M54 to M6 Link Road

TR010054

Volume 6

6.1 Environmental Statement

Chapter 11 – Noise and Vibration

Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

M54 to M6 Link Road

Development Consent Order 202[ ]

6.1 Environmental Statement

Chapter 11 Noise and Vibration

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11 Noise and Vibration

11.1 Introduction

11.1.1 This chapter assesses the potential noise and vibration impacts associated with the construction and operation of the Scheme, following the methodology set out in Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7 (Ref 11.1) and associated Interim Advice Note (IAN) 185/15 (Ref 11.2). This chapter summarises the regulatory and policy framework related to noise and vibration, details the methodology followed for the assessment, and describes the existing environment in the area surrounding the Scheme. Following this, the design and mitigation measures proposed to manage and minimise potential noise and vibration impacts are specified, after which residual effects of the Scheme are presented.

11.1.2 This chapter of the Environmental Statement (ES) has been prepared by competent experts with relevant and appropriate experience. The technical lead for the noise and vibration assessment has 12 years of relevant experience and has professional qualifications as summarised in Appendix 1.1 [TR010054/APP/6.3].

11.1.3 The results of the noise and vibration assessment have been used to inform the assessment of impacts on other topics as required. Impacts on Biodiversity are reported in Chapter 8, Cultural Heritage in Chapter 6, Landscape (including tranquillity) in Chapter 7 and Population and Health in Chapter 12.

11.2 Legislative and policy framework

Legislation

11.2.1 Legislation relevant to the Scheme consists of the following:

- Environmental Noise (England) Regulations 2006 (as amended) (Ref 11.3);
- Land Compensation Act 1973 (Ref 11.4);
- Noise Insulation Regulations 1975 (as amended 1988) (Ref 11.5);
- Highways Noise Payments and Movable Homes (England) Regulations 2000 (Ref 11.6);
- Environmental Protection Act 1990 (Ref 11.7); and
- Control of Pollution Act 1974 (Ref 11.8).

Planning Policy

11.2.2 The primary basis for deciding whether or not to grant a Development Consent Order (DCO) is the National Policy Statement for National Networks (NPSNN)[1] (Ref 11.9) which sets out policies to guide how DCO applications would be decided and how the impacts of national networks infrastructure should be considered. Table 11.1 identifies the NPSNN policies relevant to the noise and vibration assessment and

[1] Although other policies can have weight as relevant and important matters in decision making. See Case for the Scheme for more information [TR010054/APP/7.2].

where in this ES chapter information is provided to address these policy requirements.

Table 11.1: NPSNN policies relevant for the noise and vibration assessment

NPSNN para.	Requirement of the NPSNN	Location where information addresses policy requirements
5.189	Where a development is subject to EIA and significant noise impacts are likely to arise from the proposed development, the applicant should include the following in the noise assessment, which should form part of the environment statement: • A description of the noise sources including likely usage in terms of number of movements, fleet mix and diurnal pattern. For any associated fixed structures, such as ventilation fans for tunnels, information about the noise sources including the identification of any distinctive tonal, impulsive or low frequency characteristics of the noise. • Identification of noise sensitive premises and noise sensitive areas that may be affected. • The characteristics of the existing noise environment. • A prediction on how the noise environment will change with the proposed development. • In the shorter term such as during the construction period. • In the longer term during the operating life of the infrastructure. • At particular times of the day, evening and night as appropriate. • An assessment of the effect of predicted changes in the noise environment on any noise sensitive premises and noise sensitive areas. • Measures to be employed in mitigating the effects of noise. Applicants should consider using best available techniques to reduce noise impacts. • The nature and extent of the noise assessment should be proportionate to the likely noise impact.	Existing noise sources are discussed in Section 11.6 'Baseline conditions'. Noise sensitive receptors are detailed in Section 11.5 'Study area'. Predictions of how the noise environment would change during Scheme construction and operation are provided in Section 11.9 'Assessment of likely significant effects'. Mitigation measures are identified in Section 11.8 'Design, mitigation and enhancement measures'.
5.190	The potential noise impact elsewhere that is directly associated with the development, such as changes in road and rail traffic movements elsewhere on the national networks, should be considered as appropriate.	The noise impacts of the Scheme, including on the wider road network, are discussed in Section 11.9 'Assessment of likely significant effects'.
5.191	Operational noise, with respect to human receptors, should be assessed using the	The noise impact assessment methodology is discussed in

NPSNN para.	Requirement of the NPSNN	Location where information addresses policy requirements
	principles of the relevant British Standards and other guidance. The prediction of road traffic noise should be based on the method described in Calculation of Road Traffic Noise. …. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies.	Section 11.3 'Assessment methodology', including details of Calculation of Road Traffic Noise (CRTN) and relevant British Standards.
5.192	The applicant should consult Natural England with regard to assessment of noise on designated nature conservation sites, protected landscapes, protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account.	The assessment of noise impacts on biodiversity is discussed in Chapter 8: Biodiversity which provides details of consultation undertaken with Natural England.
5.193	Developments must be undertaken in accordance with statutory requirements for noise. Due regard must have been given to the relevant sections of the Noise Policy Statement for England, National Planning Policy Framework and the Government's associated planning guidance on noise.	Details of the requirements of these policy documents are provided in Section 11.2 'Legislative and policy framework'.
5.194	The project should demonstrate good design through optimisation of scheme layout to minimise noise emissions and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission. The project should also consider the need for the mitigation of impacts elsewhere on the road and rail networks that have been identified as arising from the development, according to Government policy.	Mitigation measures incorporated into the Scheme are detailed in Section 11.8 'Design, mitigation and enhancement measures'. The noise impacts of the Scheme, including on the wider road network, are discussed in Section 11.9 'Assessment of likely significant effects'.
5.195	The Secretary of State should not grant development consent unless satisfied that the proposals will meet, the following aims, within the context of Government policy on sustainable development: • Avoid significant adverse impacts on health and quality of life from noise as a result of the new development • Mitigate and minimise other adverse impacts on health and quality of life from noise from the new development. • Contribute to improvements to health and quality of life through the effective management and control of noise, where possible.	A discussion of how the Scheme complies with these three aims is provided in Section 11.9 'Assessment of likely significant effects'.

NPSNN para.	Requirement of the NPSNN	Location where information addresses policy requirements
5.196	In determining an application, the Secretary of State should consider whether requirements are needed which specify that the mitigation measures put forward by the applicant are put in place to ensure that the noise levels from the project do not exceed those described in the assessment or any other estimates on which the decision was based.	Mitigation measures incorporated into the Scheme are detailed in Section 11.8 'Design, mitigation and enhancement measures' and are specified in the Outline Environmental Management Plan (OEMP) [TR010054/APP/6.11].
5.198	Mitigation measures for the project should be proportionate and reasonable and may include one or more of the following: • engineering: containment of noise generated; • materials: use of materials that reduce noise, (for example low noise road surfacing); • lay-out: adequate distance between source and noise-sensitive receptors; incorporating good design to minimise noise transmission through screening by natural or purpose built barriers; • administration: specifying acceptable noise limits or times of use (e.g., in the case of railway station PA systems).	Mitigation measures incorporated into the Scheme are detailed in Section 11.8 'Design, mitigation and enhancement measures'. Details of decisions on proportionate and reasonable mitigation are included in the discussion of how the Scheme complies with policy provided in Section 11.9 'Assessment of likely significant effects'.
5.199	For most national network projects, the relevant Noise Insulation Regulations will apply. These place a duty on and provide powers to the relevant authority to offer noise mitigation through improved sound insulation to dwellings, with associated ventilation to deal with both construction and operational noise. An indication of the likely eligibility for such compensation should be included in the assessment. In extreme cases, the applicant may consider it appropriate to provide noise mitigation through the compulsory acquisition of affected properties in order to gain consent for what might otherwise be unacceptable development. Where mitigation is proposed to be dealt with through compulsory acquisition, such properties would have to be included within the development consent order land in relation to which compulsory acquisition powers are being sought.	The results of an initial assessment under the Noise Insulation Regulations are reported in Section 11.9 'Assessment of likely significant effects'. A complete Noise Insulation Regulations assessment will be completed following detailed design of the Scheme and in accordance with the timescales specified in the Regulations.
5.200	Applicants should consider opportunities to address the noise issues associated with the Important Areas as identified through the noise action planning process.	A discussion of the Scheme impacts on noise important areas is provided in Section 11.9 'Assessment of likely significant effects'.

11.2.3 An assessment of the Schemes conformity with the relevant paragraphs and provisions for population and human health in the NPSNN is presented in the NPSNN Accordance Table, Appendix A of the Case for the Scheme [TR010054/APP/7.2].

11.2.4 Other relevant policies have been considered as part of the noise and vibration assessment where these have informed the identification of receptors and resources and their sensitivity; the assessment methodology; the potential for significant environmental effects; and required mitigation. These policies include those listed below and discussed in the sections thereafter:

- National Planning Policy Framework (NPPF) (2018): paragraph 180 relating to pollution (Ref 11.10). The NPPF closely aligns with the aims set out in paragraph 5.195 of the NPSNN to avoid significant adverse impacts and to mitigate and reduce other adverse impacts. It also states that planning decisions should aim to '*identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason*'. In accordance with the NPPF, the NPSNN policies are the primary source of policy guidance regarding this assessment.
- Noise Policy Statement for England Explanatory Note (NPSE) (Ref 11.11) introduces the following concepts to aid in the establishment of significant noise effects:
  - **No Observed Effect Level (NOEL):** the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established.
  - **Lowest Observed Adverse Effect Level (LOAEL):** the level above which adverse effects on health and quality of life can be detected.
  - **Significant Observed Adverse Effect Level (SOAEL):** the level above which significant adverse effects on health and quality of life occur.

  The NPSE para 2.22 recognises that 'it is not possible to have a single objective noise-based measure that is mandatory and applicable to all sources of noise in all situations'. The levels are likely to be different for different noise sources, for different receptors and at different times of the day. The assessment methodology presented in Section 11.3 outlines the LOAEL and SOAEL used herein for each potential impact.
- Planning Practice Guidance (PPG) on Noise (2019) (Ref 11.12) has been used to inform the setting of LOAEL and SOAEL levels as detailed in Section 11.3.
- South Staffordshire Core Strategy Development Plan contains a policy, Policy EQ9: Protecting Residential Amenity, on protecting residential amenity, which is relevant to this assessment (Ref 11.13).
- Wolverhampton Unitary Development Plan 2001 – 2011 contains two polices, Policy EP1: Pollution Control and Policy EP5: Noise Pollution, which are relevant to this assessment (Ref 11.14).
- The Black Country Core Strategy (adopted Feb 2011) does not contain any policies relevant to this assessment (Ref 11.15).

11.3 Assessment methodology

General approach

11.3.1 The noise and vibration assessment includes the following elements:

- quantitative assessment of construction noise and vibration impacts;
- quantitative assessment of construction traffic noise impacts; and
- quantitative assessment of operational traffic noise impacts and annoyance due to operational airborne vibration impacts.

11.3.2 As discussed in Section 11.4, paragraph 11.4.1 operational impacts resulting from ground-borne vibration are scoped out of further assessment.

