the risks associated with the construction and maintenance of infrastructure must be reduced as far as reasonably practicable. These risks will increase with barrier height. Some specific examples are provided below:

- Barriers which are more than 3 m tall cannot practically be maintained from ground level, and instead, access platforms are required. These carry with them increased risks, including health and safety risks from working at height.
- Maintenance using access platforms can only be performed when trains are not running, ie, at night.
- Smaller fences pose less of a risk of obstructing the railway should extreme weather cause them to fail.

Difficulty

- In some locations, particularly on the public/non-railway side of the barrier, steep embankments can make it difficult or impossible to use access platforms.
- It is expected that the route will be electrified in the future. Once this happens, there will be a risk of people and equipment straying into the electrical cable exclusion zone for taller barriers and power to the overhead electrical cables will need to be isolated.
- Taller barriers require proportionately much larger foundations, to resist increased wind loading which results from the larger surface area. Where these foundations occur on top of embankments, there is a risk that the embankments may be destabilised.
- Large foundations may coincide with underground services and culverts. In avoiding these, it may be necessary to use non-standard barrier panel lengths which have associated higher costs and reduced flexibility.

Cost

The total installation cost, assuming good ground conditions and flat ground, rises in an approximately linear fashion with barrier height. Within this, the mobilisation costs (which remain the same for any height of barrier), mask the effect of the foundation costs (which rise far more rapidly with barrier height) on this total. In practice, the foundation costs are likely to have a greater effect on the overall cost where ground conditions are poor such as at the top of most railway embankments (which are generally built of ash and other waste).

Additional potential constraints on barrier height, including their landscape and visual impact, have also been taken into consideration. This process is summarised in *Table 5.1*.

Table 5.1 Design Considerations for Noise Mitigation

Area	Purpose of Noise Mitigation	Up / Down Line (1)	Start Chainage (2) (m)	End Chainage (2) (m)	Noise Barrier	
					Input from Design Team on Practicability	Further Potential Constraints on Proposed Barrier
Langford Lane Crossing	To protect Alchester House, Langford Lane	Up	see below barrier also screens Alchester House	see below barrier also screens Alchester House	The maximum practicable height for a barrier is 2.5m (above rail height) (3). Detailed input from the design team is presented in *Box 5.1*. Barrier heights in this report are quoted relative to rail height. As a result, if the barrier is located on higher ground than the rail, then the actual height of the barrier will be lower than the quoted height. Conversely, if the barrier is located on lower ground than the rail, then the actual height of the barrier will be higher than the quoted height.	
Wendlebury Gate Stables	To provide a 'fair' level of speech intelligibility within the riding school (as set out in planning condition 19(3)) as far as practicable	Up	112340 112570	112545 113020		In this route section there are existing trees alongside the railway. Therefore, a 2.5 m barrier is not expected to result in any significant visual or overshadowing effects.

1) The Order Scheme (*Phase 1*, *2A* and *2B*) includes double track throughout *Route Sections A* to *H*. The tracks are identified as an 'Up' line (which carries trains running from Bicester to Oxford) and a 'Down' line (which carries trains running from Oxford to Bicester). As trains drive on the left, the Up line lies to the southeast of the Down line.
2) Project chainage for the Bletchley Line.
3) Height relative to rail height, at a plan distance of 2.6m from the nearest rail.

5.2.3 Noise Control at Receiver

Eligibility for further mitigation in the form of noise insulation has been established in The Policy (sections 2.5, 2.6 and 2.7 which are reproduced in *Section 2* of this *Scheme of Assessment*). Residential buildings will be considered for noise insulation where, even with other mitigation, the external noise levels result in a noise impact that meets the criteria in The Policy.

Following local authority approval of this *Scheme of Assessment* and the mitigation outlined, a detailed schedule of properties eligible for noise insulation will be compiled. This will be verified by contact with individual property owners and a building survey. *Table 5.3* presents the noise mitigation which is to be offered (including noise insulation).

5.3 RESULTS OF THE NOISE MODELLING FOLLOWING APPLICATION OF THE SPECIFIED NOISE MITIGATION

Noise mitigation, as detailed above in *Table 5.1* has been included in the noise modelling and residual impacts from the Order Scheme have been predicted at the NSRs identified in *Section 4*.

The location of the proposed noise mitigation measures are presented in *Figure 5.1*. Railway chainage numbers (provided by Network Rail) are provided in *Table 5.1*. The results of the noise modelling are presented in *Table 5.3.*

The results of the speech communications assessment are shown in *Table 5.4*. These include the *Speech Level*, which reflects a typical noise level that can be generated by a speaker (in this case a female riding instructor) at a distance of 30 m under specific circumstances. This is compared with the predicted noise level from the train to determine the *Speech Communication Intelligibility Rating*. The assessment procedure requires a modified version of the train noise level to be calculated, called the *Speech Interference Level*. The assessment methodology is explained in detail in *Annex D*.

The results show that even with a barrier the standard at the specified points in Wendlebury Gate Stables and the nearby paddock does not achieve the target rating of “fair” that is specified in planning condition 19(3). The barrier height is set at the practical maximum which has been confirmed by Network Rail (described in *Table 5.1*). This outcome is reached even specifying the longest barrier which is reasonably practicable. Extending the length of barrier further would not result in further significant reductions and the standard would remain “bad” at the specified points at least during the noisiest parts of the train pass-by.

Throughout the planning process, the other reasonably practicable mitigation measures have been discussed but discounted. These are summarised in *Table* 5.2.

Table 5.2 ***Mitigation Measures Related to Planning Condition 19(3) Identified But Discounted***

Mitigation Measure	**Reasons for Discounting Measure**
Radio communication headsets	Ensuring maintenance and a safe management process for their use would not be under the control of NR.
Noise barrier close to the riding school boundary	Owner's concerns that such a barrier would interfere with overview of much of the area with implication for safety and good management. Visual impacts. Barrier outside the railway corridor would be difficult for NR to maintain. Potential issues related to siting a substantial barrier on a river bank (potential for interference with flood flows).
Erecting suitably soundproofed buildings to cover the existing training areas so as to provide indoor training areas	Cost Owner's safety concerns when riding or handling horses between the riding school and paddock land adjoining the railway. Owner's concerns that such a barrier would interfere with overview of much of the area with implication for safety and good management would also apply to a building.

In accordance with planning condition 19(3), all reasonably practicable measures have been identified and assessed however it has not been possible to find an additional solution that will significantly improve the effect of the Order Scheme at these specified locations. It is considered that the requirements of this planning condition have been met, and that the best practicable mitigation option has been specified.

Figure 5.1 presents a noise contour figure, showing a variety of key noise predictions at a height of 5 m above ground (1^{st} floor level) to represent the worst affected floor for the majority of NSRs. The following noise contours are included:

- Predicted residual (free field) noise level, $L_{Aeq,8h}$ of 45dB(A), for the night time period 23.00 – 07.00. Properties that lie outside the 45 dB(A) contour are not expected to experience a significant noise impact as a result of the Order Scheme.

- A residual impact of 10 dB for the night time period 23.00 – 07.00. Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.

- A maximum (free field) noise level $L_{Amax,s}$ of 82 dB(A). Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.

- Predicted relevant noise level (as defined in the NIR), $L_{Aeq,6h}$ of 63 dB(A), for the night time period 00.00 – 06.00. Properties within this contour may qualify for statutory noise insulation.

Use of the barriers proposed and additional noise insulation as outlined above will enable the noise from the Order Scheme to be mitigated in accordance with the principles of The Policy.

5.4 INSTALLATION OF MITIGATION

As set out in paragraph 1.11 of The Policy, noise mitigation measures will be installed prior to the commencement of the passenger rail services.

The approach being adopted allows for all residents to be kept informed at key stages and for those in properties immediately adjoining the railway, where mitigation measures are planned, to be kept informed individually and consulted at appropriate stages.

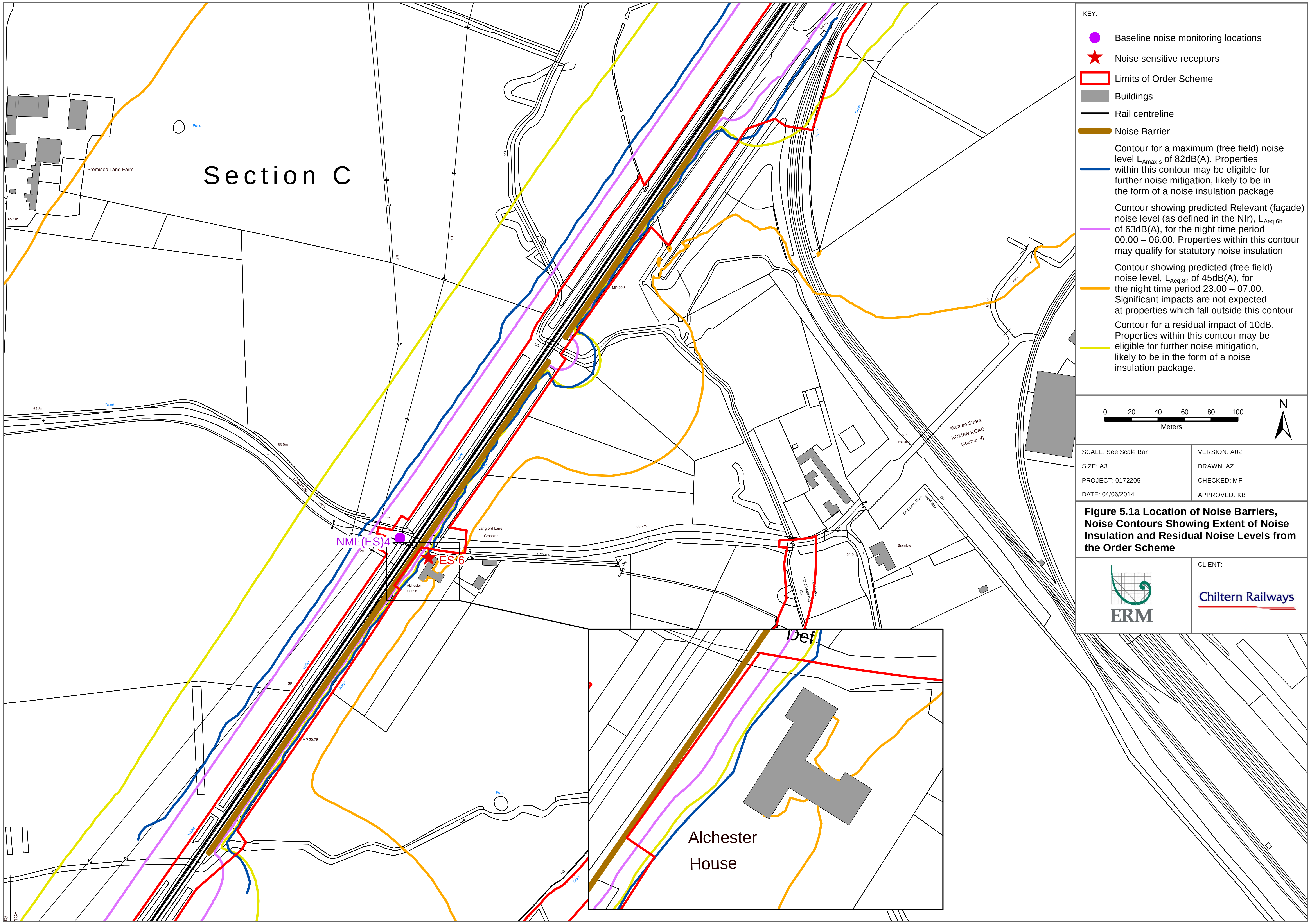
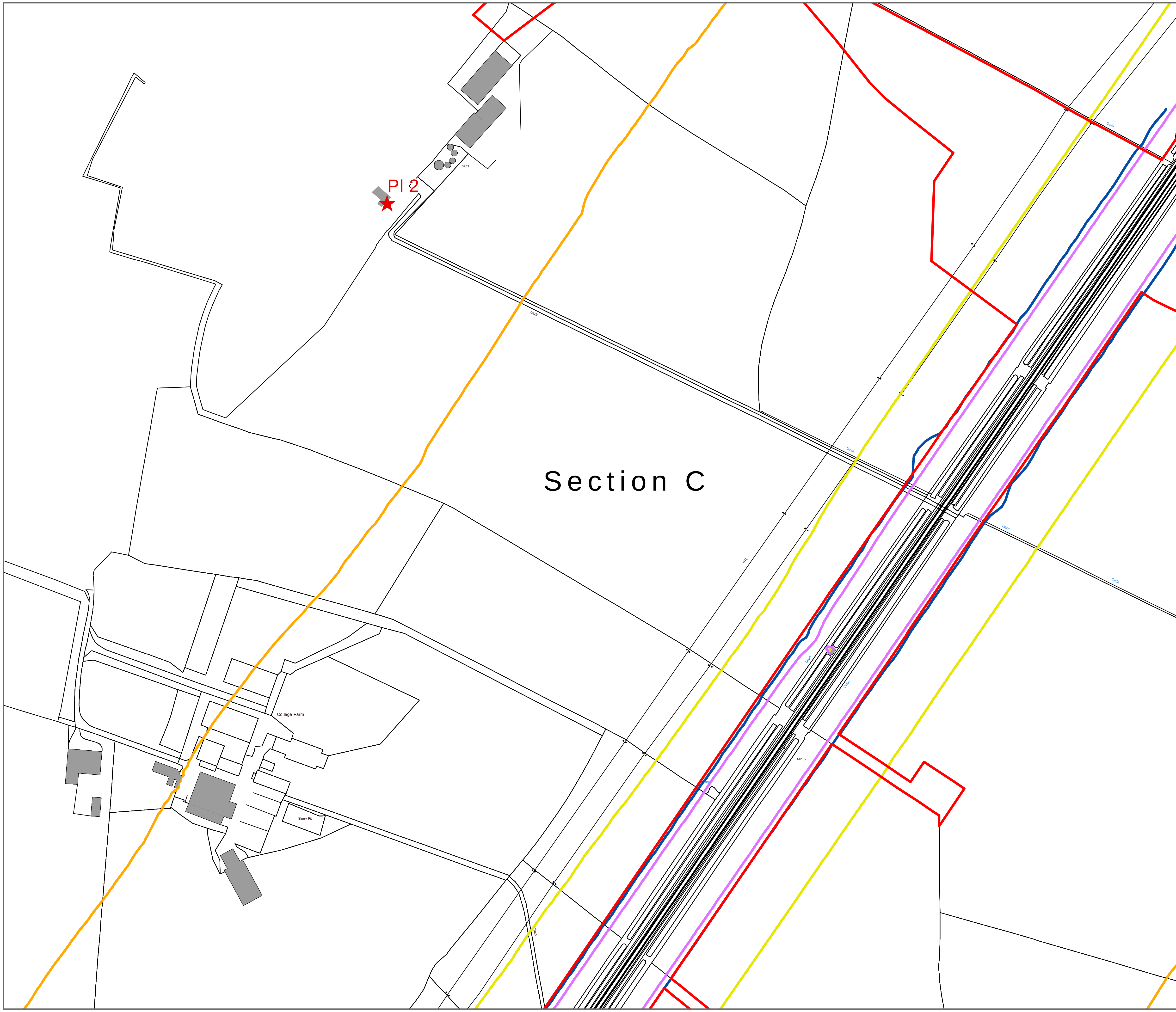