11.3.3 Key methodology documents of relevance to the noise and vibration assessment are as follows:

- DMRB Volume 11, Section 3, Part 7, Noise and Vibration HD 213/11 (Ref 11.1).
- IAN 185/15 Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into 'speed-bands' for users of DMRB Volume 11, Section 3, Part 1 'Air Quality' and Volume 11, Section 3, Part 7 'Noise' (Ref 11.2).
- Calculation of Road Traffic Noise (CRTN), (Ref 11.16).
- BS 5228: 2009+A1: 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites (Ref 11.17).
- BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (Ref 11.18).

11.3.4 It is noted that an update to the DMRB was released on 28 November 2019 which supersedes HD 213/11 and IAN 185/15. Due to the timing of the release of this guidance the assessment has been undertaken in line with the guidance listed above. A sensitivity test will be undertaken to determine whether the methodology outlined in DMRB LA 111 Noise and Vibration would change the results of the assessment reported in this chapter.

Baseline, Do-Minimum and sensitive receptors

11.3.5 The understanding of baseline conditions in 2019 has been supported by a baseline noise monitoring survey. The monitoring methodology complies with the guidance in BS 7445: 2003 Description and measurement of environmental noise (Ref 11.19). The monitoring locations and methodology were agreed with South Staffordshire Council (SSC). Further details of the baseline survey are provided in Appendix 11.2 [TR010054/APP/6.3].

11.3.6 The purpose of the baseline noise survey is to assist with developing an understanding of the general noise climate along the route of the Scheme. For example, to identify if any other local noise sources (other than road traffic) are present and contribute significantly to the local noise climate.

11.3.7 The results of the baseline noise survey have been used to support a verification exercise for the traffic noise prediction modelling. The traffic noise model has been used to predict 2019 traffic noise levels at the monitoring locations, with the predicted and measured levels being compared. The aim of this process is to demonstrate that the noise model is predicting a sensible range of results across the study area. An exact match would not be expected for a variety of reasons, for example, the noise predictions are based on typical weekday traffic conditions over a year, not the exact traffic conditions during the monitoring period; weather conditions including wind speed, wind direction and rain will affect the measurements (the prediction method is designed to be conservative in terms of the effect of wind direction and wind speed by assuming moderate adverse wind conditions). In addition, the noise predictions only consider road traffic noise, whereas the measurements include all ambient noise sources.

11.3.8 Future Do-Minimum conditions have been determined at all identified potentially sensitive receptors based on predicted traffic noise levels in the absence of the Scheme. Details of the traffic noise prediction methodology are provided in the Operational section below.

11.3.9 Potentially sensitive receptors within the study area have been determined from the OS address base dataset, OS mapping and discussions with SSC. DMRB defines potentially sensitive receptors as residential properties, educational buildings, medical buildings, community facilities (such as places of worship), designated sites (Area of Outstanding Natural Beauty (AONB), National Park, Special Area of Conservation (SAC), Special Protection Area (SPA), Site of Special Scientific Interest (SSSI) and scheduled monument, and public rights of way (PRoW). In addition, consideration has also been taken of the requirements of the NPSNN which identifies '*certain parks and open spaces*' as potentially noise sensitive, designated sites '*where noise may have an adverse impact on the special features of interest, protected species or other wildlife*', and '*quiet places and other areas that are particularly valued for their tranquillity, acoustic environment or landscape quality such as National Parks, the Broads or Areas of Outstanding Natural Beauty*'.

Construction Assessment

Construction noise

11.3.10 A quantitative assessment of Scheme construction noise impacts has been undertaken. Estimates of monthly average construction noise levels have been made for a selection of 22 potentially sensitive receptors, which includes those closest to the Scheme construction works. These selected receptors are representative of neighbouring properties in their vicinity. By focussing on a selection of the closest identified potentially sensitive receptors the reported impacts at these receptors are, therefore, typical of the worst affected receptors and all potentially significant effects are identified. The receptors selected further away from the works demonstrate how the impact would be reduced further away from the works.

11.3.11 Construction noise levels have been estimated in accordance with the methodology in BS 5228: 2009+A1: 2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites' (Ref 11.17). Precise information on the construction

works are not available, these will be confirmed during the detailed design stage. However, the appointed buildability contractor has provided reasonable assumptions regarding the construction works, plant requirements and construction traffic. Therefore, the estimated construction noise levels reported herein are based on information provided relating to the number and type of plant likely to be required for each construction activity, typical 'on' times for each item of plant, the likely location and extent of each activity, working times and which months the activity is likely to occur in. The monthly predictions are based on the likely area covered by each activity in each month. All activities programmed to occur in an individual month are assumed to occur at the same time. Further details regarding construction predictions are provided in Appendix 11.3 [TR010054/APP/6.3].

11.3.12 BS 5228 (Ref 11.17) contains a number of example methodologies for identifying significant construction noise effects based on fixed thresholds or noise level changes. For the purposes of this assessment, the 'ABC' method has been adopted. This approach is based on setting the threshold for the onset of potentially significant adverse effects (i.e. the SOAEL, as defined in Section 11.2) depending on the existing ambient noise level. Receptors with low existing ambient noise levels (Category A) have a lower threshold than those with high existing ambient noise levels (Category C). Higher thresholds are set for normal daytime construction working hours, compared to the more sensitive evening, weekend and night-time periods. As a conservative approach, the threshold for the onset of any adverse effect (i.e. the LOAEL, as defined in Section 11.2) is set at a construction noise level equal to the existing ambient noise level. Construction noise levels between the LOAEL and the SOAEL have the potential to result in adverse noise effects but would not normally be classed as significant adverse effects. However, noise mitigation measures are still considered and applied in such locations to seek to keep all noise effects to a minimum. Table 11.2 which is adapted from Table E.1 in BS 5228 (Ref 11.17), sets out the construction noise SOAEL and LOAEL used for this assessment.

Table 11.2: Construction noise SOAEL and LOAEL for all receptors

Time of day	SOAEL $L_{Aeq,T}$ dB (façade)			LOAEL $L_{Aeq,T}$ dB (façade)
	A[1]	B[2]	C[3]	
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75	Existing ambient
Evenings (19:00 – 23:00 weekdays) and Weekends (13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays)	55	60	65	Existing ambient
Night-time (23:00 – 07:00)	45	50	55	Existing ambient
1 Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values. 2 Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as the category A values. 3 Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than the category A values.				

Time of day	SOAEL $L_{Aeq,T}$ dB (façade)			LOAEL $L_{Aeq,T}$ dB (façade)
	A[1]	B[2]	C[3]	
NOTE: if the ambient noise level exceeds the Category C threshold values then the SOAEL and LOAEL are defined as equal to the existing ambient.				

11.3.13 To determine the SOAEL and LOAEL, ambient noise levels at the relevant façade of each of the selected receptors have been predicted based on the 2024 Do-Minimum traffic data.

Construction traffic noise

11.3.14 Construction traffic noise impacts along existing roads have been estimated using the traffic noise model developed for the operational traffic noise assessment.

11.3.15 The construction traffic noise assessment is based on estimated construction traffic for the busiest period of the construction works and the period of traffic management on the M54 when one lane of eastbound traffic is diverted via the eastbound off/on slip-roads. The construction traffic impact is compared to the 2024 Do-Minimum scenario.

Construction vibration

11.3.16 Construction vibration impacts have been assessed for all construction activities which are a potentially significant source of vibration proposed in close proximity of any identified potentially sensitive receptors. These construction works comprise piling, and works using vibratory rollers (earthworks, road construction (pavement), pilling platform construction and road strengthening).

11.3.17 Rotary bored piling is proposed for bridgeworks and retaining walls and vibratory pilling is proposed for sheet pilling at bridges only. Vibration associated with rotary bored pilling is minimal, however vibratory piling is a potentially significant source of vibration. A discussion of the potential impacts is provided in Section 11.9 based on example measured data provided in BS 5228 (Ref 11.17).

11.3.18 Vibration levels due to vibratory rollers have been estimated in accordance with the relevant methodologies in BS 5228 (Ref 11.17). Source data for the vibratory rollers have been taken from Transport Research Laboratory (TRL) Report 429 (Ref 11.20). It is anticipated that three types of roller would be used primarily for earthworks and road construction (pavements), namely a large single drum roller (approximately 13 tonnes), a medium sized twin drum roller (approximately 3.5 tonnes) and a medium sized towed roller (approximately 3.5 tonnes).

11.3.19 The transmission of ground-borne vibration is highly dependent on the nature of the intervening ground between the source and receptor and the activities being undertaken. BS 5228 (Ref 11.17) provides data on measured levels of vibration for various construction works. Vibration impacts are considered herein for both damage to buildings and annoyance to occupiers.

11.3.20 Table 11.3 details Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of construction vibration effects on human receptors, based on guidance contained in BS 5228 (Ref 11.17).

Table 11.3: Construction vibration criteria for human receptors (annoyance)

Peak particle velocity level	Description
10 mms^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.
1.0 mms^{-1}	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
0.3 mms^{-1}	Vibration might be just perceptible in residential environments.
0.14 mms^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.

11.3.21 For human receptors the LOAEL is defined as a PPV of 0.3 mms^{-1} (millimetres per second), this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mms^{-1}, this being the level at which construction vibration can be tolerated with prior warning.

11.3.22 In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause human annoyance. Consequently, if vibration levels within buildings are controlled to those relating to annoyance (i.e. 1.0mms^{-1}), then it is highly unlikely that buildings would be damaged by construction vibration.

11.3.23 BS 7385-2: 1993 'Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration' (Ref 11.18) provides guidance on vibration levels likely to result in cosmetic damage and is referenced in BS 5228 (Ref 11.17). Guide values for transient vibration, above which cosmetic damage could occur, are given in Table 11.4.

Table 11.4: Transient vibration guide values for cosmetic damage

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings.	50 mms^{-1} at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial buildings.	15 mms^{-1} at 4 Hz increasing to 20 mms^{-1} at 15 Hz	20 mms^{-1} at 15 Hz increasing to 50 mms^{-1} at 40 Hz and above.
NOTE 1: Values referred to are at the base of the building. NOTE 2: For un-reinforced or light framed structures and residential or light commercial buildings, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.		

11.3.24 BS 7385-2 (Ref 11.18) states that for transient vibration, such as from individual impacts, the probability of building damage tends towards zero at levels less than 12.5 mms^{-1} PPV. For continuous vibration, such as from vibratory rollers, the threshold is around half this value.

11.3.25 It is also noted that these values refer to the likelihood of cosmetic damage. ISO 4866:2010 'Mechanical Vibration and Shock. Vibration of Fixed Structures. Guidelines for the Measurement of Vibrations and Evaluation of their Effects on Structures' (Ref 11.21) defines three different categories of building damage, namely:

- Cosmetic: formation of hairline cracks in plaster or drywall surfaces and in mortar joints of brick or concrete block constructions.
- Minor: formation of large cracks or loosening and falling of plaster or drywall surfaces or cracks through brick or blocks.
- Major: damage to structural elements, cracks in support columns, loosening of joints, splaying of masonry cracks.

11.3.26 BS 7385-2 (Ref 11.18) states that minor damage occurs at a vibration level twice that of cosmetic damage, and that major damage occurs at a vibration level twice that of minor damage. Therefore, this guidance has been used to define vibration criteria as detailed in Table 11.5 which can be used to assess continuous vibration impacts.