Figure 5.1a Location of Noise Barriers, Noise Contours Showing Extent of Noise Insulation and Residual Noise Levels from the Order Scheme

Path: T:\Projects\0172205ChilternGIS_AZ_SG\MAPS\NOISE\SectionC\Figure 5_1a - Section C Noise Contours - A01.mxd



KEY:

- Baseline noise monitoring locations
- Noise sensitive receptors
- Limits of Order Scheme
- Buildings
- Rail centreline
- Noise Barrier
- Contour for a maximum (free field) noise level $L_{Amax,s}$ of 82dB(A). Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package
- Contour showing predicted Relevant (façade) noise level (as defined in the NIr), $L_{Aeq,6h}$ of 63dB(A), for the night time period 00.00 – 06.00. Properties within this contour may qualify for statutory noise insulation
- Contour showing predicted (free field) noise level, $L_{Aeq,8h}$ of 45dB(A), for the night time period 23.00 – 07.00. Significant impacts are not expected at properties which fall outside this contour
- Contour for a residual impact of 10dB. Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.

0 30 60 90 120
Meters

N

SCALE: See Scale Bar	VERSION: A03
SIZE: A3	DRAWN: JL
PROJECT: 0172205	CHECKED: MF
DATE: 04/06/2014	APPROVED: KB

Figure 5.1b Location of Noise Barriers, Noise Contours Showing Extent of Noise Insulation and Residual Noise Levels from the Order Scheme

ERM

CLIENT:

Chiltern Railways

PROJECTION: British National Grid

Path: T:\Projects\0172205ChilternGIS_AZ_SG\MAPS\NOISE\SectionC\Figure 5_1b - Section C Noise Contours - A01.mxd

Table 5.3 Results of the Noise Modelling

Receptor	Relevant Floor[1]	Predicted Unmitigated Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ (2)	Proposed Mitigation	Predicted Residual Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ (2)	Noise Insulation (statutory (3) or non-statutory (4))
		Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)			Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)		
ES 6 Alchester House, Langford Lane	1st floor	11	16	89	2.5m barrier (5)	0	3	74	No
PI 2 Elm Tree Farm, Wendlebury	1st floor	0	0	59	none	0	0	59	No

1) Worst affected floor level.
2) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: *If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance*. Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.
3) An estimation of the properties that may be eligible for statutory noise insulation under the NIR is presented. The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties.
4) Eligibility for non-statutory noise insulation is presented for the receptors identified in this report. The Promoter will confirm the extent of the mitigation required following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties. Further properties may be eligible in locations close to switches and crossings as the maximum noise level prediction methodology does not take account of this type of track form. Noise measurements will be carried out once the Order Scheme becomes operational to identify whether additional properties qualify. This is described further in *Section D3* of *Annex D*.
5) Barrier height relative to rail height.

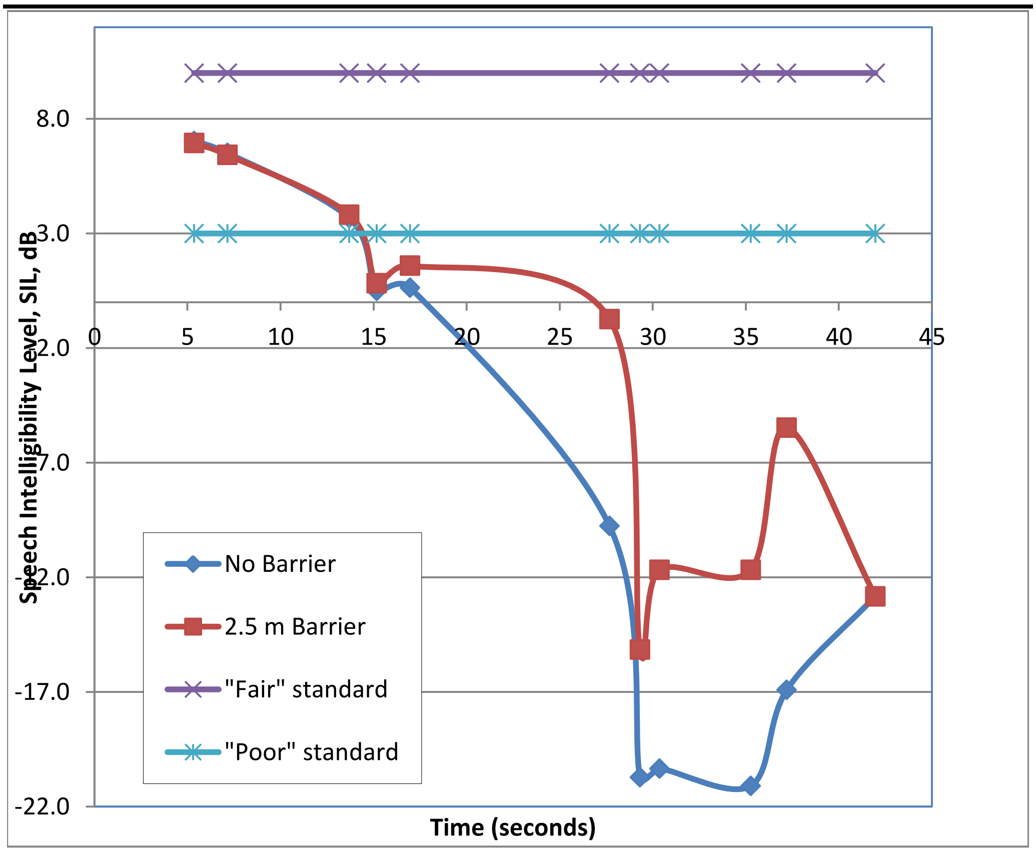
Table 5.4 *Predicted Speech Intelligibility at Wendlebury Gate Stables Riding School*

	Predicted Speech Level, dB	Predicted Maximum Train Noise Level, dB L_{Amax}	Calculated Speech Interference Level (1) (L_{SIL}), dB	Speech Intelligibility Level (2), SIL, dB	Speech-Communication Intelligibility Rating
Unmitigated (No Noise Barrier)	38	74	59	-21	Bad
With Noise Barrier	38	68	53	-15	Bad

1) The speech interference level (L_{SIL}) is calculated from the train noise level. Further details are provided in *Annex D*.
2) The speech intelligibility level (SIL) is given by the difference between the speech level and the speech interference level.

The noise from a freight train passing the Wendlebury Gate Stables has been plotted in *Figure 5.2* in term of SIL values. The vertical axis is the SIL value and the horizontal axis is the elapsed time from the start of the pass-by to the south of the barrier at ch. 113545 m. The SIL values that correspond to "fair" ad "poor" standards are also shown. SIL values less than 3 dB are rated as "bad".

Figure 5.2 *Time History of Train Passing Wendlebury Gate Stables (With Barrier Extending South of OX40a)*



It can be seen that the noise emitted by the train does not achieve the "fair" standard throughout the pass-by. The noise levels with and without a barrier give the same results at the start and end of the time history, at which points the train is unscreened by the barrier. The effect of the gap in the barrier at the bridge at OX40 can be seen as the noise level increases (and the SIL gets worse) as the locomotive passes the gap at 30 seconds. However, most of the pass-by time the barrier improves the speech intelligibility by reducing train noise. During the noisiest part of the pass-by by reductions of between 6 and 11 dB are predicted (between 29 and 37 seconds), and therefore the barrier represents a positive and practicable attempt to reduce the time during which speech interference would occur in accordance with the requirements of the planning conditions.

As discussed in *Section 3*, although the results of this assessment have only been presented numerically for the NSRs identified in the ES and additional receptors representing third parties who had a specific interest in noise levels during the public inquiry, all NSRs have been considered when determining noise mitigation.

Mitigation measures are presented in *Table 5.1* and *Figure* 5.1 to protect all NSRs in accordance with The Policy.

6 NOISE MONITORING AFTER CONSTRUCTION

Planning condition 19(1) requires that:

Operational noise and vibration monitoring and mitigation shall be carried out in accordance with the Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1, referred to in this condition as "the Policy") and this condition.

Condition 19(6) requires further that:

Any monitoring of noise and vibration shall be undertaken in accordance with the approved scheme of assessment and the Policy.

The noise monitoring scheme will follow the requirements of The Policy as follows:

[2.1] *A noise and vibration monitoring scheme for the Phase 1 and 2A works will be implemented to ensure that the performance of the mitigation measures that are installed achieve the levels of noise mitigation predicted by the design contractor, whose design instructions will include the requirement to achieve the residual noise levels set out in the Environmental Statement. The monitoring scheme will include the carrying out of surveys, the first being undertaken at around 6 months after the opening of the railway for Chiltern Railways passenger services, at locations agreed with the local planning authorities. A second survey will be undertaken 18 months after opening. If defects in construction or performance are identified in the first survey, these will be corrected in a timely manner by the contractor. If any defects in construction or performance are found in the second survey these will also be corrected in a timely manner by the contractor. The same procedure for post construction monitoring surveys and the remedy of defects or performance will be undertaken after the Phase 2B works have been completed and EWR services introduced.*

[2.2] *The results of the Phase 1 and 2A monitoring will be published in an easily accessible format on the Chiltern Railways website and in the project newsletter and will be made available, either in hard copy of in electronic format, to any person requesting the information. Arrangements for publishing the surveys after Phase 2B will be agreed with the local planning authorities.*

Because the Order Scheme is now being implemented as a single construction project only one noise monitoring programme is required. This will consist of two monitoring rounds at approximately 6 months and 18 months after the opening of the railway for railway services. The monitoring will consist of noise measurements carried out at the key receptors (for example those in the ES). Measurement locations will be agreed with the local planning authorities. The measurements will consist of measurements of sound exposure level and L_{Amax} at the most exposed floor of the NSRs. The individual measurements will be used to calculate the appropriate period L_{Aeq} values that represent the train service outlined in The Policy and the ES (i.e. the full frequency of service).

As it is the performance of the mitigation measures that is required to be understood, measurements will also be made at an open location, where no mitigation is required, for a representative sample of trains. This will ensure that the unmitigated train noise levels are consistent with the assumptions made in the modelling. If, for some reason these are different to those that were assumed, the measured mitigated levels will be adjusted to take this difference into account so that the real effect of the mitigation can be established.

Annex A

Noise and Vibration Mitigation Policy

CD/1.29/2.1

NOISE AND VIBRATION MITIGATION POLICY

THE CHILTERN RAILWAYS (BICESTER TO OXFORD IMPROVEMENTS) ORDER

TRANSPORT AND WORKS ACT 1992

ERM

Chiltern Railways

JANUARY 2011

SUMMARY OF THE NOISE AND VIBRATION POLICY

The Noise and Vibration Policy has been adopted by Chiltern Railways to ensure that mitigation of noise and vibration from trains using the railway authorised by the Chiltern Railways (Bicester to Oxford Improvements) Order is provided on a fair basis for all occupiers and landowners along the route between Bicester and Oxford.

The Policy has been based on extensive research and modelling and offers a high standard of mitigation, comparable with other similar railway schemes in Britain.

The Policy will ensure that the following are achieved:

(i) Noise will be reduced at source where it is reasonably practicable to do so.

(ii) Where this is not reasonably practicable, noise barriers or noise insulation to properties will be provided, where necessary, in accordance with relevant standards.

(iii) Where predicted noise levels exceed relevant levels set out in the Noise Insulation (Railways and Other Guided Systems) Regulations, noise insulation will be offered to the occupiers of eligible buildings to the standards required by those Regulations and provided at their request.

(iv) At other locations, where statutory noise levels are not exceeded but where significant noise impacts are predicted, noise will be mitigated wherever reasonably practicable. Significant noise impacts include a significant increase in noise in an already noisy area, or the significant exceedance of stringent thresholds in an area where the ambient noise is currently low. Chiltern Railways has chosen to offer this high standard of mitigation. It is not a statutory requirement.

(v) Vibration from trains will not cause damage to structures, and even without mitigation, will be likely only to give rise to 'adverse comments from occupiers being possible' at a few properties that are located very close to the railway. At these locations, appropriate mitigation measures will be provided.

These commitments and the ways in which the Policy will be implemented are set out in the remainder of this Policy.

The Policy, which has been agreed with Network Rail, applies to any works authorised by the Transport and Works Act Order.