Table 11.5: Construction vibration criteria for assessing building damage

Damage risk	Continuous vibration level PPV mms^{-1}
Major	30
Minor	15
Cosmetic	6
Negligible	<6

Construction Significance of effect

11.3.27 The main factor in identifying the significance of construction noise and vibration annoyance effects is the magnitude of the impact relative to the SOAEL. In general, construction noise or vibration levels at, or above, the SOAEL would be considered significant, and levels below the SOAEL as not significant. However, in line with best practice, this initial decision on the significance of an effect is then combined with professional judgement which takes into account a range of other factors, including the following:

- the duration of the impact. Based on the guidance in BS 5228 (Ref 11.17), construction noise or vibration levels at, or above, the SOAEL for less than 10 days (or 10 evenings, weekends or nights) in any 15 consecutive days, or less than 40 days (or 40 evenings, weekends or nights) in any six consecutive months, would not normally be considered significant. With regard to the Scheme, detailed information on the exact timing and duration of individual activities is not confirmed. Therefore, a conservative judgement has been made of the likelihood of the duration criteria being exceeded based on the available information, taking advice from the appointed construction contractor;
- the location of the impact at the receptor. A receptor may contain areas which are more or less sensitive than others e.g. in a school, office spaces or

kitchens would be considered as being less sensitive than the classrooms; or a residential property may have no windows on the affected facade;

- the timing of the impact, night time impacts being more likely to be considered significant than daytime impacts; and
- the nature, times of use and design of the receptor, e.g. a receptor which is not used at night would not be considered sensitive to night time construction works.

11.3.28 With regard to the magnitude of noise impacts associated with construction traffic on public roads, this has been based on the anticipated change in traffic noise level, in accordance with the same criteria as used for short-term operational road traffic noise impacts as detailed in Table 11.7. The significance of the effect of construction traffic is considered in the same way as operational traffic noise as detailed in the section below (refer to paragraphs 11.5.6 to 11.5.7).

Operational

Operational traffic noise

11.3.29 Noise from a flow of road traffic is generated by both the vehicle engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (percentage of heavy duty vehicles (HDV)), road gradient, the type of road surface, the distance from the road and the presence of any obstructions between the road and the receptor.

11.3.30 Noise from a stream of traffic is not constant, but to assess the traffic noise impact a single figure estimate of the overall noise level is necessary. The index adopted by the UK Government in CRTN to assess traffic noise is $L_{A10,18h}$. This value is determined by taking the highest 10% of noise readings in each of the 18 one-hour periods between 06:00 and 00:00, and then calculating the arithmetic mean. As recorded in DMRB, a reasonably good correlation has been shown to exist between this index and the perception of traffic noise by residents over a wide range of noise exposures.

11.3.31 CRTN provides the standard methodology for predicting the $L_{A10,18h}$ road traffic noise level. Noise levels are predicted at a point measured 1 m horizontally from the external façade of buildings.

11.3.32 Although the main focus of the assessment presented herein is on daytime impacts, DMRB also requires an assessment of night-time traffic noise levels using the parameter $L_{night,\ outside}$, which is the traffic noise level over the period 23:00 to 07:00. However, this parameter is not calculated by the standard CRTN methodology. DMRB refers to three methods for calculating night-time traffic noise levels developed by TRL (Ref 11.22). The most widely used, and the one employed for this assessment, is 'Method 3' which factors the $L_{night,outside}$ from the $L_{A10,18h}$, based on the typical diurnal pattern of traffic flows in the UK.

11.3.33 The CRTN methodology applies a 'low flow' correction between 18 hour vehicle flows of 1,000 and 4,000. The low flow correction procedure amplifies the impact of

changes in traffic flows which are already low, in particular at receptors very close to the road. The 1,000 18 hour flow cut off is the lower limit of the reliability of the CRTN prediction methodology.

11.3.34 Predicted daytime and night-time traffic noise levels have been generated using noise modelling software. The model is based on traffic data generated by a traffic model of the Scheme and the surrounding area. The traffic flow and % HDV data are taken directly from the model. However, the traffic speeds are subject to a process called 'speed banding' which assigns one of four speeds to all non-motorway roads, as set out in IAN 185/15 (Ref 11.2). The model also includes the ground topography, ground type and buildings to form a 3D representation of the study area. Further details of the noise model data sources and assumptions are provided in Appendix 11.4 [TR010054/APP/6.3], whilst details of the traffic model are available in the Transport Assessment Report [TR010054/APP/7.4].

11.3.35 The general principle of DMRB is to allocate an assessment method according to risk - this process uses three levels of assessment: scoping, simple, and detailed. The assessment level used for this Scheme is the most comprehensive detailed assessment, as the Scheme is considered to have the potential to result in significant changes in traffic noise.

11.3.36 The objective of the assessment, as set out in DMRB, is to gain an overall appreciation of the noise and vibration climate, both with (Do-Something (DS)) and without (Do-Minimum (DM)) the Scheme, in order to identify where noise impacts occur, and to determine where mitigation to reduce these impacts may be appropriate. These conditions are assessed for the future baseline year (the year of Scheme opening) and the future assessment year (15 years after Scheme opening).

11.3.37 DMRB also requires consideration of the likely annoyance to residents caused by traffic noise, in both the short and long-term. Individuals vary widely in their response to the same level of traffic noise. However, the average or community response from a large number of people to the same level of traffic noise is fairly stable and, therefore, a community average degree of annoyance caused by traffic noise can be related to the long-term steady state noise level. In addition, DMRB notes that people are more sensitive to abrupt changes in traffic noise, for example, following the opening of a new road, than would be predicted from the steady state relationship between traffic noise and annoyance (as described above). These effects last for a number of years. However, in the longer term, the perceived noise annoyance tends towards the steady-state level due to familiarisation.

11.3.38 DMRB outlines the steps to be carried out at the detailed assessment stage, which have been followed for this assessment:

a) Identify the study area (see Section 11.6) and predict 18-hour (06:00 - 00:00) and night-time (23:00 - 07:00) traffic noise levels at all residential properties within the 600 m calculation area for all assessment scenarios.

b) Carry out the following comparisons for each property in order to identify the number of properties where residents may experience an increase or decrease in traffic noise levels and annoyance:

- The DM scenario in the future baseline year against the DM scenario in the future assessment year (long-term).
- The DM scenario in the future baseline year against the DS scenario in the future baseline year (short-term).
- The DM scenario in the future baseline year against the DS scenario in the future assessment year (long-term).

c) For night-time traffic noise levels, comparisons are only required for the long-term scenario and for properties where the $L_{night,outside}$ level is 55 dB or more in the relevant scenarios.

d) DMRB includes provision for the consideration of additional scenario comparisons. No other scenario comparisons are considered to be required for this assessment.

e) Assess the impact on sensitive receptors, other than residential properties, within the 600 m calculation area. This is based on 18-hour (06:00 - 00:00) traffic noise levels and considers the same three comparisons as outlined in (b) above for residential properties.

f) Complete a qualitative assessment of sensitive receptors which are within the 1 km study area, but outside the 600 m calculation area.

g) For affected routes which are outside the 1km study area, complete an assessment by estimating the CRTN BNL on these roads (the traffic noise level at 10 m) with and without the Scheme. Count the number of dwellings and other sensitive receptors within 50 m of these routes.

11.3.39 Different façades of the same property can experience different changes in traffic noise level depending on their orientation to the noise source. DMRB requires that each of the above comparisons of traffic noise levels is based on the façade which experiences the least beneficial change i.e. the largest increase, or, if all façades undergo a decrease, the smallest decrease. Additionally, DMRB requires that the above comparisons of annoyance use the highest levels of annoyance in the first 15 years. For properties which experience an increase in noise due to the Scheme, the greatest annoyance is likely to be immediately after the Scheme opens to traffic. For properties which experience a decrease in noise (and also in the DM comparison), the greatest annoyance is the steady-state level of annoyance in the long-term.

11.3.40 The SOAEL and the LOAEL for road traffic noise used in this assessment are detailed in Table 11.6.

Table 11.6: Traffic noise SOAEL and LOAEL for all receptors

Time period	SOAEL	LOAEL
Daytime	68dB $L_{A10,18h}$ (façade) 63dB $L_{Aeq,16h}$ (free-field)	55dB $L_{A10,18h}$ (façade) 50dB $L_{Aeq,16h}$ (free-field)
Night	55dB $L_{night,outside}$ (free-field)	40dB $L_{night,outside}$ (free-field)

11.3.41 For daytime, the SOAEL is set at 68 dB $L_{A10,18h}$ (façade), which is consistent with the daytime trigger level in the Noise Insulation Regulations. The Noise Insulation Regulation threshold has a history of use in UK noise policy as it has previously been incorporated into planning guidance on the acceptability of sites for new residential developments. It is the external level which corresponds to an internal level, with a closed single glazed window, which would meet the internal daytime criteria of 35 dB $L_{Aeq,16h}$ specified in BS 8233 (Ref 11.23) as desirable for resting in living rooms. It also correlates with the results of Defra Study NANR316 (Ref 11.24) and is supported by the guidance in the Professional Practice Guidance: Planning and Noise produced by the Association of Noise Consultants, Institute of Acoustic and Chartered Institute of Environmental Health (Ref 11.25).

11.3.42 The daytime LOAEL is set at 50 dB $L_{Aeq,16h}$ (free field), based on the guidance provided in the 1999 WHO Guidelines for Community Noise regarding the onset of moderate community annoyance (Ref 11.26). The WHO published the Environmental Noise Guidelines for the European Region in 2018 (Ref 11.27) which provides guidelines for specific noise sources including road traffic. The 2018 WHO Guidelines suggests a recommended 53 dB L_{den} for road traffic noise (note L_{den} correlates approximately to $L_{A10,18h}$) based on a 10% risk of being Highly Annoyed. The 2018 WHO guidelines state they are “not meant to identify effect thresholds”. Instead, they are based on the “smallest relevant risk increase” for various effects, and therefore lie slightly above the LOAEL. On this basis a LOAEL of 50 dB $L_{Aeq,16h}$ (free-field) is consistent with the latest WHO Guidelines.

11.3.43 For night-time, the SOAEL is set at 55 dB $L_{night,outside}$ (free field) this corresponds to an internal level, with a closed single glazed window, which would be slightly below the night time criteria of 30 dB $L_{Aeq,8h}$ specified in BS 8233 as desirable for sleeping in bedrooms. It also correlates well with the results of Defra Study NANR316 and is supported by the Professional Practice Guidance: Planning and Noise guidance (Ref 11.25). The WHO 2009 Night Noise Guidelines for Europe (Ref 11.28) explicitly identify the night time LOAEL as 40 dB $L_{Aeq,8h}$ (free-field). Therefore, this LOAEL has been adopted in the assessment. Levels between 40 and 55 dB are identified in the guidelines as where ‘adverse’ but not significant adverse, health effects are observed among the exposed population. 55 dB is identified in the guidelines as when the risk of cardiovascular disease increases.

11.3.44 The 2018 WHO Guidelines complement the WHO 2009 Night Noise Guidelines and suggest a recommended 45 dB L_{night} for road traffic noise based on a 3% risk of being Highly Sleep Disturbed. However, as discussed above the 2018 WHO guidelines state they are “not meant to identify effect thresholds”. Instead, they are based on the “smallest relevant risk increase” for various effects, and therefore lie slightly above the LOAEL, as explicitly defined in the WHO 2009 Night Noise Guidelines.

11.3.45 The operational road traffic noise SOAELs and LOAELs have been used successfully for numerous road schemes in recent years, including schemes which have successfully been determined through the Planning Act 2008 procedures. The same approach to the setting of LOAELs and SOAELs has also been adopted on other major infrastructure schemes such as the High Speed 2 rail project.

11.3.46 No special circumstances have been identified for the Scheme which suggest an alternative SOAEL or LOAEL should be adopted.

11.3.47 The road traffic noise SOAEL and LOAEL are used to consider how the Scheme complies with the three policy aims detailed in paragraph 5.195 of the NPSNN within the context of UK Government policy on sustainable development, namely:

- To avoid significant adverse impacts as a result of the Scheme i.e. reduce traffic noise levels at receptors to below the SOAEL.
- To mitigate and minimise other adverse impacts as a result of the Scheme i.e. reduce traffic noise levels at receptors which are between the LOAEL and the SOAEL.
- To contribute to improvements where possible i.e. reduce traffic noise levels at receptors where possible.

11.3.48 The assessment sets out what mitigation measures have been incorporated into the Scheme to meet these three aims, and also any measures which were not considered reasonable or practical to include.

Noise Insulation Regulations

11.3.49 A preliminary indication of any properties likely to qualify under the Noise Insulation Regulations is provided in the assessment. A full assessment would be completed once the detailed design of the Scheme is finalised and in accordance with the timescales set out in the Regulations.

Operational Traffic vibration

11.3.50 Vibration from traffic can be transmitted through the air or through the ground. Airborne vibration is produced by the engines and exhausts of road vehicles, with dominant frequencies typically in the range of 50 – 100 Hz. Ground borne vibration is produced by the interaction of the vehicle tyres and the road surface with dominant frequencies typically in the range of 8 – 20 Hz. The passage of vehicles over irregularities in the road surface can also be a source of ground borne vibration.

11.3.51 Traffic vibration can potentially affect buildings and disturb occupiers. DMRB reports that extensive research on a wide range of buildings has found no evidence of traffic induced ground borne vibration being a source of significant damage to buildings and no evidence that exposure to airborne vibration has caused even minor damage.

11.3.52 Airborne vibration is noticed by building occupiers more often than ground borne vibration, as it may result in detectable vibrations in building elements such as windows and doors.

11.3.53 DMRB states that perceptible vibration only occurs in rare cases and identifies that the normal use of a building, such as closing doors and operating domestic appliances, can generate similar levels of vibration to that from traffic in most circumstances.

11.3.54 It is a requirement that newly constructed highways have a highway surface that is smooth and free from any discontinuities. Paragraph A5.25 of DMRB Volume 11, Section 3, Part 7 (Ref 11.1) highlights that in relation to ground borne vibration: '*no evidence has been found to support the theory that traffic induced vibrations are a source of significant damage to buildings*'. Paragraph A5.26 of DMRB also states: '*Such vibrations are unlikely to be important when considering disturbance from new roads and an assessment will only be necessary in exceptional circumstances*'. Hence, no significant effects from traffic induced ground borne vibration due to the passage of vehicles over irregularities on the Scheme, in terms of either disturbance or damage to buildings (or other structures), are anticipated and thus no further assessment has been completed.

11.3.55 To assess the magnitude of the impact of traffic induced airborne vibration on residents, a parameter is needed which reflects a person's subjective rating of vibration disturbance. DMRB recommends the use of the $L_{A10,18h}$. The relationship between the $L_{A10,18h}$ and annoyance due to vibration is similar to that for annoyance due to steady state traffic noise, except that the percentage of people bothered by vibration is lower. For a given level of noise exposure, DMRB states that the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for annoyance due to traffic noise. Below 58 dB DMRB states that the percentage of people bothered by traffic induced vibration is zero.

11.3.56 The potential for vibration impacts is limited to the immediate vicinity of a road, and the relationship between annoyance due to vibration and traffic noise level in DMRB is based on properties located within 40 m of a road. Therefore, at each property within 40 m of the Scheme, the existing A460 replaced by the Scheme or other affected routes, and at which traffic noise levels are predicted to be 58 dB, $L_{A10,18h}$ or more, the percentage of people likely to be bothered very much or quite a lot by vibration has been calculated.

Operational Significance of effect

11.3.57 An initial identification of significant effects is carried out based on the magnitude of change in traffic noise levels due to the Scheme. DMRB provides two example classifications for the magnitude of the traffic noise impact of a proposed road scheme, as shown in Table 11.7. These relate to both short-term changes and long-term changes in noise levels. The short-term classification detailed in Table 11.7 is the main driver of the initial identification of significant effects.

Table 11.7: Magnitude of traffic noise impacts

Short-term change		Long-term change	
Noise level change (rounded to 0.1 dB) $L_{A10,18h}$ dB	**Magnitude of impact**	**Noise level change (rounded to 0.1 dB) $L_{A10,18h}$ dB**	**Magnitude of impact**
0	No change	0	No change
0.1 – 0.9	Negligible	0.1 – 2.9	Negligible
1.0 – 2.9	Minor	3.0 – 4.9	Minor
3.0 – 4.9	Moderate	5.0 – 9.9	Moderate
5.0+	Major	10.0+	Major

11.3.58 In general, a negligible or minor magnitude of impact is not normally considered significant and a moderate or major magnitude of impact is normally considered significant. However, in line with best practice this initial decision on the significance of an effect is then combined with professional judgement, which takes into account a range of other factors, including:

- the absolute noise levels e.g. if traffic noise levels are already very high (above the SOAEL), then a smaller noise level change than outlined in Table 11.7 may be considered significant (i.e. a 1.0 dB change in the short term, rather than a 3.0 dB change). Conversely if traffic noise levels are very low (below the LOAEL), then a larger noise level change may be required to be considered significant;
- where the magnitude of change in the short-term lies relative to the boundaries between the bands outlined in Table 11.7, e.g. in some circumstances a change towards the top end of the minor category, may be considered significant, conversely a change towards the bottom end of the moderate category may not be considered significant;
- if the magnitude of change in the long-term is different to that in the short-term e.g. if the short-term change is minor (not significant), but the long-term change is moderate (significant), then a significant effect may be identified;
- the circumstances of the receptor. A receptor may contain areas which are more or less sensitive than others e.g. office spaces or kitchens in a school would be considered less sensitive than classrooms. Alternatively, a receptor may be particularly vulnerable, such as a school for hearing impaired children;
- the acoustic character of an area. e.g. if a scheme introduces road noise into an area where road noise is not currently a major source;
- the likely perception of a traffic noise change e.g. does the noise change combine with other changes, such as an increase in the visibility of a road, which may increase the perceived impact; and
- the proportion of a designated site that is affected by the noise change e.g. moderate or major changes that affect a larger proportion of a designated site are more likely to be significant than changes that affect a smaller proportion of

a site. The overall judgement also considers the importance of the site, and the potential effect of noise changes on the site as a whole.

Scoping response

11.3.59 The proposed scope of the noise and vibration assessment was detailed in the EIA Scoping Report (Ref 11.29) submitted to the Inspectorate on 11 January 2019. An overview of the Inspectorate's Scoping Opinion in relation to noise and vibration is presented in Table 11.8. Where the assessment has been undertaken in accordance with the scoping opinion point, a response and the relevant ES section is provided; where an alternative approach has been agreed with the relevant stakeholders, an explanation is provided.

Table 11.8: Scoping opinion and response

Scoping Opinion	Where addressed in the ES
The Inspectorate	
This matter is not explicitly stated as being scoped out of the ES, but it is not included as 'scoped in' in Table 17.1 and this paragraph indicates that aside from the research described, no further assessment is intended. The Inspectorate notes the evidence from research provided in the Scoping Report that traffic-induced ground borne vibration is not expected to produce significant effects either through damage to buildings or disturbance to occupiers. However, the Scoping Report does [not] provide evidence in relation to disturbance of ecological receptors. The Inspectorate agrees that effects with respect to damage to buildings and disturbance to occupiers can be scoped out of the ES. However, the ES should assess impacts from ground borne vibration during operation on ecological receptors, where these could result in significant effects.	Impacts on ecological receptors are reported in Chapter 8: Biodiversity. The Scheme has not been identified as a potentially significant source of vibration. No ecological receptors have been identified which would be potentially sensitive to vibration in the vicinity of the Scheme.
A qualitative assessment is proposed for receptors located over 600m from but within 1km of affected routes. The reasons supporting this approach for receptors in these locations is not presented in the Scoping Report. This information should be explained in the ES and should ensure there is a robust assessment of the likely significant effects.	This approach is in accordance with the methodology prescribed in DMRB and is set out in Section 11.3 'Assessment methodology'.
Paragraph 12.2.1 of the Scoping Report explains that receptors, will be identified based on 'a selection of the closest identified potentially sensitive receptors to the works'. It is not explained what selection process/distance will be applied to this identification. The ES should provide an explanation of the process used to identify receptors, including where the consultation process has been used to inform the process, for all phases of the Proposed Development.	Construction receptor selection is set out in Section 11.5 'Study Area'. SSC have been consulted on the selected construction receptors.
The Inspectorate notes that the monitoring locations and methodology will be informed by consultation. It will be essential for the monitoring to provide a robust, representative sample of the baseline noise conditions,	Monitoring locations and methodology were agreed with SSC as detailed in Section 11.3 'Assessment methodology'.