1. HOW WILL THE POLICY BE APPLIED?

INTRODUCTION

1.1. Chiltern Railway has applied for the Chiltern Railways (Bicester to Oxford Improvements) Order. The Order, if made, would allow for the railway works to be carried out in phases. Phase 1 consists of those works required to allow the operation of Chiltern Railways' proposed London Marylebone to Oxford passenger services together with the freight services that currently operate on the Bletchley to Oxford line between Bicester and Oxford. Phase 2A, which is the lowering of the trackbed of the Wolvercot Tunnel , will be undertaken at the same time as the Phase 1 works.

1.2. The Phase 1 and 2A works will be carried out as soon as the Order is approved, so that their passenger services can start no later than May 2013. Further works, in Phase 2B, will take place at a later date and be undertaken either by the East West Rail (EWR) consortium or others on behalf of Network Rail (NR). The Phase 2B works are mainly those to provide double track between the MoD depot at Bicester and Islip and through the Wolvercot Tunnel.

1.3. The Noise and Vibration Mitigation Policy has been prepared by Chiltern Railways and agreed by Network Rail. It will be applied, in the first instance, by Chiltern Railways when designing in detail, building and operating the works in Phase 1 and 2A. EWR, or others on behalf of NR, when they undertake the Phase 2B works, will also apply this policy. Hereafter, in this policy, the organisation which builds the relevant works is called the 'Promoter'.

1.4. The purpose of this policy is to set out the Promoter's commitments to mitigating noise and vibration effects arising from operation of the railway. These are based on the commitments made in the Environmental Statement [(1)].

1.5. The mitigation of noise and vibration effects during construction will be the responsibility of the Contractor, who will have to work within and abide by an approved Code of Construction Practice.

1.6. Chiltern Railways' consultants, Environmental Resources Management, have carried out an assessment of the likely effects of noise and vibration which is reported in the Environmental Statement [(2)] . This has been undertaken by:

- identifying representative noise sensitive receptors (primarily residential properties) along the entire railway route;
- measuring current actual noise levels at these locations;

(1) Chiltern Railways (Bicester to Oxford Improvements) Order, Environmental Statement, ERM, 2009
(2) See chapter six (of volume 2) of the Environmental Statement which accompanies the Transport and Works Act Order Application.

- predicting likely future noise levels, based on noise measurements relating to the actual types of passenger and freight trains that will be used on the railway;
- comparing these predicted levels against noise impact assessment criteria and outlining, where necessary, appropriate mitigation measures.

1.7. The detailed design of the Phase 1 and 2A works will be developed by Chiltern Railways' appointed contractor. This will involve refinement of the mitigation following the principles set out in this policy. This will ensure that the residual noise effects at any location are no worse than those reported in the Environmental Statement.

1.8. The assessment of noise and vibration has been based on two operational patterns of new train services:

- After the implementation of the works in Phases 1 and 2A, operational services will consist of up to two Chiltern Railways passenger trains per hour each way. The passenger trains will replace the existing passenger service operated by First Great Western between Bicester Town and Oxford stations.
- After the implementation of the East West Rail (EWR) link including works in Phase 2B, there are likely to be an additional two passenger trains per hour each way.

Neither Chiltern Railways or EWR will be running passenger trains throughout the night, and services in late evening and early morning will be at a reduced frequency. A small number of passenger trains may arrive in Oxford after midnight or depart from Oxford before 0600.

1.9. In the operation of Phase 1 and 2A, there are likely to be no more freight trains than operate at present, as there will be no new freight destinations that can be served. When the East-West Rail (EWR) link is in operation, there may be more freight trains. For this reason, additional freight services were included in the noise assessment in the Environmental Statement, so that this reflects a reasonable planning scenario. The actual number of freight services will reflect national freight demand, but will be limited to the maximum number of available freight 'paths' (1 per hour in each direction). Experience shows that about half of the available freight train paths are likely to be used on a given day, which would suggest a reasonable planning scenario of 8 freight train movements between 11pm and 7am. Freight trains will not use the 'new' railway line between Oxford North Junction (where the Bicester to Oxford Line meets the Oxford-Banbury main line) and Oxford, but instead will use the existing main line, as at present.

1.10. The noise and vibration mitigation will be designed based on the assumptions in paragraph 1.8 and 1.9 regarding the numbers and timing of train movements.

INSTALLATION OF NOISE MITIGATION MEASURES

1.11. Noise mitigation measures in accordance with this policy will be installed during the Phase 1 and 2A works, to be completed before the commencement of Chiltern Railways passenger services. Before the Phase 2B works take place, any additional noise mitigation measures made necessary by those works and the services in the reasonable planning scenario for Phase 2B will be designed. The assessment of noise and vibration for Phase 2B will cover all parts of the route, where service frequencies are expected to increase in Phase 2B. The mitigation measures will be installed before the Phase 2B works are brought into use. After each Phase of works, the effectiveness of the noise insulation measures installed will be monitored, as detailed in para 2.11.

2. *HOW IS NOISE ASSESSED TO DETERMINE APPROPRIATE MITIGATION?*

PRINCIPLES

2.1. The Noise and Vibration Policy is intended to ensure that noise and vibration mitigation is provided on a fair basis for all landowners and occupiers affected by the Order Scheme.

2.2. The Promoter is committed to using the Best Practicable Means [(1)] to design the railway so as to avoid significant noise and vibration impacts at existing sensitive receptors (e.g. residential properties, educational buildings and places of worship). The first preference will be to apply necessary noise control measures at source where this is reasonably practicable. These may include rail damping or other infrastructure measures to reduce noise at source. Where this is not reasonably practicable or sufficient to mitigate significant noise impacts, the Promoter will:

- where they are effective and reasonably practicable to install, provide noise barriers to mitigate noise between the track and sensitive receptors; and

- after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, offer noise insulation to properties where residual noise impacts on sensitive receptors remain high.

(1) Best Practicable Means are defined in Section 72 of the Control of Pollution Act 1974 as those measures which are "reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge, financial considerations and compatibility with safety and safe working conditions"

2.3. The Promoter will consult with landowners and occupiers who may be affected by noise and vibration to explain the mitigation measures that are proposed.

The assessment of noise uses technical terms, which are described in Annex A. The provision for noise mitigation will be based on two sets of absolute noise levels (1). The first are 'Noise Impact Threshold' levels, below which noise impacts are never significant. The second set of levels are the 'Noise Insulation Trigger' levels. These are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field (2) noise levels.

Noise Impact Threshold levels:	*Day - $L_{Aeq,\,(0700\text{-}2300\ hours)}$ 55 dB* (3)
	Night – $L_{Aeq,\,(2300\text{-}0700\ hours)}$ 45 dB

2.4. Where train noise is predicted to be above either of these threshold levels, but where the level is still less than that set out in the Noise Insulation Regulations requiring noise insulation to be provided, the Promoter will provide mitigation measures to reduce the adverse impact of noise. These will vary according to the extent to which the train noise level exceeds the threshold levels and the extent to which overall noise is increased above the existing or ambient noise level, as follows:

- exceedances of 3 dB or greater and increases of 3 dB or greater – mitigation at source through rail infrastructure solutions will be implemented where reasonably practicable;

- exceedances of greater than 5 and up to 7 dB and increases of greater than 5 dB and up to 7 dB -- at source and/or in the form of noise barriers if reasonably practicable and have no other negative effects;

- exceedances of greater than 7dB and increases of greater than 7dB – at source through rail infrastructure solutions and where these cannot be reasonably practicably achieved, noise barriers will be provided, where reasonably practicable.

These standards are consistent with those applied in the Environmental Statement, where noise mitigation is considered at source for impacts that are greater than 3 dB and in the form of noise barriers for impacts above a minimum of 5 dB. (Noise impacts in the ES are calculated by considering both the exceedance of the threshold criteria and the increase in overall noise, and taking the lower of the two.) The noise benefits of noise barriers are more likely to outweigh any dis-benefits, where the noise increase is above 7 dB. There are certain locations where because of the topography of the railway

(1) The standards relate to disturbance of building occupants, and do not relate to specific effects such as speech interference.

(2) Free-field means away from reflective surfaces, except the ground.

(3) $L_{Aeq,T}$ is the A-weighted equivalent sound level over the period T. A-weighting is a frequency weighting that replicates the frequency response of the ear. $L_{Aeq,T}$ is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. It is recommended parameter for train noise.

and adjacent properties, safety or visual impact, barriers cannot be installed or will not be effective.

2.5. Noise barriers or other noise attenuating infrastructure solutions will achieve noise reductions in most areas, to near to the existing noise levels. However residual noise impacts may still occur at particular locations. If, after consideration of the effects of noise mitigation measures at source, any of the Noise Insulation Trigger levels is still exceeded, then noise insulation to relevant properties will be offered, provided the corresponding existing or ambient noise level is routinely exceeded by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations. The noise level thresholds at which this will be offered are shown below in terms of free-field noise levels that are equivalent to the façade levels provided for in the Regulations.

Noise Insulation Trigger Levels *Day* $> L_{Aeq,\ (0600\text{-}0000\ hours)}$ *66 dB* [(1)]
Night $> L_{Aeq,\ (0000\text{-}0600\ hours)}$ *61 dB*

2.6. Even with the mitigation in paragraph 2.5, some of the properties close to the railway may still experience residual noise impacts that may be classed as 'high'. A 'high' impact is the equivalent of a noise impact of greater than +10 dB. If these properties are not already to be provided with insulation under the Noise Insulation Regulations, they will be offered additional mitigation, which is likely to be in the form of noise insulation.

2.7. If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field)at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance, except where ambient maximum noise levels are already above the predicted train noise level. One or two events per night would not be interpreted as regular, but the 8 assumed freight movements each night in Phase 2B are considered to be regular. In those very few locations likely to have such noise effects, additional noise attenuation measures will be taken to include the offer of noise insulation to affected properties. This form of mitigation is particularly effective in addressing night-time noise impacts when noise levels inside buildings are the key factor as regards sleep disturbance. The following additional criterion for noise insulation is therefore being applied.

Significant impact, need for further
mitigation likely to be noise insulation: *Night* $> L_{Amax}$ *82 dB* [(2)]

(1) Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations, where it is defined as 0600 hours to midnight. These noise levels are free-field values that are equivalent to the values defined in the Noise Insulation Regulations

(2) L_{Amax} is a measure of the peak noise level, A-weighted.

MITIGATION OF VIBRATION

2.8. The levels of vibration resulting from passenger and freight trains operating on the new railway will be far below the levels that might cause structural damage to buildings. However, the additional trains may give rise to perceptible levels of ground vibration in adjacent occupied properties. Vibration Dose Value (VDV) [(1)] is a measure of the accumulated level of ground vibration over a period, and, through the application of BS6472 [(2)] , is a standard metric for predicting the likelihood of adverse comments from building occupants. The standard gives the following threshold VDV levels at or below which the probability of adverse comment is low:

- Day (0700 – 2300 hours) - 0.4 $m/s^{1.75}$
- Night (2300 – 0700 hours) - 0.2 $m/s^{1.75}$

2.9. By comparison, the measured levels from the types of passenger and freight trains that will be used on the new railway, running on standard ballasted track, suggest that even at 8 m from the track the levels will be 0.14 $m/s^{1.75}$ during the day and 0.12 $m/S^{1.75}$ at night which are very much less than the "adverse comment" thresholds set out above. Trackforms will be designed and installed adjacent to occupied vibration sensitive receptor buildings using Best Practicable Means to keep within the thresholds.

2.10. Where existing vibration levels are already above either of the thresholds set out above, mitigation will be considered where the change in VDV is 50% or more as a result of the Phase 1, 2A and 2B works.

MONITORING AND MAINTENANCE

Monitoring

2.11. A noise and vibration monitoring scheme for the Phase 1 and 2A works will be implemented to ensure that the performance of the mitigation measures that are installed achieve the levels of noise mitigation predicted by the design contractor, whose design instructions will include the requirement to achieve the residual noise levels set out in the Environmental Statement. The monitoring scheme will include the carrying out of surveys, the first being undertaken at around 6 months after the opening of the railway for Chiltern Railways passenger services, at locations agreed with the local planning authorities. A second survey will be undertaken 18 months after opening. If defects in construction or performance are identified in the first survey, these will be corrected in a timely manner by the contractor. If any defects in construction or performance are found in the second survey, these will also be corrected in a timely manner by the contractor. The same procedure for post construction monitoring surveys and the remedy of defects or performance

(1) Vibration Dose Value, VDV, is the vibration metric recommended in BS6472 -1, 2008 for the assessment of annoyance from railway vibration. It is a measure of the overall vibration dose throughout a day or night period. It is highly weighted towards peaks and has the units $m/s^{1.75}$

(2) BS6472: 2008 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) Part 1 Vibration Sources Other than Blasting.

will be undertaken after the Phase 2B works have been completed and EWR services introduced.

2.12. The results of the Phase 1 and 2A monitoring will be published in an easily accessible format on the Chiltern Railways website and in the project newsletter and will be made available, either in hard copy of in electronic format, to any person requesting the information. Arrangements for publishing the surveys after Phase 2B will be agreed with the local planning authorities.

Maintenance

2.13. The railway, and in particular the wheel and rail surfaces, will be maintained so as to minimise noise and vibration at sensitive receivers.

OTHER NOISE MITIGATION

Station Announcements

2.14. Directional public address systems will be used that minimise the impact on nearby properties whilst maintaining audibility on platforms. The station operator will establish appropriate sound levels for station Public Address systems and will seek to address complaints, if they are received from occupiers of noise sensitive premises, as far as is reasonably practicable within railway safety requirements.

Train Stabling and Servicing

2.15. Chiltern Railways trains will not be stabled or serviced in the carriage sidings at the north end of Oxford station. Drivers will be instructed to shut down engines if the train is not to be moved within 5 minutes of arrival at Oxford station, and all Chiltern trains are equipped with automatic systems to shut down the engines if the train has been standing for more than 15 minutes.