Scoping Opinion	Where addressed in the ES
allowing for variations across daytime/ night-time/ weekdays/ weekends. The monitoring should be carried out in such a way that can achieve this. The Applicant should make effort to reach agreement with relevant consultees in order to refine the methodology applied.	
The Scoping Report describes residential, educational facilities, and community facilities as potential receptors. It will be important for the ES to demonstrate that other types of receptors, for example offices/commercial properties and sensitive ecological receptors have been considered. Where information from the noise assessment has been informed by other assessments in the ES or used to inform other assessments (for example effects on human health), this should be identified in the ES.	Potentially sensitive receptors have been identified in accordance with the requirements of DMRB and NPSNN as detailed in Section 11.3 'Assessment methodology' and include ecological receptors. Offices and commercial premises are not identified as potentially sensitive and are not included in the assessment.
The Scoping Report assumes that low noise surfacing will form part of the scheme design, and that this will be in place on the M54, M6, M6 Toll and A449 in the opening year of the Proposed Development. The project description in the ES should reflect this and the noise assessment in the ES should clearly set out the assumptions regarding embedded mitigation on which it has been based. Measures to be employed (both embedded and additional) to mitigate noise impacts should be described in the ES.	Mitigation included within the design is set out in Section 11.8 'Design, mitigation and enhancement measures'.
The Scoping Report discusses applying a 'low-flow' correction to the roads in the study area. It is not explained why this is appropriate given the nature of the roads involved, and this should be clarified in the ES. Any assumptions applied to the assessment should be explained and justified in the ES.	Details of the CRTN low flow procedure are set out in Section 11.3 'Assessment methodology'.
The Scoping Report explains how receptors of air borne traffic induced vibration will be identified, and then states that the percentage of people likely to be bothered 'very much' or 'quite a lot' will be calculated. The Scoping Report does not explain how this calculation will be done and how it relates to the assessment of significance. This information should be provided in the ES.	Details of the operational vibration annoyance assessment methodology are set out in Section 11.3 'Assessment methodology'.
Hilton Parish Council	
Exact figures relating to noise pollution which will inevitably have a negative effect on the Parishes of Featherstone, Shareshill and Hilton due to their close proximity to Junction 1 of the M54.	The results of the operational traffic noise assessment are reported in Section 11.9 'Assessment of likely significant effects'.
Public Health England	
We recommend that the proposed consultation with the local community and wider public recognises the potential for increased noise levels associated with the construction	Public consultation events included details of draft operational traffic noise changes and auralisations of the changes

Scoping Opinion	Where addressed in the ES
and operational phases of the Scheme and possible noise mitigation strategies.	in selected locations. Further details are provided in the Consultation Report [TR010054/APP/5.1].
We encourage the scheme promoter to use effective ways of communicating changes in the acoustic environment as a result of the scheme to local communities.	Public consultation events included details of draft operational traffic noise changes and auralisations of the changes in selected locations. Further details are provided in the Consultation Report [TR010054/APP/5.1].
We expect the Consultation Report to explain how stakeholder responses in relation to noise have influenced the development of the proposal, including any mitigation measures. In addition, the applicant should propose a suitable strategy to disseminate the findings of the PEIR (and EIA) regarding the effects of noise on health to stakeholders, including communities which may experience a change in their local noise environment as a result of the scheme.	Refer to the Consultation Report [TR010054/APP/5.1]. Mitigation included within the design is set out in Section 11.8 'Design, mitigation and enhancement measures'.
We expect due consideration to be given to the potential effects on human health due to changes in environmental noise arising from construction and operational phases of the Scheme. We recommend the quantification of health outcomes such as annoyance, sleep disturbance and cardiovascular effects – these can be expressed in terms of number of people affected, Disability Adjusted Life Years (DALYs) and/or monetary terms, and the applicant should use the methodologies and exposure response relationships set out in publications by the WHO [1, 2] and the IGCBN [3].	Discussions have been held with PHE to confirm that the Noise assessment has been completed in accordance with the requirements of DMRB. Human health effects are considered in Chapter 12: Population and Human Health. Quantification of health effects has not been completed as part of the ES, though it is noted that the Transport Analysis Appraisal completed for the business case does include monetization of noise health effects.
We recommend that assessments of significance are based on impacts on health and quality of life, and not around noise exposure per se (in line with the Noise Policy Statement for England, NPSE). Furthermore, significance should reflect both the severity of the health outcome and the size of the population affected. Other considerations that can be taken into account are: i. The existing noise exposure of affected communities – particularly any designated Noise Important Areas in proximity to the scheme. These are areas with the highest levels of noise exposure at a national level, and require very careful consideration in terms of opportunities for improvement of health and quality of life through noise management;	The results of the operational traffic noise assessment on Noise Important Areas are reported in Section 11.9 'Assessment of likely significant effects'. This includes consideration of the effects in Noise Important Areas. Cumulative effects are reported in Chapter 15: Assessment of Cumulative Effects. Human health effects are considered in the Chapter 12: Population and Human Health.

Scoping Opinion	Where addressed in the ES
ii. Cumulative exposure to other environmental risk factors, including other sources of noise and air pollution; and [ ] iii. Local health needs, sensitivities and objectives.	
We expect decisions about noise mitigation measures to be underpinned by good quality evidence, in particular whether mitigation measures are proven to reduce adverse impacts on health and quality of life. For interventions where evidence is weak or lacking, it is expected that a proposed strategy for monitoring and evaluating their effectiveness during construction and operation of the Scheme.	Mitigation included within the design is set out in Section 11.8 'Design, mitigation and enhancement measures'. Discussions have been held with PHE to confirm that mitigation in the form of Noise Insulation has not been assumed to remove significant effects. Monitoring is discussed in Section 11.10 'Monitoring'.
It is expected that a Construction Environmental Management Plan (CEMP) will be developed and implemented by the Contractor, in part to mitigate the adverse impact of construction noise. We recommend that the CEMP includes a detailed programme of construction which highlights the times and durations of particularly noisy works, the proposed noise mitigation measures, and a strategy for actively communicating this information to local communities.	Construction mitigation measures are detailed in Section 11.8 'Design, mitigation and enhancement measures' and are specified in the OEMP [TR010054/APP/6.11]. This includes the requirement to produce a CEMP.
We expect proposals to take into consideration the evidence which suggests that quiet areas can have both a direct beneficial health effect and can also help restore or compensate for the adverse health effects of noise in the residential environment. Research from the Netherlands suggests that people living in noisy areas appear to have a greater need for areas offering quiet than people not exposed to noise at home.	Identification of potentially noise sensitive receptors includes consideration of public open spaces, as required by NPSNN and detailed in Section 11.3 'Assessment methodology'.
Noise insulation schemes do not protect amenity spaces (such as private gardens or community green spaces) from increased noise exposure, and there may be opportunities to create new tranquil public spaces that are easily accessible to those communities exposed to increased noise from the scheme.	Refer to Chapter 12: Population and Human Health, Section 12.9.

Consultation

11.3.60 Consultation has been carried out with the Environmental Health Department of SSC. Discussions in December 2018 and October 2019 confirmed:

- The council is not aware of any unusual noise sensitive receptors in the area in addition to those identified from OS mapping which includes residential properties and various schools, village halls etc. Hilton Hall was confirmed as a business and therefore not considered to be noise sensitive. The noise levels at Hilton Hall, as a grade I listed building, is considered as part of the heritage assessment in Chapter 6: Cultural Heritage.

- The council has not identified any quiet places or other areas that are particularly valued for their tranquillity or acoustic environment in the vicinity of the Scheme.
- The council is not aware of any proposed developments in the area that might affect the assessment e.g. major housing or commercial developments.
- Noise or vibration from existing roads in the area is not a source of complaint, though it was noted the local authority do not have powers to deal with this issue.
- The proposed assessment methodology for the operational road traffic noise assessment is in accordance with DMRB.
- The proposed construction noise and vibration assessment is in accordance with BS 5228 method 1 (ABC Method). The council does not have any specific requirements for construction in terms of noise criteria etc. however standard construction hours are 08:00-18:00 weekdays and 08:00-13:00 Saturdays, with no working on Sundays or Bank Holidays. The likely requirement for some night/weekend works to tie in the Scheme to the existing roads was identified though durations should be limited and this will be considered in the assessment.
- The council's agreement to the proposed baseline noise monitoring locations and monitoring methodology.

11.3.61 The Preliminary Environmental Information (PEI) Report for this Scheme (Ref 12.24) was published in May 2019 as part of the statutory consultation. The PEI Report presented the environmental information collected, together with the preliminary findings of the assessment of likely significant environmental effects of the Scheme at the time. Comments received during public consultation and the associated responses, are detailed within the Consultation Report [TR010054/APP/5.1].

11.4 Assessment assumptions and limitations

11.4.1 The following assumptions or limitations are relevant to this noise and vibration impact assessment:

- Speed banding has been applied to the traffic data used in the noise assessment.
- A small number of road links have very low flows, below the lower cut off of the CRTN prediction methodology of 1000 vehicles over an 18 hour day, mainly to the north-west of Shareshill and on Dark Lane, once the Scheme is operational as it would become a cul-de-sac. As a conservative approach these road links have been retained in the traffic noise predictions though the contribution to traffic noise levels at nearby receptors must be treated with caution. Road links with a flow of less than 1000 vehicles are not included in the identification of affected routes.
- The information on existing road surfacing on Highways England roads and the M6 Toll in the study area is based on the data in the Highways England Highways England Highways Agency Pavement Management System

(HAPMS) database and discussions with the Area 9 Maintaining Agents. Information on future resurfacing plans in the area is based on Highways England's current maintenance proposals (based on information provided by the Area 9 Maintaining Agents). All non-Highways England roads included in the detailed quantitative noise modelling are assumed to be standard hot rolled asphalt in all scenarios.

- Road surfacing corrections as follows have been assumed during the assessment, based on the requirements of DMRB:
  - Standard hot rolled asphalt and high friction surfacing:
    - Speed <75 km/hr: -1.0dB.
    - Speed ≥75 km/hr: -0.5dB.
  - Thin surfacing (low noise):
    - Speed <75 km/hr: -1.0dB.
    - Speed ≥75 km/hr: -3.5dB.
  - Concrete:
    - Speed <75 km/hr: -1.0dB.
    - Speed ≥75 km/hr: -+2.0dB.
- Details of the location and height of existing noise barriers in the study area have been taken from the HAPMS database, Lidar data and site observations.
- The existing barrier at Junction 1 of the M54 is assumed to be retained or replaced in an equivalent position with the Scheme in operation.
- OS Address Base Plus data detailing building usage and OS Building Height Attribute data have generally been used as provided. However, the heights of residential buildings have been standardised, and a check for obvious errors (such as buildings with 0 m height) has been completed using information available online, and adjustments made accordingly.
- The construction assessment is based on the construction information that is currently available, with advice being provided by the appointed construction contractor. As with all construction assessments, the exact details of construction activities would not be fully understood before the detailed design stage of a scheme when the exact construction methods and programme will be determined.
- The potential for operational ground borne vibration impacts is related to the presence of irregularities in the road surface, which are not an issue with new road surfaces and are resolved by routine maintenance of existing roads. Therefore, in accordance with the guidance in DMRB, operational ground borne vibration impacts are scoped out of the assessment.

11.5 Study area

Construction

11.5.1 The study area for the quantitative assessment of construction phase noise and vibration impacts focuses on 22 potentially sensitive receptors, which includes those

closest to the Scheme construction works . Receptors have been chosen based on their potential sensitivity (as defined in DMRB and as discussed with SSC) and receptor proximity to the various works. The selected receptors are also representative of neighbouring properties in their vicinity. By focussing on a selection of the closest identified potentially sensitive receptors, the reported impacts are, therefore, typical of the worst affected receptors such that all potentially significant effects have been identified. The receptors further away from the works demonstrate how the impact is reduced further away from the works.

Operation

11.5.2 The study area for the assessment of operational phase noise impacts has been defined following the guidance set out within DMRB. The study area consists of the Scheme, the existing A460 route bypassed by the Scheme, and all surrounding existing roads that are predicted to be subject to a change in traffic noise level as a result of the Scheme of:

- 1.0 dB or more in the short-term (Do-Minimum (DM) opening year to Do-Something (DS) opening year); or
- 3.0 dB or more in the long-term (DM opening year to DS 15 years after Scheme opening), subject to a minimum change of 1.0 dB between the DM and DS 15 years after Scheme opening.

11.5.3 These roads are defined as ‘affected routes’ and are identified by the analysis of the operational phase traffic data. The identification of affected routes considered all roads with 18 hour (06:00 - 00:00) weekday traffic flows above the lower cut off of the CRTN prediction methodology in all scenarios.

11.5.4 The study area for the detailed quantitative assessment of noise impacts comprises a 600 m area either side of the Scheme carriageway, 600 m either side of the existing A460 carriageway replaced by the Scheme, and 600 m either side of all affected routes within a 1 km maximum study area around the Scheme and existing A460 bypassed by the Scheme. Additionally a 50 m corridor either side of the A460 south of the M54 Junction 1 as far as the junction with Underhill Lane, has been included within the detailed quantitative assessment study area to ensure a potentially significant effect in this area is captured.

11.5.5 For residential properties and other sensitive receptors that are within the 1 km maximum study area around the Scheme and the existing A460 replaced by the Scheme, but are more than 600 m from an affected route, the Scheme or existing A460 bypassed by the Scheme, a qualitative assessment of the traffic noise impacts has been completed.

11.5.6 For all other affected routes which are outside the 1 km maximum study area around the Scheme and existing A460 bypassed by the Scheme, an assessment has been undertaken by estimating the CRTN BNL for these routes with and without the Scheme. A count of the number of dwellings and other sensitive receptors within 50 m of these routes has been undertaken.

11.5.7 The study area for the assessment of operational phase airborne vibration annoyance impacts is defined, in accordance with DMRB, as 40 m from the Scheme, the existing A460 bypassed by the Scheme, identified affected routes within the 1 km maximum study area, and the section of the A460 south of the M54.

11.5.8 The 1 km and 600 m study areas are illustrated in Figure 11.1 [TR010054/APP/6.2]. The identified affected routes are illustrated in Figure 11.2 [TR010054/APP/6.2].

11.6 Baseline conditions

11.6.1 The study area consists of a mixture of agricultural land use, built up areas, including Featherstone, Hilton and Shareshill, individual or small groups of properties and major transport infrastructure including the M54, M6 and M6 Toll. These motorways and 'A' roads including the A460, A462 and A4601 are the main existing noise sources in the area.

11.6.2 Residential properties are concentrated in the built up areas of Featherstone and Shareshill. Smaller areas of residential properties are located close to the Scheme at Dark Lane, Park Road, Hilton Lane and Brookfield Farm.

11.6.3 Non-residential potentially sensitive receptors including educational buildings, medical buildings and community facilities are concentrated in Featherstone and Shareshill. Moseley Old Hall, owned by the National Trust and open to the public is located to the south of the M54 just beyond the western end of the Scheme. A number of PRoW are located in the study area.

11.6.4 No parks or designated open spaces which are open to the public are located in the study area. SSC completed an Open Space Audit in 2008 (Ref 11.30) which identified Moseley Old Hall and a range of small informal open spaces concentrated within the housing areas of Featherstone, Hilton and Shareshill, primarily associated with other uses such as community centres and places of worship, which are included as non-residential potentially sensitive receptors in the assessment.

11.6.5 No international or national designated areas (Scheduled Monument, World Heritage Site, SAC, SPA, SSSI, National Park or AONB) have been identified within the study area.

11.6.6 No quiet places or other areas that are publicly accessible and particularly valued by the public for their tranquillity or acoustic environment have been identified in the vicinity of the Scheme.

11.6.7 Within South Staffordshire, Housing Allocation Site 168, west of Featherstone, lies within the 1 km study area.

11.6.8 Under the Environmental Noise Directive (END) strategic noise mapping of major roads, railways, airports and agglomerations has been completed across England, including for the M54, M6, M6 Toll, A460 and other major roads in the vicinity of the Scheme. Three 'Noise Important Areas' (those areas most exposed to noise) were identified in the Round 3 strategic noise mapping (carried out in 2017) in the 1 km study area. Details of the Noise Important Areas in the 1 km study area are detailed below (together with details regarding the relevant authority):

- 7364: Wolverhampton Road (Highways England);
- 11490: A460 (Staffordshire County Council); and
- 7365: M54 (Highways England).

11.6.9 Figure 11.1 illustrates the identified potentially sensitive receptors in the study area and the designated Noise Important Areas [TR010054/APP/6.2].

Existing noise barriers

11.6.10 Within the study area a section of existing timber noise barrier has been identified from the HAPMS database on the M54 eastbound carriageway at Junction 1. The HAPMS database does not include any details of the barrier height; however, it has been determined that the barrier is 1.8 m high, based on the Lidar data.

11.6.11 The existing barrier at Junction 1 of the M54 is assumed to be retained with the Scheme, though some slight adjustment for the Scheme would be required.

Existing and future surfacing

11.6.12 Taking into account surfacing information in the HAPMS database, thin surfacing has been assumed to be in place on the M54, M6, M6 Toll and A449 throughout the study area, in the opening year and design year, with and without the Scheme (with the exception of short sections of high friction surfacing in the vicinity of junctions). Thin surfacing is proposed as part of the Scheme within the Scheme extents, with the exception of short sections of high friction surfacing in the vicinity of junctions as a safety precaution.

11.6.13 The majority of other roads included in the detailed quantitative noise modelling are assumed to be standard hot rolled asphalt in the opening year and design year both with and without the Scheme. The exception is the A5 which is a mixture of thin surfacing, hot rolled asphalt and high friction surfacing, as detailed in HAPMS.

11.6.14 A short section of the M54 west of Junction 2 is identified in HAPMS as currently being concrete, though as detailed above this is assumed to have been replaced with thin surfacing by the Scheme opening year of 2024. As this section is remote from the Scheme it is not critical to the assessment.

Baseline noise survey

11.6.15 A baseline noise survey was completed in March 2019. Noise monitoring locations are detailed on Figure 11.1 [TR010054/APP/6.2]. These locations were chosen to focus on some of the closest receptors to the Scheme and were agreed with SSC.

11.6.16 A combination of long-term unattended monitoring over a number of weeks, and a short-term daytime three hour monitoring session were completed. A summary of the noise monitoring results is provided in Table 11.9, which details the range of measured noise levels for the long-term monitoring sites and a comparison with predicted traffic noise levels. Further details are provided in Appendix 11.2 [TR010054/APP/6.3].

Table 11.9: Baseline noise monitoring 2019 (for locations refer to Figure 11.1)

Ref.	Description	Short-term (ST)/ Long-term (LT)	Measured	Predicted
			$L_{A10,18h}$ dB	$L_{A10,18h}$ dB
M1	43 Dark Lane	LT	51.6 to 54.0	54.7
M2	Park View, Hilton Lane	LT	57.1 to 59.0	59.4
M3	Brookfield Farm	LT	48.4 to 54.7	54.5
M4	Near to Kings Pool, A460	ST	76.4	77.5
M5	Lower Lodge, A460	LT	62.7 to 65.3	66.1

11.6.17 Table 11.9 indicates that the highest measured and predicted noise levels were recorded at locations close to the existing A460, at monitoring locations M4 and M5.

11.6.18 At all the long-term monitoring locations the predicted $L_{A10,18h}$ noise levels match very well with the upper range of the measured levels, within 0.8 dB. The noise prediction methodology is designed to be conservative, in particular with regard to wind direction, therefore, this is as would be expected.

11.6.19 Overall, the comparisons provide confidence that the noise model developed to estimate the noise impacts of the Scheme is robust.

Future do-minimum

11.6.20 As detailed in Chapter 4: Environmental Assessment Methodology, in order to identify the effects of the Scheme on environmental features, it is important to understand the future do-minimum situation at the year of construction commencement and at the year the Scheme becomes operational. The do-minimum conditions for these years may be different to the current conditions and such changes could alter the sensitivity of existing environmental receptors, as well as introduce new sensitive receptors.

Construction year do-minimum (2021)

11.6.21 The baseline detail as reported in the section above describes the noise climate in 2019, the year that the baseline noise survey was undertaken, and for which baseline traffic data is available.

11.6.22 Preliminary works associated with the Scheme are anticipated to start in 2021, subject to securing a DCO with construction works being completed in 2024.

11.6.23 The majority of the land that would be impacted by the Scheme (and in its vicinity) comprises agricultural land and residential areas. Accordingly, environmental do-minimum conditions are not anticipated to change significantly by 2021 from the conditions as detailed above. However, as detailed in Chapter 15: Assessment of Cumulative Effects, a number of development projects are ongoing, or are planned, that have the potential to change baseline conditions. The impact of these developments in terms of traffic flows are included within the traffic data used in the noise assessment.

11.6.24 As detailed in Section 11.3 ambient noise levels used to set significance criteria in the construction noise assessment are based on 2019 traffic data, which is considered to constitute a conservative approach.

Opening year do-minimum (2024)

11.6.25 As detailed in Chapter 15: Assessment of Cumulative Effects, a number of additional development projects in the area will have been completed by 2024. These are captured by the 2024 traffic data used in the operational traffic noise assessments.

15 years after opening do-minimum (2039)

11.6.26 A range of long-term potential future development proposals including the West Midlands Freight Interchange, have been taken into account, by the traffic modelling used to support the 2039 noise assessment (both with and without the Scheme).

11.6.27 A summary of predicted Do-Minimum traffic noise levels and the change from the Scheme opening year (2024) to the future assessment year (2039) is provided in Table 11.10.

Table 11.10: Long-term change in predicted DM traffic noise levels (DM 2024 to DM 2039)

Change in noise level		Daytime		Night-time
		Number of residential buildings	Number of other sensitive receptors	Number of residential buildings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 2.9	2072	9	439
	3.0 - 4.9	19	0	0
	5.0 - 9.9	10	0	0
	≥10	0	0	0
No change	0	0	0	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 2.9	0	0	0
	3.0 - 4.9	0	0	0
	5.0 - 9.9	0	0	0
	≥10	0	0	0

11.6.28 Table 11.11 provides a summary of the corresponding change in traffic noise annoyance at residential buildings from the Scheme opening year of 2024 to the future assessment year of 2039, as required by DMRB.

Table 11.11: Long-term change in DM traffic noise annoyance (DM 2024 to DM 2039)

Change in % Annoyed		Daytime
		Number of residential buildings
Increase in annoyance level	<10%	2098
	10 <20%	3
	20 <30%	0
	30 <40%	0
	≥40%	0
No change	0	0
Decrease in annoyance level	<10%	0
	10 <20%	0
	20 <30%	0
	30 <40%	0
	≥40%	0

11.6.29 An estimated total of 2101 residential buildings are located within the Calculation Area (as shown on Figure 11.1). However, only 439 buildings meet the DMRB criterion of 55 dB $L_{night,outside}$ at one or more façades in one or more scenarios for inclusion in the night-time traffic noise assessment.

11.6.30 A total of nine non-residential sensitive buildings are located within the study area, consisting of Mosley Old Hall, a place of worship, school and village hall in Shareshill, a church, health centre, community centre and school in Featherstone, and a nursery off the A460 south of the M54 Junction 1, as shown on Figure 11.1 [TR010054/APP/6.2].

11.6.31 Table 11.10 and Table 11.11 are based on the façade at each building which undergoes the least beneficial change in traffic noise level from the DM 2024 scenario to the DM 2039 scenario. The results are provided for the top floor of each building, for example, 1.5 m for a one storey house, 4.0 m for a two storey house. Further details of the noise model set-up and assumptions are provided in Appendix 11.4 [TR010054/APP/6.3].