Train Horns

2.16. Safety regulations require train drivers to sound the train's horn to warn of their approach in certain situations, for example, at certain level crossings or where there is risk of collision. This is essential, but after the Phase 1 works are completed, all of the present level crossings, except London Road, Bicester will be permanently closed and the situations where horns need to be sounded will be much reduced. There will be audible alarms on the crossing at London Road, Bicester and horns will not be used except in emergency. Although it is an inherent feature of the scheme rather than a specific mitigation measure, the reduction in horn noise will reduce noise impacts from this distinctive noise source, and so it has been noted in this section.

ANNEX A NOISE TERMINOLOGY

WHAT IS 'NOISE'?

A.1 The terms "sound" and "noise" tend to be used interchangeably, but noise can be defined as unwanted sound. Your neighbour may enjoy the sound of his music at 2am but you would be disturbed by the noise.

A.2 Sound is a normal and desirable part of life. However, when noise is imposed on people (such as from industry, construction or transportation) it can lead to disturbance, annoyance and other undesirable effects.

A.3 It is relatively straightforward to physically measure sound with a sound level meter, but it is a different matter to quantify the sound in terms of how noisy it is perceived to be and the effects it may cause.

A.4 For this reason we draw on various standards and guidelines that relate a measured noise level to the effect it is likely to have. These guidelines are generally based on large scale social surveys that have produced accepted, all be it approximate, relationships between noise level and effect.

AN EXPLANATION OF NOISE LEVELS

A.5 Noise is measured and quantified using decibels (dB). This scale is logarithmic, which means that noise levels do not add up or change according to simple linear arithmetic. For example, any two equal noise sources added together give only an increase of 3dB higher than the individual levels (e.g. 60 dB + 60 dB = 63 dB, not 120 dB). This represents what happens in practice when two equal sounds coincide; the ear perceives only a slight increase in noise and not a doubling.

The following table provides examples typical of noise levels.

Examples of Noise Levels on the Decibel Scale

Noise Level dB(A)*	**Typical noise source / example**
0	Threshold of hearing (lowest sound an average person could hear)
30	Quiet bedroom at night
40	Whispered conversation at 2 metres
50	Conversational speech at 1 metre
60	Busy general office
70	Loud radio indoors
70 – 75	Existing trains at Lakeside
80	Lorry at 30 kph at 7 metres
90	Lawnmower at 1 metre

*The dB(A) scale is a particular way of measuring the different frequencies in sound designed to match how the human ear works, called 'A'-weighting.

A.6 The way human hearing works is conveniently similar to the logarithmic changes in noise.

- An increase of 1 dB in noise levels cannot usually be heard (except possibly in 'laboratory' conditions).
- An increase of 3 dB is generally accepted as the smallest change that is noticeable in ordinary conditions.
- An increase of 5dB is clearly perceptible.
- An increase of 10dB seems to be twice as loud.

HOW IS NOISE MEASURED?

A.7 There is a little more to the measurement of noise than pointing a sound level meter and taking a reading. Because noise tends to vary over time, we need to find a way of measuring it in a manner which represents the variation in noise level that also reflects people's perception of how noisy it is. Over the years a number of different ways to measure noise (metrics or parameters) have been developed as the best ways of representing different types of noise sources (single events, industry, road traffic, railway, aircraft etc). Those relevant to the Chiltern Railways are introduced below.

NOISE MEASUREMENT PARAMETERS

A.8 The parameter or metric $\mathbf{L_{Aeq,T}}$ is called the continuous equivalent sound level. It is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. The letter 'A' denotes that 'A'-weighting has been used and 'eq' indicates that an equivalent level has been calculated. Hence, $\mathbf{L_{Aeq}}$ is the A-weighted equivalent continuous sound level, measured over time period 'T'.

A.9 Detailed surveys have been carried out into people's responses to different sources of noise and these have been used to define which noise metrics provide good relationships with perceived noisiness. PPG 24 which deals with the assessment of environmental noise from sources for example, advocates $\mathbf{L_{Aeq\ Period}}$ for all types of transportation noise.

A.10 It is important to appreciate that whilst $\mathbf{L_{Aeq}}$ does give a measure of the accumulated noise over a period of time it is not like a conventional (arithmetic) average. It is in fact a logarithmic average. The effect of this is to give a high weighting to high noise levels even if they are relatively short lived or infrequent peaks.

A.11 The difference between arithmetic and logarithmic ($\mathbf{L_{Aeq}}$) averaging can be illustrated by considering the average age of a class of 30 children and their teacher. Suppose the children are 5 years old and the teacher is 40 years old. The arithmetic average age is just 6, whereas the logarithmic ($\mathbf{L_{eq}}$) average is 16. This partly explains why $\mathbf{L_{eq}}$ has been found to be a good indicator of the effects of noise that comprise a series of varying signals over a period of time, such as railway noise.

A.12 An **L_{Aeq}** level can be calculated over different time periods depending on the characteristics of the noise and how people are exposed to it. If the noise is steady, a relatively short measurement period will be sufficient to characterise it. If it fluctuates randomly or has cyclical elements, then a longer measurement period will be required to obtain a representative sample. Some standards specify a measurement period, but 10 to 15 minutes is often adequate to obtain repeatable results. In terms of train noise for Chiltern Railways, the approach that has been taken is to identify the noise levels from individual trains and to use these to calculate the noise levels over suitable day and night periods.

Annex B

Relevant Planning Conditions

The Planning Condition 19(1) to (14) which relate to operational noise are shown below.

1. Operational noise and vibration monitoring and mitigation shall be carried out in accordance with the Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1, referred to in this condition as "the Policy") and this condition. In the event of any conflict between the two, this condition shall prevail.

2. Development shall not commence within each Individual Section, until a detailed scheme of assessment of predicted noise impacts during operation of Phase 1 and 2A of the railway works, predicted vibration effects of the railway with Phases 1, 2A and 2B and details of proposed monitoring and mitigation measures, has been submitted to and approved in writing by the local planning authority.

3. The schemes of assessment of the predicted noise impacts of Phase 1 and 2A and of Phase 2B on the Individual Section or Sections that abut Wendlebury Gate Stables shall also identify measures that should be taken to ensure, insofar as reasonably practicable, that the noise caused by individual passing trains, using the railway, does not significantly impede voice communication over a distance of 30 metres within either the "large riding school" or the "small riding school" at those Stables, or within the paddock opposite Bramlow. For direct voice communications (i.e. without electro- acoustic assistance), the term "not significantly impede" shall be taken to mean that the speech intelligibility shall be at least "fair" at an increased (i.e. "loud") vocal effort as defined in BS EN ISO 9921:2003 Ergonomics Assessment of Speech Communications. The assessment method used shall be the Speech Interference Level as described in Annex E to that Standard. The assessment shall be based on a native female speaker facing the rider under instruction and the standard to be achieved will be for alert situations where short known words are used and the wind speed is less than 5 metres per second. A correction factor of -5dB shall be used to convert the standard for male voices to female voices. If personal communications or sound reinforcement systems are proposed, the assessment methodology shall be subject to the approval of the independent expert appointed in accordance with Condition 19.9. This part of the condition shall not apply if, at the time of assessment, the Stables are no longer a licensed riding establishment under the Riding Establishments Act 1964.

4. The schemes of assessment of the predicted noise impacts of Phase 1 and 2A and of Phase 2B on the Individual Section or Sections that abut 45 Lakeside shall also identify measures that shall be taken to ensure that the noise caused by passing trains in the Studio at 45, Lakeside does not exceed 35dB $L_{Aeq,\ 30\ min}$ and 55dB $L_{A1,\ 30\ min}$, the standards to be met by music teaching rooms as defined in Building Bulletin 93, Acoustic Design of Schools (Table 1.1).

5. Where vibration mitigation measures required for Phase 2B can be installed cost-effectively during the Phase 1 and 2A works, this shall be done. All mitigation measures, including those prescribed in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996, required for Phase 1 and 2A shall be installed as soon as possible after commencement of the works and no later than the date on which a passenger rail service is resumed on that section of railway.

6. Any monitoring of noise and vibration shall be undertaken in accordance with the approved scheme of assessment and the Policy.

7. Before the commencement of the laying of the second track between the MoD Depot at Bicester and Islip, a detailed scheme of assessment of the predicted noise impacts arising from the works and from the additional services assessed as likely to operate under Phase 2B in the Environmental Statement and details of proposed mitigation measures, which achieve the standards for noise and vibration attenuation set out in the Policy, shall be submitted to and approved in writing by the local planning authority.

8. Any vibration mitigation measures not already installed during the Phase 1 and 2A works necessary for Phase 2B shall be installed during the Phase 2B works. All mitigation measures, including those prescribed in the Noise Insulation Regulations (Railways and Other Guided Transport Systems) 1996, required for Phase 2B shall be undertaken as soon as possible after commencement of the works and completed no later than the date on which the second track is brought into use.

9. The submitted schemes of assessment shall show how the standards of noise mitigation set out in the Policy will be achieved. Supporting calculations, or printouts of inputs and outputs from recognised computer software, shall be provided. Each scheme shall be accompanied by a report, prepared by an independent expert previously approved in writing by the local planning authority, on the robustness of the noise-related elements of the scheme of assessment. Noise mitigation measures shall be permanently installed as approved.

10. The submitted schemes of assessment shall show how the standards of vibration mitigation set out in the Policy will be achieved. Supporting calculations or empirical data, or a combination of the two, shall be provided. Each scheme shall be accompanied by a report, prepared by an independent expert previously approved in writing by the local planning authority, on the robustness of the vibration-related elements of the scheme of assessment. Vibration mitigation measures shall be permanently installed as approved.

11. The submitted schemes of assessment shall include a list of properties assessed and the results of the assessment at each. By the times that the mitigation measures are due to be brought into use, notice shall be served on the local planning authority of the mitigation measures that have been installed for each property assessed.

12. The situation may arise in which Chiltern finds "not reasonably practicable" the provision of mitigation measures that otherwise would be required by the Policy. In such circumstances, the mitigation measure or an equally effective substitute previously approved in writing by the local planning authority shall be installed in the timescale set out in item 1.10 of the Policy, unless the local planning authority has confirmed, in writing, its agreement that the mitigation in question is not reasonably practicable and that there is no suitable substitute.

13. Where noise barriers are promoted in an approved scheme of assessment, they shall be installed only once the local planning authority has given written approval of their size, appearance and location. Noise barriers shall be maintained in *their approved form and may be removed only with the written approval of the local planning authority.*

14. Development shall be in accordance with the approved schemes and this condition.

Annex C

Glossary of Acoustic Terms

C1 GLOSSARY OF ACOUSTIC TERMS

Decibels

Noise levels are measured using the decibel scale. This is not an additive system of units (as for example, metres or kilograms are) but a proportional system (a logarithmic progression). A change of 10 dB corresponds to a perceived doubling in loudness; changes in environmental noise of less than 3 dB are not normally regarded as noticeable.

A-weighting

Environmental noise measurements and levels are usually expressed using a variation of the decibel scale, which gives less weight to low frequencies and very high frequencies. This system was derived to correspond to the reduced sensitivity of the human hearing mechanism to these frequencies.

$L_{Aeq, T}$ -Equivalent Continuous Sound Level

The L_{Aeq} level gives a single figure to describe a sound that varies over a given time period, T. It is the A-weighted steady sound level that would result in the same sound energy at the receiver as occurred in practice with the varying level. It is derived from the logarithmic summation of the sound signal and so unlike a conventional (linear) average it gives additional weighting to higher levels.

***Sound Exposure Level** - SEL*

The noise level at the reception point which if maintained constant over a period of one second would cause the same sound energy to be received as would be received from a given noise event. The standard UK rail prediction methodologies use this as a source term for noise prediction for individual railway vehicles, which can then be combined to predict the $L_{Aeq, T}$ noise levels defined above.

Background Noise Level - L_{A90}

Background noise level is a measure of the low level of noise that occurs between the higher levels from particular events, for example passing vehicles. This may be abbreviated to BNL and the symbol is L_{A90}. It is the value exceeded for 90% of the time period being considered. Note that it is higher than the minimum noise level but may be regarded as the typical noise level during 'quiet periods'.

LA10

Similarly to the L_{A90} described above , L_{A10} is the noise level which is exceeded for 10 per cent of the time.

Maximum Noise Levels

The $L_{Amax,s}$ is the highest value of the sound level over the specified period. It is sometimes referred to as 'peak' noise level. However, the term 'peak' has a special meaning in acoustics and the expression 'maximum' is preferable to avoid confusion. The 's' stands for slow response, which is the metric which has been used throughout this assessment.

Annex D

Noise Prediction Methodology

D1 INTRODUCTION

The main *Scheme of Assessment* document summarises the assessment of the potential noise and vibration impacts from the operation of the Order Scheme. This *Annex* describes in detail the prediction methodologies that have been used and the assumptions regarding the train operations which are relevant to *Route Section C*.

Section D2 describes how the general assumptions that have been used are derived and describes those assumptions that are relevant to the prediction of the L_{Aeq} parameter, which is the default parameter for railway noise. *Section D3* provides more detail on the additional procedures developed to predict maximum (L_{Amax}) noise levels. *Section D4* describes the detailed results from modelling outputs to supplement those provided in the main *Scheme of Assessment*.

D2 GENERAL RAILWAY NOISE MODELLING METHODOLOGY

D2.1 NOISE PREDICTION METHODOLOGY

Noise levels (in terms of the L_{Aeq} parameter) at the nearest noise sensitive receptors (NSRs) from the railway have been predicted according to CRN [(1)] in order to establish the requirements for mitigation.

D2.2 MODEL INPUTS

D2.2.1 Introduction

This section presents the source information and assumptions that have been used to model noise from the Order Scheme at the nearest NSRs. When predicting noise from the railway, the track was divided into segments by the modelling software following the procedures in CRN, the lengths of these track segments were determined by factors such as train speed. Each segment is then treated as a separate line source and the noise contribution from each segment is summed to obtain the total predicted noise level at the receptors. As set out in the main *Scheme of Assessment* document, railway noise from all of the phases of the Order Scheme (*Phase 1*, *2A* and *2B*) have been assessed, which includes double track throughout *Route Sections A* to *H*. The tracks are identified as an 'Up' line (which carries trains running from Bicester to Oxford) and a 'Down' line (which carries trains running from Oxford to Bicester). As trains drive on the left, the Up line lies to the southeast of the Down line.