11.6.32 The traffic noise changes from DM 2024 to DM 2039 are presented as a noise difference contour plot in Figure 11.3 [TR010054/APP/6.2]. This plot is based on free-field traffic noise levels at first floor level (4.0 m above ground) using a 10 m x 10 m grid and is provided for illustration purposes.

11.6.33 Figure 11.3 illustrates that the vast majority of residential buildings (over 98%), and all the sensitive non-residential receptors, would experience a negligible (0.1 - 2.9 dB) increase in daytime traffic noise levels from 2024 to 2039 in the absence of the

Scheme. This is due to the general growth in traffic over time. In the absence of the Scheme 19 residential buildings are predicted to experience a minor (3.0 – 4.9 dB) increase and 10 a moderate (5.0 – 9.9 dB) increase. All except one of the minor increases and all of the moderate increases are located on the western end of Church Road in Shareshill. The increase in traffic on this road from 2024 to 2039 in the absence of the Scheme is due to the operation of the proposed West Midlands Interchange located to the north-west of the noise study area in Four Ashes, which is included in the 2039 traffic data. However, it should be noted that both the 2024 and 2039 Do-Minimum 18 hour traffic flows on this road are very low, increasing from around 700 vehicles in 2024 to around 1600 vehicles in 2039. The 2024 flow of 700 vehicles is below the lower cut off of 1000 vehicles per 18 hour day for the CRTN prediction methodology. The 2039 flow of 1600 is classed as a 'low flow' in the CRTN methodology. Therefore, the magnitude of the predicted increases in traffic noise levels should be treated with some caution.

11.6.34 A summary of the change in annoyance due to airborne vibration from road traffic between the two DM scenarios (DM 2024 to DM 2039) is provided in Table 11.12.

Table 11.12: Long-term change in Do-Minimum traffic vibration annoyance (DM 2024 to DM 2039)

Change in % annoyed		**Daytime**
		Number of residential buildings
Increase in annoyance level	<10%	365
	10 <20%	0
	20 <30%	0
	30 <40%	0
	≥40%	0
No change	0	0
Decrease in annoyance level	<10%	0
	10 <20%	0
	20 <30%	0
	30 <40%	0
	≥40%	0

11.6.35 A total of 365 residential buildings have been identified within the 40 m operational vibration annoyance study area (40 m from the Scheme, the existing A460 which is bypassed by the Scheme, the identified affected routes within the 1 km study area, and the A460 south of M54 Junction 1). The affected routes include Hilton Lane, east of the A460, a section of Church Road in Shareshill and New Road on the northern edge of Featherstone. All of these residential buildings would experience

a small increase in annoyance from 2024 to 2039 in the absence of the Scheme due to the general growth in traffic over time.

11.6.36 Table 11.13 details the long-term change in the CRTN BNL at the identified affected routes beyond the 1 km study area. The location of these roads is illustrated in Figure 11.2 [TR010054/APP/6.2].

Table 11.13: Affected routes beyond 1 km - change in traffic noise levels (DM 2024 to DM 2039)

Link ref.	Description	Number of receptors within 50 m		BNL $L_{A10,18h}$ dB at 10 m from the road		
		Residential	Non-residential	2024 DM	2039 DM	Change
49632_49633	Whitehouse Lane	56	1 Place of worship	60.5	62.0	+1.5
50294_50296	A5 Telford to junction with Woodhouse Lane	44	0	70.0	70.3	+0.3
50295_50296	A5 around junction Woodhouse Lane	0	0	70.0	70.3	+0.3
50315_50295	A5 junction with Woodhouse Lane to junction with B4379	4	0	70.0	70.3	+0.3
50315_50330	A5 junction with B4379 to junction with A41	9	0	70.3	70.8	+0.5
50227_50228	A442 on-slip from Hollinswood Interchange	0	0	62.3	64.0	+1.7
50240_50217	A442 on-slip from Greyhound Roundabout	6	0	60.6	63.7	+3.1
2043_15150, 15150_2043	A449 Stafford Road - At junction with A5	0	0	68.3	68.4	+0.1
2045_2043, 15150_2043	A449 Stafford Road - South of Junction with A5	0	0	69.1	69.4	+0.3
2045_2043, 2043_2045	A449 Stafford Road - Passing Marsh Farm	4	0	70.3	70.6	+0.3

Link ref.	Description	Number of receptors within 50 m		BNL $L_{A10,18h}$ dB at 10 m from the road		
		Residential	Non-residential	2024 DM	2039 DM	Change
2045_2043, 2043_2045	A449 Stafford Road - between Gravely Way and North of Station Drive	1	0	70.3	72.1	+1.8
16015_2045, 2045_16015	A449 Stafford Road - North of junction with Station Drive	1	0	68.3	69.9	+1.6
2047_16015, 16015_2047	A449 Stafford Road - South of junction with Station Drive	2	0	69.7	70.5	+0.8
49753_2047, 2047_49753	A449 Stafford Road - between South of Station Drive and Standeford	7	0	71.8	72.7	+0.9
2048_49753, 49753_2048	A449 Stafford Road - South of Standeford	6	0	70.2	71.3	+1.1
16014_2048, 2048_16014	A449 Stafford Road - South of roundabout to Poplars Farm Way	19	0	68.4	69.4	+1.0
18516_90198	Vicarage Road - Between junction with A5 and North of Woodside Farm	2	0	66.6	69.9	+3.3
18516_90198	Vicarage Road - Between North of Woodside Farm and junction with Straight Mile	7	0	66.6	69.0	+2.4
90198_96068	Vicarage Road - Between junction with Straight Mile and Four Ashes	3	0	63.3	63.7	+0.4
96074_16028	Hilton Lane – Between junction with A462 and junction with Dark Lane	2	0	65.0	65.6	+0.6

Link ref.	Description	Number of receptors within 50 m		BNL $L_{A10,18h}$ dB at 10 m from the road		
		Residential	Non-residential	2024 DM	2039 DM	Change
2026_96074	Hilton Lane – Between junction with Dark Lane, passing into Wakeman's Wood	0	0	64.4	65.1	+0.7
49753_49750	School Lane - Between Standeford and the junction with Light Ash Lane	78	1 Community Facility, 1 Educational Facility	66.0	66.5	+0.5
95025_60715	Old Stafford Road – Between Cross Green and junction with New Road	11	0	64.4	65.0	+0.6
16121_2049	Brewood Road – Off the roundabout with Stafford Road, South East	13	0	63.4	64.3	+0.9
2049_60715	Brewood Road – Between Cross Green and junction with The Nurseries	5	0	65.2	66.1	+0.9
49648_16018	Brinsford Lane – Between junction with A449 and junction with Dark Lane	1	0	55.2	59.5	+4.3
95025_49646	New Road – Between junction with Old Stafford Road and junction with Paradise Lane	2	0	65.4	66.0	+0.6
49646_49645	New Road – Between junction with Paradise Lane and junction with Oaks Drive	6	0	65.7	66.1	+0.4
49645_49643	New Road – Between junction with Oaks Drive and West of Featherstone Lane junction	10	0	65.3	65.8	+0.5

Link ref.	Description	Number of receptors within 50 m		BNL $L_{A10,18h}$ dB at 10 m from the road		
		Residential	Non-residential	2024 DM	2039 DM	Change
39736_90173	M54 Jc2 Roundabout - A449-A4510-M54, North	5	0	69.3	69.7	+0.4
90171_90172	M54 Jc2 Roundabout - A449-A4510-M54, South	0	0	70.3	65.5	+0.3
39734_90169	M54 Jc2 Roundabout - A449-A4510-M54, West	0	0	65.2	70.9	+0.6
39733_2002	M54 – Start of eastbound on-slip from Jc2 roundabout	0	0	68.7	69.6	+0.9
2002_39729	M54 – End of eastbound on-slip from Jc2A449 roundabout	0	0	69.7	70.6	+0.9
39730_2003	M54 – Start of westbound off-slip to Jc2 A449 roundabout	0	0	70.2	70.5	+0.3
2003_90170	M54 – End of westbound off-slip to Jc2 A449 roundabout	0	0	68.8	69.0	+0.2
96002_14736	Upper Sneyd Road	61	0	66.0	66.4	+0.4
90135_14452	B4156 Hobnock Road - at junction with Bursnips Road	3	1 Place of Worship	64.7	65.4	+0.7
90135_95042	B4156 Hobnock Road - West of junction with Bursnips Road, to junction with Bognop Road	34	1 Medical facility	67.1	67.8	+0.7
95043_96002	Kitchen Lane	228	0	64.0	65.0	+1.0

Link ref.	Description	Number of receptors within 50 m		BNL $L_{A10,18h}$ dB at 10 m from the road		
		Residential	Non-residential	2024 DM	2039 DM	Change
49699_49698	Upper Ladywood Lane	66	0	61.4	61.9	+0.5
1203_2054	M6 - Off-slip to Gailey Interchange	0	0	68.6	70.1	+1.5
2056_1208, 1207_2055	A5 - Entry/Exit to Gailey Interchange, West	0	0	71.5	72.8	+1.3
15150_2042	A5 – At junction with A449, East	4	0	70.7	70.6	-0.1
2042_12341	A5 – Between East of junction with A449 to East of Gailey	7	0	72.4	72.4	0.0
12341_45673	A5 – East of Gailey to East of Croft Lane	10	0	72.4	72.4	0.0

11.6.37 As would be expected, all the identified affected routes are predicted to experience a negligible or minor long-term increase in traffic noise levels at the roadside in the absence of the Scheme. This is due to the normal growth of traffic over time.

11.7 Potential impacts

11.7.1 Mitigation measures incorporated in the Scheme design and measures to be taken to manage Scheme construction are set out in Section 11.8. Prior to implementation of defined mitigation measures, the Scheme has the potential to affect noise and vibration (positively or negatively), both during construction and once in operation - potential impacts are detailed in the sections below.

Construction

11.7.2 The main construction activities that would take place during the Scheme construction phase are site clearance, earthworks, retaining wall construction, bridge construction, bridge demolition and road construction (pavement) works. These construction activities have the potential to result in temporary noise impacts at the receptors closest to the works.

11.7.3 The potential for temporary construction vibration impacts is dependent on the need for construction activities which are a potentially significant source of vibration, such as earthworks and road construction (pavement) works using vibratory rollers. Piling would be required at the new bridges and at retaining walls. Rotary bored piling is proposed for bridge works and retaining walls and vibratory pilling for sheet piles at bridges only. Vibration associated with rotary bored pilling is minimal. Vibratory pilling is a potentially significant source of vibration.

11.7.4 Construction traffic can have a temporary impact on sensitive receptors located along existing roads used by these vehicles. Details regarding construction traffic and temporary traffic management measures are detailed in the Outline Traffic Management Plan [TR010054/APP/7.5].

11.7.5 The potential for construction traffic impacts is dependent on the volume and route of construction traffic. No regular night-time road closures are currently anticipated with the exception of short periods to set up traffic management and safety barriers, tie in the Scheme to the existing road network and to install the new bridge decks. At this stage specific details of the traffic management required during the works are not available, however it is anticipated that one lane of the eastbound M54 at Junction 1 would be re-routed via the existing slip-roads and roundabout for various phases of the works. No long term re-routing of mainline traffic is anticipated to be required at M6 Junction 11. It is assumed that the traffic management scheme for the works provides sufficient capacity to prevent a significant re-routing onto alternative routes.