D2.2.2 Topographical Data

Topographical data provided by the project engineers, Atkins (for the railway corridor) and Bluesky (for the wider area), were used to create the three dimensional ground model used in the noise model. In some cases, the model was refined based on site observations or assumptions.

D2.2.3 Receptor Heights

The receptor height, and particularly the height of noise sensitive windows, is important to accurately predict noise levels where barriers are intended to be used to mitigate noise levels. Heights of the tops of windows have been used to predict the effects of noise from the Order Scheme.

Tools such as Google Street View and observations made from public rights of way have been used to make a reasonable assumption about window heights in this *Route Section*.

(1) Calculation of Railway Noise 1995. The DoT

Where window heights have been estimated by counting the number of brick courses on the building façade, one brick course has been assumed to be 7.5 cm in height. The height of the sensitive receptors in this *Route Section* are shown in *Table D2.1*.

Table D2.1 Receptor Height Characteristics

ES / PI Receptor Number(1)	Calculated Height	Comments
ES 6 Alchester House, Langford Lane	Ground floor 2.3 m 1st floor 4.8 m	Estimated by counting brick courses
PI 2 Elm Tree Farm, Wendbury	1st floor 6 m	- (2)

1) Receptors identified during the Environmental Statement were given receptor numbers, which have been presented here. Additional receptor locations to represent third parties who requested noise level predictions during the public inquiry period have been considered. These receptors have been given the prefix 'PI'.
2) Unmitigated noise predictions show no impacts at this location and so no noise barriers have been included. As a result, window heights are not crucial to the assessment of residual impacts and a conservative value of 6 m has been assumed for the top floor window of this two storey building. Impacts are based on the floor where predicted train noise levels were highest.

D2.2.4 Rail Cant

The cant of a railway track is the difference in elevation between the two rails. This is normally required where the railway is curved, raising the outer edge. CRN specifies that the train noise for most vehicles (except locomotives on full power) should be modelled as a source line that is positioned at the railhead (top of the rail). This reflects the fact that the main source of noise from vehicles operating on the railway is located at the railhead.

Where there is a difference between rail heights the higher of the two has been used, which will reduce the predicted effectiveness of noise barriers and is therefore a cautious assumption.

Within *Route Section C*, there are no areas of significant rail cant.

D2.2.5 Rail Enhancements

Higher noise levels can occur when trains pass over different types of track or structures such as bridges. Properties which lie in close proximity may receive higher levels of noise as a result.

CRN specifies source enhancement corrections which have been applied along the route where necessary; however no such corrections are required within this *Route Section*.

D2.2.6 Stations

No stations are located within *Section C*.

D2.2.7 Existing Trains (Before the Blockade of the Track)

Existing Passenger Train Types

The First Great Western (FGW) passenger service, which existed at the time the ES baseline measurements were taken, consisted of Class 165 DMUs. Since the ES was written other vehicles, such as Class 168 DMUs, have been used by Chiltern Railways. These would result in a similar noise source term (approximately 0.6 dB higher) to a Class 165. A Class 165 DMU has been assumed when predicting baseline train noise which results in a conservative assessment of baseline noise.

Existing Passenger Train Movements

Passenger service levels were based on the *First Great Western Oxford to Bicester timetable for the period 17th May 2009 to 12th December 2009*. This service was then provided by Chiltern Railways before the blockade of the track, having been taken over in May 2011. Timetabled services before the blockade of the track were very similar to those previously operated by First Great Western, and consequently, the same assumptions regarding service level, and the train noise source term in the baseline situation, have been made.

Existing Freight Train Types

Class 66 locomotives are currently used by the vast majority of UK freight operators and have been assumed for this assessment. Before the blockade of the track, freight trains typically comprise 15 wagons, with occasional shorter trains.

Existing Freight Train Movements

Before the blockade, freight train movements were understood to be:

- up to one stone train using the line in each direction each day to Banbury Road;
- one train in each direction most days to the Bicester MoD; and
- one train in each direction, with occasionally two, to the Calvert Waste Terminal.

This is summarised in *Table D2.2* below, the third column is relevant to this *Route Section*.

Table D2.2 Current Freight Train Movements

	Train movements per day from the North Junction to Banbury Road stone sidings	Train movements per day from Banbury Road sidings to MOD sidings	Train movements per day from the MOD sidings to Bicester
Stone Train	2	**0**	0
Trains to Bicester MoD	2	**2**	0
Calvert Waste Terminal	2-4	**2-4**	2-4
Total	6-8	**4-6**	2-4

Route Section C runs from the south of Bicester, adjacent to the MoD, to the M40 motorway, and accordingly, 4-6 freight movements have been assumed for the baseline situation. To present a conservative assessment, two trains each day in each direction (four freight movements), has been adopted.

Just before the blockade was put in place, one freight train ran during the night-time period (early in the morning), taking waste from the Calvert Waste Terminal. All other freight trains ran during the daytime.

Summary of All Modelled Existing Train Movements

The relevant data for this *Route Section*, are contained in the third row of data in *Table D2.3*.

Table D2.3 Modelled Baseline Train Movements along the Route

Area	Number of Existing Chiltern Train Movements		Number of Freight Train Movements	
	Day (07.00 – 23.00)	Night (23.00 – 07.00)	Day (07.00 – 23.00)	Night (23.00 – 07.00)
North of Bicester Town Station	0	0	1	1
Bicester Town Station to the MoD Sidings	20	2	1	1
MoD Sidings to the Banbury Road Sidings	**20**	**2**	**3**	**1**
Banbury Road Sidings to the Oxford North Junction	20	2	5	1
Oxford North Junction to Oxford Station	0(1)	0(1)	0(1)	0(1)

1) Baseline noise surveys along this section of the route include measured train noise and so no modelling has been included.

D2.2.8 Order Scheme Trains

Overview of Order Scheme Passenger Trains

Trains will run from 06.00 through to 01.00. However, there will be a reduced Chiltern Railways service between 21.00 and 01.00 each evening/night. This is described further below. A full service frequency has been assumed for EWR trains from 05.30 to 01.00 as required in The Policy.

Order Scheme Chiltern Railways Passenger Trains

Chiltern Railways will run a service between Oxford and London, via Bicester. The train stock will comprise Class 168 DMUs. These will be run as a train of up to eight cars during peak hours (between 07.00 and 09.00 and between 17.00 and 19.00), and four cars during off-peak hours. This is based on service forecasts for the year 2026.

The noise modelling has been based on a service frequency of two Chiltern Railways trains per hour in each direction for the majority of the day but with a reduction in service to one train per hour in each direction after 22.00, with one train from Oxford to Bicester between 21.00 and 22.00 and no trains from Oxford to Bicester after midnight. There is consequently a total of 61 movements during the day (07.00 – 23.00) and 7 movements during the night (23.00 – 07.00). This service pattern is presented in *Table D2.4*

Order Scheme EWR Passenger Trains

EWR will run a passenger service using this line, from Reading to Bedford and onwards. The choice of engines/rolling stock had not been finalised during the ES and public inquiry, and so a reasonable worst case assumption of Class 172 DMUs has been adopted. Based on a 15 year forecast, these have been modelled as 3 car trains. The service will operate at a frequency of two trains per hour in each direction from 05.30 to 01.00 each day. No information on a reduction in service frequency early in the morning and late at night is available and so the full service frequency has been assumed throughout the service period (05.30 – 01.00). This results in a total of 64 movements during the day (07.00 – 23.00) and 14 movements during the night (23.00 – 07.00), as shown in *Table D2.4*.

Summary of All Order Scheme Passenger Train Movements

The assumed passenger train movements from the Chiltern Railways and EWR services are summarised in *Table D2.4.* As required, the Order Scheme mitigation has been designed to follow the assumptions specified in The Policy.

Table D2.4 Passenger Service with the Order Scheme

Time	Chiltern Passenger Service. Number of Train Movements		EWR Passenger Service. Number of Train Movements	
	Oxford to Bicester	**Bicester to Oxford**	**Oxford to Bicester**	**Bicester to Oxford**
05.00 – 06.00	0	0	1	1
06.00 – 07.00	2	2	2	2
07.00 – 08.00	2	2	2	2
08.00 – 09.00	2	2	2	2
09.00 – 10.00	2	2	2	2
10.00 – 11.00	2	2	2	2
11.00 – 12.00	2	2	2	2
12.00 – 13.00	2	2	2	2
13.00 – 14.00	2	2	2	2
14.00 – 15.00	2	2	2	2
15.00 – 16.00	2	2	2	2
16.00 – 17.00	2	2	2	2
17.00 – 18.00	2	2	2	2
18.00 – 19.00	2	2	2	2
19.00 – 20.00	2	2	2	2
20.00 – 21.00	2	2	2	2
21.00 – 22.00	1	2	2	2
22.00 – 23.00	1	1	2	2
23.00 – 00.00	1	1	2	2
00.00 – 01.00	0	1	2	2
Total	**33**	**35**	**39**	**39**

1) Normally Chiltern Railways passenger trains will comprise 4 cars. During peak hours (between 07.00 – 09.00 and between 17.00 – 19.00), the trains will comprise 8 cars.

Order Scheme Freight Trains

Freight trains will generally be hauled by Class 66 locomotives. As outlined above, these engines are used by the vast majority of the UK freight locomotive fleet, and this is expected to continue for the foreseeable future. Although this could change over time, newer locomotives (eg the new Class 68 locomotives on order for Freightliner, which runs waste trains to the Calvert Waste Terminal), are likely to be quieter. Freight trains currently comprise up to 26 wagons. National planning is moving towards 30-wagon trains, and consequently this length of train has been adopted in this assessment.

Freight trains are expected to travel between the Oxford North Junction and Bicester, as part of the Order Scheme. These trains already run between Oxford and Banbury and so form a part of the baseline between Oxford Station and the Oxford North Junction.

The maximum number of freight paths (time slots where freight trains could run), is one per hour in each direction (ie 32 movements in a 16 hour day and 16 movements in an 8 hour night). However, experience of freight path usage suggests that this would be an unrealistic assumption. A value for the likely frequency of freight trains has been calculated based on the current freight path usage through Oxford, in order to produce a reasonable assumption, as follows:

- During the busiest (16h) daytime period, 53 freight paths exist and 28 freight trains run, producing a utilisation factor of 53%. This utilisation figure has been used to produce a figure of 17 freight trains per day (based on 32 x 0.53 movements, and after rounding up to the nearest whole number).

- During the busiest (8h) night-time period, 32 freight paths exist and 14 trains run, producing a utilisation factor of 44%. This has been rounded up to 50%, which gives a value of eight freight trains per night (based on 16 x 0.5 movements) which has been used in this assessment.

The assumed train movements are summarised in *Table D2.5*.

Freight trains will have a maximum speed of either 97 kph or 121 kph depending on the class of engine. A top speed of 121 kph has been used throughout as a conservative assumption (where line speeds and limits permit). Line speed limits along the route as well as specific speed limits for freight trains will decrease freight train speeds along sections of the route. All train speeds are described in *Section D2.2.9* and *D2.2.10* below.

Summary of All (Passenger and Freight) Order Scheme Train Table D2.5 presents a summary of the number of trains assumed in the noise modelling. These assumptions have been specified in The Policy. As required, the Order Scheme mitigation has been designed to follow the assumptions in The Policy.

Table D2.5 Summary of Modelled Train Movements with the Order Scheme

Area	Number of Chiltern Train Movements		Number of EWR Train Movements		Number of Freight Train Movements	
	Day 07.00 – 23.00	**Night 23.00 – 07.00**	**Day 07.00 – 23.00**	**Night 23.00 – 07.00**	**Day 07.00 – 23.00**	**Night 23.00 – 07.00**
Bicester Chord	61	7	0	0	0	0
North of Gavray Junction	0	0	64	14	17	8
Gavray Junction to the MoD Sidings	61	7	64	14	17	8
MoD Sidings to the Banbury Road Sidings	61	7	64	14	17	8
Banbury Road Sidings to the Oxford North Junction	61	7	64	14	17	8
Oxford North Junction to Oxford Station	61	7	64	14	0 (1)	0 (1)

1) Freight trains that currently use the Banbury-Oxford mainline are expected to divert via the Order Scheme between North of Gavray Junction and Oxford North Junction. At Oxford North Junction they will rejoin the mainline through Oxford as they would have done prior to diversion. Therefore, no additional movements are expected as a result of the Order Scheme in this area.

D2.2.9 Train Speed Limits

Line speeds define the maximum allowed train speeds along various sections of the route. These are effectively speed limits on the railway. For the purpose of defining line speeds, the route has been split into areas. These areas, with their associated line speeds, are presented in

Table D2.6 below. Additional speed restrictions for freight trains in the area of the Oxford North Junction have also been included.

The sections of the route which are relevant to this *Scheme of Assessment* are shown in bold typeface.

Table D2.6 Speed Limits Along the Proposed Alignment[(1)]

Area	Passenger Train Speed Limit Up Line (kph)	Passenger Train Speed Limit Down Line (kph)	Freight Speed Limit Up Line (kph)	Freight Speed Limit Down Line (kph)
North of the Bicester Chord (no Chiltern Railways trains)	**161**	**161**	**121**	**121**
Bicester Chord (only Chiltern Railways trains)	**64**	**64**	**(no freight trains use Chord)**	**(no freight trains use Chord)**
Bicester Chord to Bicester Town Station	**161**	**161**	**121**	**121**
Bicester Town Station to South of Oxford Parkway Station	**161**	**161**	**121**	**121**
Wolvercot Tunnel area	TBC(1)	TBC(1)	TBC(1)	TBC(1)
Oxford North Junction	TBC(1)	TBC(1)	TBC(1)	TBC(1)
Oxford North Junction to close to Oxford Station	TBC(1)	TBC(1)	TBC(1)	TBC(1)
Oxford Station area	TBC(1)	TBC(1)	TBC(1)	TBC(1)

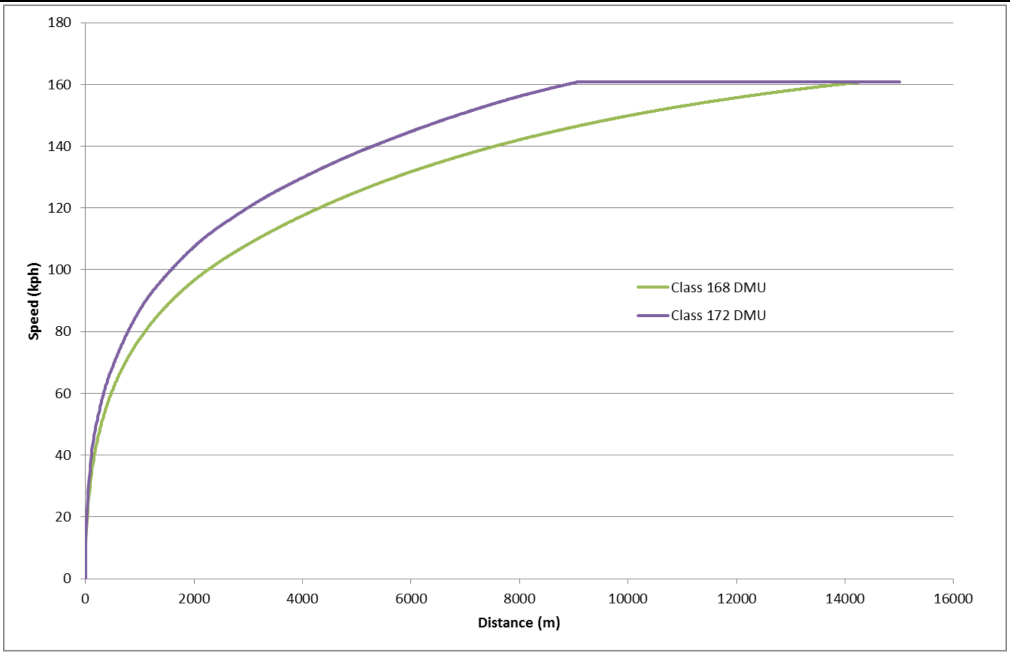
1) TBC = Speeds to be confirmed when relevant Schemes of Assessment are submitted.

D2.2.10 Train Acceleration Profile

This section discusses the actual train speeds that are expected to be achieved by trains using the railway given the speed limits discussed in *Section D2.2.9* and the train acceleration and deceleration profiles. These train speeds have been used in the noise modelling of this *Scheme of Assessment.*

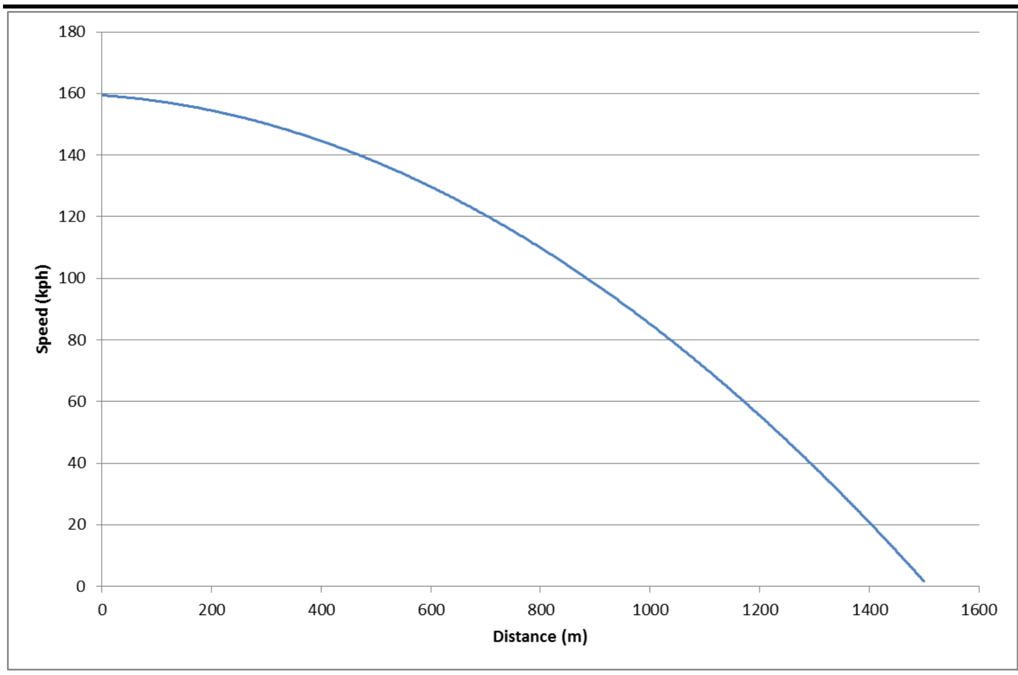
Chiltern Railways train stock will comprise Class 168 DMUs whilst Class 172 DMUs have been adopted as a reasonable worst case assumption for the EWR service. Acceleration data for these trains has been provided, by Chiltern Railways fleet department, for unladen trains on level track. These data are presented in *Figure* 2.1 below.

Figure 2.1 ***Acceleration Profiles for a Class 168 DMU and Class 172 DMU (Unladen Trains on Level Track)***



Deceleration data have been based on the document 'Bicester to Oxford Line Speed Profiles'(1), which presents the results of speed modelling for a Class 168 DMU. These data are presented in *Figure 2.2* below. Data for the Class 172 DMU is not readily available and so it has been necessary to use the data for the Class 168 DMU.

Figure 2.2 ***Deceleration Profile for a Class 168 DMU***



(1) ART-CRCL-2011-2. Bicester to Oxford Line Speed Profiles.Advanced Rail Technologies. D.Potter, D.Wilkinson. V1.0. 07/04/2011

Within *Route Section C*, assumptions regarding train acceleration / deceleration are listed below.

- After leaving Bicester Town Station, Chiltern Railways trains using the Up line (travelling towards Oxford) will accelerate, achieving a speed of approximately 70 kph by the time they reach the boundary between *Route Section B* and *C* and a speed of 120 kph by the time they reach the boundary between *Route Section C* and *D*.

- Chiltern Railways trains using the Down line (accelerating away from Oxford Parkway Station) will cross the boundary between *Route Section D* and *C* at a speed of 146 kph, reaching a maximum speed of 155 kph briefly (adjacent to the MoD), before decelerating on the approach to Bicester Town Station. They will be travelling at a speed of approximately 110 kph as they cross the boundary between *Route Section C* and *B*.

- After leaving Bicester Town Station, EWR trains using the Up line (travelling towards Oxford) will accelerate to the line speed of 161 kph, achieving a speed of approximately 78 kph by the time they reach the boundary between *Route Section B* and *C* and a speed of 132 kph by the time they reach the boundary between *Route Section C* and *D*.

- EWR trains using the Down line (accelerating away from Oxford Parkway Station) will reach the maximum line speed of 161 kph as they cross the boundary from *Route Section D* into *Route Section C*. They will keep their maximum speed for about 2.6 km and will then decelerate as they approach Bicester Town Station, reaching a speed of approximately 110 kph as they cross the boundary between *Route Section C* and *B*.

- Freight trains will not stop at stations and will therefore accelerate and decelerate only in response to changes in the speed limits. Within *Route Section C*, the speed limit is 121 kph and it is assumed that trains will run at this speed in both directions.

D2.2.11 Signal Stopping

Signals are present at a number of locations along the route. Normal operation is that trains will not encounter any signal stops and therefore will not slow down. Assuming no signal stops enables a conservative assessment for passenger trains, which has been adopted here.

Should trains be required to stop at a signal, diesel locomotives may produce significantly higher levels of noise when accelerating away from rest on full power. Because it is expected to occur only infrequently, average noise levels over the assessment period are not expected to be significantly affected.

The Policy requires that maximum noise levels ($L_{Amax,s}$) which regularly exceed 82 dB at night, at NSRs, may trigger a requirement for non-statutory noise insulation to be offered. Since these stopping events are expected to occur infrequently, it is considered unlikely that more than one such event will affect a NSR in any single night time period. A single event occurring at night would not change the requirements for noise mitigation as set out in The Policy, and therefore the effect of diesel locomotives stopping at signals has not been included in the modelling.

D2.2.12 Additional Details Regarding Noise Mitigation Measures

Noise mitigation measures are discussed in the main *Scheme of Assessment* document. This section provides additional details that have been omitted from the *Scheme of Assessment* to improve clarity.

Wheel Dampers

Reductions in noise can be achieved by mitigating noise from vehicles at source and wheel dampers have been considered for this purpose. Whilst the Promoter could apply mitigation to their vehicles, they have no power to require other train operating companies to do so. Therefore, when considering the potential benefit of this noise control measure, it has been assumed that it will not be adopted by freight train operators .

Analysis of the potential benefits of using wheel dampers has been conducted. Train service patterns assumed for the analysis are those adopted for the majority of the route (from the Gavray Junction to the Oxford North Junction), details are provided at *Section D2.2.8*. In this analysis, wheel dampers have been assumed to reduce overall train noise by 3 dB(A). Three scenarios have been considered, to represent operating conditions on the majority of the route. They are listed below:

- *Scenario 1*. Passenger and freight trains are assumed to run at full line speed.

- *Scenario 2*. Passenger trains are assumed to run at half line speed as they accelerate and decelerate between stops. Freight trains are assumed to run at full line speed.

- *Scenario 3*. Passenger and freight trains are assumed to run at a lower speed (of 97kph). This is expected to be comparable to operating conditions in the North Oxford area.

The results, which compare train noise with and without wheel dampers, are presented below in *Table D2.7*.

Table D2.7 Predicted Effect of Wheel Dampers as a Mitigation Measure

Scenario	Mitigated	Predicted Free Field Train Noise Level ($L_{Aeq,T}$) at 25 m, dB			
		Day (16h)	Night (8h)		
		Total	Passenger	Freight	Total
1. Passenger and freight trains are assumed to run at full line speed.	No	64.5	56.7	60.0	61.7
	Yes	63.0	53.7	60.0	61.0
2. Passenger trains are assumed to run at half line speed as they accelerate and decelerate between stops. Freight trains are assumed to run at full line speed.	No	61.9	50.7	60.0	60.5
	Yes	61.3	47.7	60.0	60.3
3. Passenger and freight trains are assumed to run at a lower speed (of 97kph). This is expected to approximate operating conditions in the North Oxford area.	No	61.3	52.4	58.1	59.2
	Yes	60.2	49.4	58.1	58.7

The results show that the greatest benefit from the use of wheel dampers as a mitigation measure is experienced for *Scenario 1*, in which passenger and freight trains run at full speed. In this scenario, wheel dampers are predicted to reduce overall train noise levels by approximately 1.5 dB during the day and 0.7 dB at night. In *Scenario 2*, where freight trains run at full speed but passenger trains run somewhat slower, the contribution from passenger trains to overall train noise levels is lower and therefore the benefit of the wheel dampers is reduced. In *Scenario 3*, both passenger trains and freight trains run at a reduced speed. Wheel dampers are predicted to reduce overall train noise levels by 1.1 dB during the day and 0.5 dB at night.

Wheel dampers have been assumed to reduce overall train noise by 3 dB, however it has also been assumed that they will not be adopted for use on freight trains. As can be seen in *Table D2.7*, the contribution to overall train noise is higher from freight trains than from passenger trains, particularly for *Scenario 2* where passenger train speeds (and consequently noise levels) are reduced. As a result, the effectiveness of wheel dampers in reducing overall train noise is limited.

Curve Noise

Curve noise was considered in the ES and based on the likely curve radius of the Bicester Chord it was considered unlikely to occur. However, the effects of curve noise are difficult to predict and mitigate prior to operation. If it occurs once the Order Scheme is operational and leads to complaints from local residents, mitigation measures will be considered and discussed with the relevant local authority.

D2.3 *NOISE SOURCE DATA*

Data for some of the train noise sources that have been modelled in this assessment are not available in CRN. These sources are listed below with a description of the data that have been used.

- Class 66 locomotive (off power). CRN correction data from Additional Railway Noise Source terms for "Calculation of Railway Noise 1995" (1) have been used.
- Class 172 DMU (off power). A CRN correction value for Class 168 DMU (off power) has been adopted as a reasonable substitution. This is the same correction as used for similar DMUs such as the Class 170.
- Freight train vehicles. A CRN correction value for a *Disc Braked Freight Vehicle (4 axles)* has been adopted and the model has been calibrated using measured data (see *Section D2.4 Freight Train Noise Measurement Survey*).

D2.4 *FREIGHT TRAIN NOISE MEASUREMENT SURVEY*

Freight trains may haul a variety of different wagons and containers. Noise source levels for an 'average' freight vehicle have been based on measurements carried out at Oddington Crossing House. Measurements were made of 11 freight trains between the 26th and 28th of August 2009. Measurements were made at a height of 1.5 m in free field conditions, level with the façade of the property (at a distance of 5.3 m from the track), in accordance with the guidance given in BS 7445. The results of these measurements are presented in *Table D2.8*.

These data were then used to calibrate the noise model so that an appropriate freight vehicle type could be selected from CRN, with a source correction which best represented measured noise levels (whilst not being quieter). The chosen freight vehicle was a *Disc Braked Freight Vehicle (4 axles)* with a CRN correction value of +7.5 dB.

Using this CRN vehicle for a freight train hauled by a Class 66 locomotive produces a predicted noise level (SEL as defined in *Annex C*) at Oddington Crossing House of 94 dB(A). The average measured noise level (SEL) of a freight train under the same operating conditions at Oddington Crossing House was 92 dB(A). This showed that robust predictions could be based on the predicted values in CRN based on the freight vehicle type above, and that they would be likely to result in slightly higher noise levels by 2 dB(A).

The train speed at this location is currently lower than it will be with the Order Scheme and reflects the maximum line speed (40 mph).

Table D2.8 Noise Level Measurements of Freight Trains at Oddington Crossing House

(1) Additional Railway Noise Source terms for "Calculation of Railway Noise 1995". Defra 2007

Date	Time	Noise Level (SEL Free Field), dB(A)	Freight Train Type
26.08.09	05.05	90	4M60 waste
	12.05	94	4V60 waste
	12.20	94	6A49 MoD
	14.35	91	6A48 MoD
27.08.09	12.32	83	6A49 MoD
	14.35	90	6A48 MoD
	20.35	95	6M49 waste
28.08.09	05.20	93	4M60 waste
	12.07	92	4V60 waste
	12.43	90	6A49 MoD
	14.34	85	6A48 MoD
Average (logarithmic)		**92**	

D3 ADDITIONAL PROCEDURES FOR PREDICTION OF MAXIMUM NOISE LEVELS

D3.1 REQUIREMENTS FOR PREDICTION OF MAXIMUM NOISE LEVELS

CRN enables predictions to be carried out using the L_{Aeq} parameter. In most cases it is this parameter that determines the need for mitigation in The Policy (see *Annex A*).

However, The Policy also contains thresholds in terms of the maximum noise level (L_{Amax}) [(1)], and in some cases, very close to the track, the maximum noise may exceed the relevant mitigation threshold before the L_{Aeq}. The Policy states that:

"If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact… except where ambient maximum noise levels are already above the predicted train noise."

Where such an impact is identified the need for further mitigation (likely to be noise insulation) is investigated.

D3.2 PREDICTION METHODOLOGY

CRN does not provide a methodology to predict maximum noise levels (L_{Amax}). However, it does contain relevant noise source terms for the trains that will use the railway, in the SEL parameter (see *Annex C*), at 25 m from the track. Additional noise source terms are also provided in an addendum to CRN [(2)].

Maximum noise levels can be predicted from SEL noise source terms by assuming that the noise during a train pass-by follows a nearly flat topped profile [(3)] in terms of rolling noise, using the equation originally proposed by the Noise Advisory Council [(4)]. A second equation, based on work by Kurzweil, is presented in the Transport Noise Reference Book[(5)]. The two prediction methods show close agreement.

Maximum noise levels at 25 m from the nearest rail have been predicted based on CRN noise source terms for the Class 168 DMU, Class 172 DMU and Class 66 diesel locomotive that will use the railway. Maximum noise levels for freight wagons are lower than the noise from the locomotive for freight trains, and so these have not been considered.

(1) The "slow" time constant is applied following the approach in PPG24 from which this measure is derived.
(2) Additional Railway Noise Source Terms for "Calculation of Railway Noise 1995", AEAT for Defra, 2007.
(3) Transport Noise Reference Book (equation 15.21 for rolling noise), Nelson, 1987.
(4) A Guide to the Measurement and Prediction of the Equivalent Continuous Sound Level Leq, The Noise Advisory Council, 1978.
(5) Transport Noise Reference Book (equation 15.24), Nelson, 1987.

CRN contains two source terms for diesel locomotives;

- one for "locomotives under full power", where engine noise is a significant component of the noise which can result in higher noise at low speeds; and
- a second which is always dominant at higher speeds where rolling noise (noise from the rail/wheel interaction) is the key noise source.

In order to trigger further mitigation, The Policy requires regular exceedences of the maximum noise level threshold. Occasional exceedences are not considered to be regular and therefore are not relevant to the assessment of noise mitigation and no mitigation would be offered as a result. Since there will be no more than the occasional instances of locomotives under "full power" close to receptors with the Order Scheme, the source term for rolling noise has been adopted to determine mitigation requirements rather than one for "full power".

The source terms for the three types of trains that are expected to use the track are as shown in *Table D3.1*.

Table D3.1 ***Source Terms Assumed for Analysis***

Type of Vehicle	SEL at 25m (from CRN), dB	L_{Amax} at 25m (Converted from SEL), dB	Uncertainty
Class 168 DMU – Chiltern Railways	31.2 + 20*log(155) +7.6 = 82.6	82.4 (2)	Not stated.
Class 172(1) DMU – East West Rail (worst case)	31.2 + 20*log(161) +7.6 = 82.9	82.9 (3)	Standard deviation 0.4 dB(A).
Class 66 Freight Locos (the most likely freight loco based on vehicles trends)	31.2 + 20*log(121) +13 = 85.9	84.1 (4)	Not stated.

1) No data, based on Class 170 DMU
2) Calculated for the highest speed for this *Route Section*, of 155 kph.
3) Calculated for the highest speed for this *Route Section*, of 161 kph.
4) Calculated for the highest speed for this *Route Section*, of 121 kph.

D3.3 PROPAGATION MODEL

D3.3.1 Method of Modelling Rolling Noise Close to Trains

Models for maximum noise levels from trains often include propagation, assuming the noise behaves like a line source. However, researchers (eg Peters (1)) have highlighted that a dipole directivity model was the most accurate for predicting the rise and decay of rolling noise as a train passed a receiver. In some research this approach is used to simulate the total noise

(1) S Peters, 'The Prediction of Railway Noise Profiles', Journal of Sound and Vibration, Volume 32, No 1, 1974, pages 87-99

from a train, by modelling noise from individual wheels with appropriate directivity.

Models which simulate individual wheels as described above are not available in commercially available noise models, and manually implementing this sort of procedure on a scheme-wide scale would be prohibitive. Additionally, Peters' paper acknowledges that there are limitations to the prediction method, in that it does not include frequency information or a range of vehicle types. It also does not include engine noise, or take account of geometry. A method is required which can predict maximum noise levels under a wider range of circumstances, including those where noise mitigation has been applied.

Therefore, the approach in this assessment has sought to find a method that is available in SoundPlan[1], which takes into account the distribution of sources along a train and their height above the rail, and which applies a suitable directivity to noise from the train.

The Nordic Method

The Nordic Method [2] has been used and is implemented using the SoundPlan software package. This method, which is often referred to as Nord 2000, considers an input sound power for each type of train. A standard set of rail vehicles which are operational in Nordic countries are available as noise source terms for use in this method. In order to give appropriate predictions for the types of trains within the Order Scheme, a standard Nordic Method source term has been adjusted so that the predicted maximum noise levels give the same result as those derived in *Section D3.2* at 25 m.

The noise source in the Nordic Method is divided between 7 locations on a train. Horizontally, one source is located at the centre of the train, whilst the remaining three pairs of sources are located either side of this, at distances of L/2, L/4 and L/8 (where L is the length of the train). The directivity term that is applied to the maximum noise calculation in the horizontal plane is:

$$\Delta(\emptyset) = 10\log(0.15 + 0.85\sin^2(\emptyset)) + 2$$

The sources are treated as three pairs and one single source, and these sources are located at 4 heights, which are specified for particular train types or that can be defined by the user. The heights of 0.01, 0.35, 0.7 and 2.5 m above the railway, specified for the IC3 "Flexliner" DMU, have been assumed when predicting noise from the Class 168 and the Class 172 DMU.

The predicted values for DMUs at distances between 2 and 25 m are shown for the Nordic Method in for a Class 168 Predictions have been based on a Danish DMU Passenger train (IC3 "Flexliner"). The overall length of the train has been modelled as 24 m to reflect a typical Class 168 vehicle length

(1) SoundPlan v.7.1, the software package which has been used for the project noise modelling.
(2) Nord 2000 New Nordic Prediction Method for Rail Traffic Noise, H J Jonasson and S Storeheier, 2001.

(rounded from 23.6 m). The values have then been adjusted, by subtracting 1.1 dB(A) for a Class 168 DMU, to give the same value at 25 m as that predicted using the CRN noise source term and the equation proposed by the Noise Advisory Council (described in *Section D3.2*) at the highest train speeds in the area. Due to the higher speed which the EWR trains will achieve through the section, a correction of -1.2 dB(A) would be appropriate for a Class 172 DMU.

Table D3.2 ***Predicted Noise Levels for a Class 168 / Class 172 DMU Following the Nordic Method***

	Predicted Maximum Noise Level (L_{Amax})		
Distance to Train (m)	**Class 168 DMU at 155 kph, dB (1)**	**Class 172 DMU at 161 kph, dB (1)**	**Class 66 Loco at 121 kph, dB (1)**
2	95.6	96.0	102.3
4	93.0	93.4	99.8
6	91.3	91.7	97.5
8	89.8	90.2	95.3
10	88.5	89.0	93.3
12	87.4	87.9	91.7
14	86.5	86.9	90.3
15	86.0	86.5	89.6
18	84.7	85.2	87.8
20	84.0	84.5	86.7
22	83.3	83.8	85.7
24	82.7	83.2	84.6
25	82.4	82.9	84.1

1) The source levels for the modelling were taken from the database in the Nordic Method, and have been calibrated to match the noise levels at 25 m for the trains listed in this table which are relevant to this railway.

D3.3.2 Treatment of Freight Locomotives

The noise from a freight locomotive, such as the Class 66 loco which is modelled in this *Scheme of Assessment*, is likely to comprise noise from the rail/wheel interface as well as a component from the engine. As outlined above for DMUs, the Nordic Method recognises these different elements and splits the noise from a train into seven individual point sources with equal sound power. These include a source at the centre of the train, which represents the engine.

There is one limitation in the Nordic Method when it is used to predict noise from freight locomotives; the source terms are for complete freight trains rather than simply the locomotive. Since much of the energy on a complete train is from rail wheel noise, the source term over emphasises the contribution of the wheels compared to the engine for a single freight locomotive. This results in a propagation characteristic that does not follow the expected, broadly spherical, pattern which would be expected for a freight locomotive.

In order to model an appropriate spreading pattern, the locomotive length has been set to 1 m in the model. This source is then moved along the track in the model and results in spreading, which is within 1 dB of spherical spreading. The source term has then been appropriately calibrated to give the same maximum noise level at 25 m as the one predicted using CRN for a Class 66 locomotive by adding 7.5 dB to the predicted levels. The correction required is relatively large as a result of the short modelled train length. This relationship is valid to as close as 4 m from the track, which covers the range of interest for this *Scheme of Assessment*. The predicted maximum noise level values for a Class 66 loco at distances between 2 and 25 m are shown for the Nordic Method in *Table D3.2*.

The freight locomotive modelled assumes heights of 0.01, 0.35, 0.7 and 2.5 m above the railway. Since these sources have equal sound power, the engine noise sound power is equal to the total sound power plus 10 x log (1/7) dB (ie 8.5 dB(A) lower than the total sound power). As freight speeds are expected to be high and freight locomotives are expected to be off-power in the area covered by this *Scheme of Assessment*, rail/wheel noise will dominate and this is considered to be a reasonable assumption.

Effect of Switches and Crossings

The Nordic method does not provide a correction to account for the presence of track discontinuities that may exist at switches and crossings. The effect of these on maximum noise levels is therefore not quantified in the noise modelling. However, within this *Route Section*, there are no switches and crossings close to NSRs.

Weather Conditions

The Nordic Method, as implemented in the current version of SoundPlan, uses an average of weather conditions in the calculation procedure despite specifying down-wind propagation. However, the predicted maximum noise levels are only of interest at receptors very close to the railway, and at these distances meteorological conditions will not have a significant effect on the predicted noise levels.

As required by planning condition 19(3), an assessment of speech communications has been carried out for users of the "large riding school" and "small riding school" at Wendlebury Gate Stables, and the paddock opposite Bramlow, nearby. The assessment has been carried out according to the Speech Interference Level (SIL) assessment method described in Annex E of the British Standard, *Ergonomics Assessment of Speech Communications* (1).

As set out in planning condition 19(3), the assessment has been based on a native female speaker facing the rider under instruction for alert situations where short known words are used and the wind speed is less than 5 metres per second. A correction factor of -5dB has been used to convert the standard for male voices to female voices.

Noise levels will increase as a train approaches, reaching a maximum as the train passes, before reducing again. Maximum noise levels have been predicted and have been used to determine the equivalent speech intelligibility level (SIL), which is required by the planning conditions. The assessment has been carried out at the "large riding school" as this is the closest and therefore worst affected of the locations specified in the planning condition.

The prediction methodology for maximum train noise levels is described in *Section D3*. Train noise is expected to remain at this maximum level for a short period only as each train passes, however using this noise level ensures a worst case assessment is presented.

The assessment procedure requires a modified version of the train noise level to be calculated, called the *Speech Interference Level*. This level is calculated from the arithmetic average of the four octave bands, 500 Hz, 1 kHz, 2 kHz and 4 kHz. An octave band spectrum has been taken from measurements of freight trains on a similar railway line where trains were running at a similar speed to those expected to use the Order Scheme. This has been used to derive a correction of -15 dB between the measured maximum noise level ($L_{max,s}$) and the arithmetic average of the four octave bands and has been used to correct predicted maximum noise levels.

The SIL is given by the difference between the *Speech Level*, $L_{S,A,L}$, and the *Speech Interference Level* of noise L_{SIL}, both determined at the listener's position. *Table* D4.1 presents intelligibility ratings from the British Standard. *Table* D4.2 presents the results of the assessment in terms of intelligibility ratings for the mitigated and unmitigated case. The predicted levels without mitigation result in a SIL of -21 dB which produces a *Speech-Communication Intelligibility Rating* of 'Bad'. With mitigation in the form of a noise barrier (the dimensions of which are detailed in *Section 5* of the main *Scheme of Assessment* document),

(1) BS EN ISO 9921:2003 Ergonomics Assessment of Speech Communications

maximum train noise is predicted to reduce resulting in an SIL of -15 dB which also results in a *Speech-Communication Intelligibility Rating* of 'Bad'.

Table D4.1 Speech-Communication Intelligibility Ratings

Rating	SIL, dB
Excellent	SIL 21 or above
Good	SIL 15 – 21
Fair	SIL 10 – 15
Poor	SIL 3 – 10
Bad	SIL less than 3

Table D4.2

Table D4.2 Predicted Speech Intelligibility

	Speech Level, dB	Maximum Noise Level, dB L_{Amax}	Speech Interference Level (L_{SIL})	SIL, dB	Speech-Communication Intelligibility Rating
Unmitigated	38	74	59	-21	Bad
With Noise Barrier	38	68	53	-15	Bad

D5 RESULTS OF THE NOISE MODELLING

This section provides further details of the noise modelling results to supplement the data provided in the main *Scheme of Assessment* document. Details of the predicted train noise with, and without, mitigation are provided, as well as baseline noise levels and the resulting total noise level. The changes in noise levels, as a result of the Order Scheme are also shown where relevant.

Table D5.1 presents the results of the noise modelling without noise mitigation measures (other than those inherent in the design of the railway).

Table D5.2 presents the results of the noise modelling with noise mitigation.

Details of the noise mitigation are presented in *Section 5* of the main *Scheme of Assessment* document and are supplemented by figures identifying receptor locations, baseline noise monitoring locations and the location of the noise mitigation. Additionally, noise contours are presented for predicted night time train noise at a level of 45 dB(A), the threshold of a significant impact (ignoring the effects of baseline noise which may increase this threshold).

Table D5.3 presents an estimation of eligibility for statutory noise insulation under the Noise Insulation (Railways and Other Guided Transport Systems) Regulations.

Table D5.1 Results of the Noise Modelling Without Mitigation (Free-field)

Receptor	**Relevant Floor** [1]	**Predicted Train Noise / Exceedence of Threshold** [2]**, dB**		**Baseline Noise Level (Without Baseline Trains / With Baseline Trains)** [3]**, dB**		**Resulting Total Noise Level / Change in Noise Level** [3]**, dB**		**Predicted Unmitigated Impact** [4] **, dB**		**Maximum Noise Level ($L_{Amax,night}$)** [5]**, dB**
		Day ($L_{Aeq,16h}$)	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Night**
ES 6 Alchester House, Langford Lane	1st floor	66 / **11**	64 / **19**	40 / 49	44 / 48	66 [7] / **17**	64 [7] / **16**	**11**	**16**	89
PI 2 Elm Tree Farm, Wendlebury	1st floor	45 / **0**	43 / **0**	40 / 40 [6]	44 / 44 [6]	46 / **6**	46 / **2**	**0**	**0**	59

1) Worst affected floor level.

2) As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night

3) Noise from existing train movements was removed from measured baseline noise levels. The 'Resulting Total Noise Level' combines predicted train noise from the Order Scheme with existing baseline noise (without existing train noise as this will be replaced by the Order Scheme). The 'Change in Noise Level as a Result of the Order Scheme' compares the 'Resulting Total Noise Level' with existing baseline noise levels. Predicted train noise from existing railway traffic has been added to these baseline noise levels (from which existing train movements were removed) to represent the existing baseline noise situation for a 16h day and an 8h night. However, within this *Route Section*, existing train movements are minimal and are not expected to have a significant effect on existing noise levels.

4) The predicted impact is calculated as the lower of:
- the amount by which train noise levels are predicted to exceed the threshold criteria. As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night; and
- the change in noise level as a result of the Order Scheme (compared to the baseline noise level including trains).

5) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance. Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.

6) This receptor is situated over 500 m from the existing railway and train noise is predicted not to significantly influence the baseline noise level.

7) Train noise is predicted to be the dominant noise source at the majority of the nearest NSRs. Where this is the case, baseline noise levels do not significantly influence the resulting total noise level and so this level will be the same as the predicted train noise.

Table D5.2 Results of the Noise Modelling With Mitigation (Free-field)

Receptor	Relevant Floor (1)	Predicted Train Noise / Exceedence of Threshold (2), dB		Baseline Noise Level (Without Baseline Trains / With Baseline Trains) (3), dB		Resulting Total Noise Level / Change in Noise Level (3), dB		Predicted Mitigated Impact (4), dB		Maximum Noise Level ($L_{Amax,night}$) (5), dB
		Day ($L_{Aeq,16h}$)	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Day ($L_{Aeq,16h}$)**	**Night ($L_{Aeq,8h}$)**	**Night**
ES 6 Alchester House, Langford Lane	1st floor	52 / **0**	50 / **5**	40 / 49	44 / 48	52 (7) /**3**	51 /**3**	**0**	**3**	74
PI 2 Elm Tree Farm, Wendlebury	1st floor	45/ **0**	43 / **0**	40 / 40	44 / 44	46 /**6**	46 /**2**	**0**	**0**	59

1) Worst affected floor level.

2) As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night

3) Noise from existing train movements was removed from measured baseline noise levels. The 'Resulting Total Noise Level' combines predicted train noise from the Order Scheme with existing baseline noise (without existing train noise as this will be replaced by the Order Scheme). The 'Change in Noise Level as a Result of the Order Scheme' compares the 'Resulting Total Noise Level' with existing baseline noise levels. Predicted train noise from existing railway traffic has been added to these baseline noise levels (from which existing train movements were removed) to represent the existing baseline noise situation for a 16h day and an 8h night. However, within this *Route Section*, existing train movements are minimal and are not expected to have a significant effect on existing noise levels.

4) The predicted impact is calculated as the lower of:
   - the amount by which train noise levels are predicted to exceed the threshold criteria. As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night; and
   - the change in noise level as a result of the Order Scheme (compared to the baseline noise level including trains).

5) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance. Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.

6) This receptor is situated over 500 m from the existing railway and train noise is predicted not to significantly influence the baseline noise level

7) For NSRs where train noise is the dominant noise source, baseline noise levels do not significantly influence the resulting total noise level and so this level will be the same as the predicted train noise.

Table D5.3 presents an estimation of those properties that may be eligible for noise insulation under The Noise Insulation (Railways and Other Guided Transport Systems) Regulations (1). The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation specified in it) and will make formal offers following a building survey to identify eligible properties.

Table D5.3 Estimation of Eligibility for Statutory Noise Insulation Under The Noise Insulation (Railways and Other Guided Transport Systems) Regulations

Receptor	**'Prevailing'(1) Noise Level ($L_{Aeq,T}$), dB**		**Predicted 'Relevant' (2) (Façade) Noise Level ($L_{Aeq,T}$), dB**		**Likely to be Eligible (4)**
	Day-time (3)	**Night-time (3)**	**Day-time (3)**	**Night-time (3)**	
ES 6 Alchester House, Langford Lane	48	47	55	52	No
PI 2 Elm Tree Farm, Wendlebury	28	26	48	45	No

1) The prevailing noise level is defined in the Regulations and is the noise level from trains before the Order Scheme is built.
2) The relevant noise level is defined in the Regulations and is the noise level from all trains following implementation of the scheme. The predicted relevant noise level includes the noise mitigation outlined in this Scheme of Assessment.
3) For the purpose of the Regulations, the day-time period is defined as 06.00 to 00.00 and the night-time is defined as 00.00 – 06.00
4) An estimation of the properties which may be eligible for noise insulation under the Regulations is presented. A property may be eligible under the Regulations if train noise exceeds the (façade) threshold levels (of 68 dB during the day-time and 63 dB during the night-time). Other conditions which must also be met are set out in the Regulations. The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (Ammended 1998).

Annex E

Supporting Baseline Information

E1 METHODOLOGY

E1.1 INTRODUCTION

This *Annex* provides details of the noise measurements that have been used in the noise assessment.

E1.2 MEASUREMENT LOCATIONS

As discussed in *Section 4* of the main *Scheme of Assessment* document, noise measurements were carried out to inform the Environmental Statement (ES). The measurement location relevant to this *Route Section* is:

- NML(ES) 4 (Langford Lane Crossing).

The measurements at this location were short sample measurements during the day and night periods.

Since publication of the ES, additional long-term, unattended monitoring was carried out at several locations to inform the public inquiry. These surveys have been used to increase the baseline coverage in some areas, notably in Islip and in the Wolvercote area of north Oxford where the topography and road locations may result in significant differences in existing noise levels. In other areas monitoring has been carried out in order to increase the level of detail.

Additional noise monitoring was carried out in June and August 2010, at the following locations:

- Whimbrel Close, Bicester;
- Mill Street, Islip;
- Lakeside, Oxford;
- Blenheim Drive, Oxford; and
- Stone Meadow, Oxford.

Monitoring at each location was carried out over a period of several days so that unusual events and bad weather could be excluded. Where rain or wind speed in excess of 5 m/s has been noted during measurements at Lakeside and Whimbrel Close, the noise data has been discarded because, in this case, the wind appeared to affect the noise measurements.

None of the additional NMLs are in *Route Section C*.

The noise monitoring location for *Route Section C* is shown in *Figure 5.1* of the main body of the *Scheme of Assessment*.

E1.3 SURVEY PROCEDURE

Measurements were made of the existing noise environment during the day-time and night-time in accordance with BS 7445 (1). Class 1 sound level meters have been used. All sound level meters were within their calibration period. Sound level meters were calibrated before use, and the calibration levels were checked after the survey. No deviation of greater than 1 dB was noted.

Noise monitoring equipment was mounted on a tripod so that the microphone was in a free-field position; approximately 1.5 m above ground level. Monitoring was carried out on an attended sample basis.

(1) British Standard (BS) 7445: Description and measurement of environmental noise, Part 1, Guide to quantities and procedures (2003)

E2 *MEASURED NOISE LEVELS*

E2.1 *NOISE LEVEL MEASUREMENTS CARRIED OUT FOR THE ES*

The attended noise samples recorded during the ES, at the locations listed below, are reported in *Table* E2.1. None of the measurements include noise from existing trains.

- NML(ES) 4 (Langford Lane Crossing).

Table E2.1 Attended Measurement Survey Results

Measurement Position	Date	Time	Duration (Mins)	Sound Pressure Level (dB)				Description of Noise Climate	Meteorological Conditions
				L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}		
NML(ES) 4 (Langford Lane Crossing)	4 June 09	14.14	15	44	36	45	60	Distant traffic, tractor in field, bird song, measurement paused for level crossing signal	Dry, light breeze
	4 June 09	14.32	15	40	35	41	67	Distant traffic on the M40	Dry, light breeze
	4 June 09	23.51	10	44	40	47	52	Distant traffic on the M40	Dry and still
	5 June 09	00.01	10	44	40	46	57	Distant traffic on the M40	Dry and still
	25 Aug 09	01.08	10	44	41	46	58	Distant traffic on the M40. Sheep noise may contribute	Dry and still

At Langford Lane Crossing (NML(ES) 4), measurements were made between the 4th and 5th June and on the 25th of August 2009. The measurements (which do not include train noise) gave a range of 40 to 44 dB L_{Aeq} during the day, and 44 dB L_{Aeq} at night.

Baseline train noise has been predicted for the two NSRs in this *Route Section* and has been added to the measured baseline noise level without train noise to produce the baseline noise level with trains. The baseline noise levels measured at NML(ES) 4 are expected to be representative of existing noise levels at NSR(ES) 6 which is situated close by. These noise level measurements have also been adopted for NSR(PI) 2, which is situated further away. The main source of noise noted during these measurements was road traffic from the M40 motorway. NSR(PI) 2 is situated in a similarly isolated location to NML(ES) 4, but is considerably closer to the motorway. It is therefore reasonable to expect that existing noise levels at NSR(PI) 2 would be higher than those measured at NML(ES) 4 and therefore present a conservative estimate of the baseline noise level. In addition, the adopted baseline noise levels are low and do not affect the assessment of impacts at this location.

The adopted baseline noise levels at NSRs considered in this assessment are summarised below in *Table* E3.1:

Table E3.1 Baseline Noise Levels Assumed for Scheme of Assessment – $L_{Aeq,period}$ (Free-field)

Receptor	Noise Level without Trains		NML Used	Noise Level with Baseline Trains	
	$L_{Aeq, day}$ (2)	$L_{Aeq, night}$ (3)		$L_{Aeq, day}$ (2)	$L_{Aeq, night}$ (3)
ES 6 Alchester House, Langford Lane	40	44	*NML(ES) 4*	49	48
PI 2 Elm Tree Farm, Wendlebury	40	44	*NML(ES) 4*	40 (1)	44 (1)

1) This receptor is situated over 500 m from the existing railway and train noise is predicted not to significantly influence the baseline noise level.
2) The daytime period for this assessment is taken to be from 07.00 to 23.00.
3) The night-time period for this assessment is taken to be from 23.00 to 07.00.

An initial assessment of eligibility for noise insulation under The Noise Insulation (Railways and Other Guided Transport Systems) Regulations (1) has been carried out. This assessment uses the time periods specified in the Regulations; the day-time period is defined as the period of 18 hours between 06.00 and midnight, whilst the night-time period means the six hours between midnight and 06.00.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (Ammended 1998).

The Regulations give a specific term for existing noise ie 'prevailing noise level', which is defined as the level of noise caused by the movement of trains on railways immediately before the start of construction. One of the steps in determining eligibility under the Regulations is to ensure that noise from the Order Scheme exceeds the prevailing noise level by at least 1 dB(A).

The prevailing noise level has been predicted for NSRs in this *Route Section*, based on existing service levels as set out in *Annex D*. The results are presented in *Table 4.2*.

Table 3.2 Predicted Prevailing Noise Level (Free-field)

Receptor	**Predicted Prevailing Noise Level (Free-field), dB(A)**	
	$\mathbf{L_{Aeq,day}}$	$\mathbf{L_{Aeq,night}}$
ES 6 Alchester House, Langford Lane	48	47
PI 2 Elm Tree Farm, Wendlebury	28	26

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