Operation

11.7.6 The operation of the Scheme has the potential to result in both beneficial and adverse permanent traffic noise impacts. The Scheme would alleviate traffic flow on the A460 close to some receptors but would provide a new noise source close to others. Additionally, the Scheme would attract traffic to the area (refer to the Transport Assessment Report [TR010054/APP/7.4]) which has the potential to generate adverse noise impacts.

11.7.7 The magnitude of operational traffic noise impacts at a receptor is dependent on a range of factors, including the traffic flow, composition, speed, road surface, ground topography, the presence of intervening buildings and structures, and the distance to the road.

11.8 Design, mitigation and enhancement measures

Embedded mitigation

11.8.1 The Scheme has been designed, as far as possible, to avoid and minimise impacts and effects on receptors sensitive to noise and vibration through the process of design-development (Refer to Chapter 3: Assessment of Alternatives) considering good design principles. Embedded mitigation defined within the DMRB as ‘Design measures which are integrated into a project for the purpose of minimising environmental effects.’ is reported as part of the Scheme description in Chapter 2: The Scheme. For noise this includes positioning approximately half of the route in cutting, use of a thin surfacing system (i.e. a low noise surface) and a reduction in the speed limit on the realigned Hilton Lane.

11.8.2 The following section reports the essential mitigation required in addition to embedded mitigation to reduce and offset likely significant adverse environmental effects.

Essential mitigation

Construction

11.8.3 As detailed in Chapter 2: The Scheme, construction of the Scheme would be subject to measures and procedures as defined within the OEMP for the Scheme [TR010054/APP/6.11]. The OEMP includes a range of good practice measures associated with mitigating potential environmental impacts. The measures detailed within the OEMP would be developed into a CEMP by the selected construction contractor which would be implemented for the duration of the Scheme construction phase.

11.8.4 The CEMP would include a range of industry standard best practice construction phase noise mitigation measures required during all works undertaken where there is a potential for adverse effects on sensitive receptors (e.g. residential properties, schools). The CEMP would include relevant noise criteria, proposed surveys and a range of range of Best Practicable Means (BPM) associated with mitigating potential noise and vibration impacts. Such measures include:

- Appointment of a Community Relations Manager (CRM) responsible for leading engagement with affected communities (see paragraph 11.8.7).
- Implementation of a noise insulation and temporary re-housing policy.
- Selection of quiet and low vibration equipment and methodologies.
- Review of construction programme and methodology to consider low noise and low vibration methods (including non-vibratory compaction plant where required).
- Optimal location of equipment on site to minimise noise disturbance.
- The provision of acoustic enclosures around static plant, where necessary.
- Use of less intrusive alarms, such as broadband vehicle reversing warnings.
- Compliance with working hours as specified within the draft DCO as set out in Chapter 2: The Scheme, Table 2.3 and the OEMP [TR010054/APP/6.11].
- No start-up or shut down of large vibratory rollers (approximately 13 tonnes) within 50 m of receptors and medium vibratory rollers (approximately 3.5 tonnes) within 15 m of receptors.

11.8.5 There is also the potential for additional attenuation of noise from construction activities through the use of localised temporary site hoardings or noise barriers. These have not been included in the assessment of construction noise in order to represent a worst-case scenario. BS 5228 (Ref 11.17) advises that such barriers can provide a reduction in noise levels of 5 dB when the top of the plant is just visible over the noise barrier, and 10 dB when the plant is completely screened from a receptor. The effectiveness of a noise barrier depends upon its length, effective height, position relative to the noise source and to the receptors, and the material from which it is constructed. Therefore, the potential attenuation provided by any such additional localised barriers cannot be quantified at this stage. Proposals for the use of localised temporary site hoardings or noise barriers would be developed at the detailed design stage and implemented during the works.

11.8.6 In addition to the above, although not included in the assessment, where possible, material excavated from the Scheme and stockpiles would be placed so as to provide screening of noise from the works to nearby receptors during construction.

11.8.7 As detailed above, during the Scheme construction phase appropriate mechanisms to communicate with local residents would be set up to highlight potential periods of disruption (e.g. web-based, newsletters, newspapers, radio announcements). This would include the appointment of a CRM responsible for leading engagement with affected communities. An information web-page would be provided and kept up-to-date on the Highways England website to reflect construction and community liaison requirements. It is envisaged that the web-page would provide up-to-date information on the progress of the construction works, areas affected by construction, mitigation in place to reduce adverse effects, information regarding planned construction works (including any proposed works outside normal hours, diversion routes etc.) and works recently completed. The communication strategy would minimise the likelihood of complaints, including those associated with noise and vibration. Residents would be provided with a point of contact, the CRM, for any queries or complaints. In addition, the Highways England Customer Contact Centre (HECCC) would also be available to deal with queries from the public. This includes an information line staffed by Highways England at all times. A complaint management system would be in place, in line with systems used by Highways England on other major infrastructure projects. Any noise and vibration complaints would be investigated and appropriate action taken as required. The complainant would be provided with a response outlining the results of the investigation and any action taken.

11.8.8 As detailed in the section below on operation phase noise mitigation measures, the Scheme design includes a number of noise barriers. The noise barriers would be constructed as early as possible in the programme of works to help reduce noise during construction.

11.8.9 Materials are expected to be transported to and from the site during the Scheme construction phase which would increase the number of HGV movements on the road network. Details regarding traffic movements and restrictions are detailed in the Outline Traffic Management Plan [TR010054/APP/7.5.] which includes details of measures to be taken to minimise the impact of construction traffic on customers and stakeholders, while ensuring work is carried out efficiently. Such measures include restricting HGV movements to the strategic highway network. Such restrictions would assist in avoiding construction traffic impacts on nearby residential areas. In addition, the traffic management scheme for the works would provide sufficient capacity to prevent a significant re-routing onto alternative routes.

11.8.10 During the construction phase, surveys would be required which would include physical measurements and observational checks and audits to ensure that BPM were being employed at all times. The contractor would undertake and report noise and vibration surveys as is necessary to ensure and demonstrate compliance with all noise and vibration commitments and the requirements of the CEMP (refer to

Section 11.10). As detailed in the OEMP, proposals for all survey locations would be set out in the CEMP [TR010054/APP/6.11].

11.8.11 The survey and compliance assurance process would be set out in the noise and vibration management plan(s), as part of the CEMP. Site reviews would be logged and any remedial actions recorded. Such checks would report:

- Compliance with hours of working.
- Presence of mitigation measures e.g. engine doors closed, air lines not leaking and site hoarding in place.
- Compliance with agreed working methods.
- Compliance with any specific requirements of the CEMP.

Operation

11.8.12 Environmental considerations including traffic noise have been taken into account during the choice of route, as detailed in Chapter 3: Assessment of Alternatives. Once the overall route was chosen the development of the Scheme design in terms of both the horizontal and vertical alignment, has aimed to avoid and reduce potential impacts upon nearby sensitive receptors.

11.8.13 Approximately half of the route is in cutting, in particular at Hilton Lane, which would screen traffic thus reducing noise impacts in the vicinity and reducing the need for additional noise barriers which have potential knock on impacts, such as visual impacts, and require ongoing maintenance. Cutting depth has been maximised to give the maximum noise benefit. The majority of the existing earth bund on the north side of the M54 eastbound off slip which provides some noise mitigation for Featherstone is retained, where the new Scheme alignment diverges from the existing road layout a section of new earth bund, which ties into the eastern end of the existing bund, is proposed. Within the overall selected route, the distance between the Scheme and the eastern end of Dark Lane has been maximised.

11.8.14 The Scheme would be constructed with a thin surfacing system (i.e. a low noise surface), which results in lower levels of noise generation than a standard hot rolled asphalt surface, with the exception of short sections at the approaches to junctions where high friction surfacing would be used for safety reasons. This includes the section of the existing A460 within the Scheme extents north of M6 Junction 11. The use of thin surfacing reduces noise levels by 3.0 dB at speeds of ≥75 km/hr.

11.8.15 The speed limit at the western end of Hilton Lane past the residential properties is reduced as part of the Scheme design from the national speed limit to 30mph. This is primarily to address safety issues and limit the amount of land take required for the realignment, reducing tree loss and also has the potential to reduce traffic noise impacts.

11.8.16 Following initial noise modelling of the outline Scheme design, proposals for potential noise barriers were developed in conjunction with other environmental disciplines to avoid secondary impacts (including, for example, landscape and visual impacts). The initial proposals for the design of noise barriers on the main line as the Scheme passes close to the receptors on Dark Lane was consulted upon during

statutory consultation, for details refer to the Consultation Report [TR010054/APP/5.1]. Taking into account the analysis of consultation responses, and subsequent development of the traffic and noise models, the following noise barriers have been included within the Scheme design:

- 3.0 m high reflective noise barrier on the west side of the main line as it passes close to Dark Lane.
- 1.5 m high reflective noise barrier on the east side of the existing A460 north of M6 Junction 11 in the vicinity of properties on Wolverhampton Road.
- 2.5 m high reflective noise barrier on the west side of the main line as it passes close to Brookfield Farm.
- 1.5 m high reflective noise barrier on the north side of the M54 eastbound off slip on top of the existing earth bund and the proposed eastern extension of this earth bund incorporated into the design.
- 3 m high reflective noise barrier east of the proposed earth bund on the north side of the M54 extending to the new western dumbbell roundabout.

11.8.17 Details regarding the location of these noise barriers are provided in Figure 11.1 and also illustrated on the Environmental Masterplan as presented in Figures 2.1 to 2.7 [TR010054/APP/6.2] and detailed in the OEMP [TR010054/APP/6.11] and Environmental Mitigation Schedule (EMS) presented in Appendix 2.1 [TR010054/APP/6.3].

11.9 Assessment of likely significant effects

Construction noise

11.9.1 Predicted monthly noise levels during the construction phase have been calculated over the Scheme construction period, taking into account applicable mitigation measures as detailed in Section 11.8.

11.9.2 Predicted monthly noise levels at each selected representative receptor during the construction phase are shown in Appendix 11.3 [TR010054/APP/6.3]. Receptor locations are marked on Figure 11.1 [TR010054/APP/6.2]. For two storey residential properties, ground floor results are provided for the daytime and evening, and first floor results for the night. The maximum predicted construction noise level, and whether the construction levels are predicted to be at or above the LOAEL and/or SOAEL, is summarised in Table 11.14. The predicted noise levels shown are based on the area over which each activity is likely to occur over the course of each month during the construction programme. As detailed in Section 11.3, to define the SOAEL and LOAEL, ambient noise levels at the relevant façade of each of the selected receptors has been determined as based on predicted 2024 Do-Minimum traffic flows.

Table 11.14: Summary of predicted construction noise levels (levels at or above the SOAEL/ LOAEL in bold underline)

Receptor ID	Daytime L_{Aeq} dB (façade)			Evening/ weekend L_{Aeq} dB (façade)			Night L_{Aeq} dB (façade)		
	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level
R01 - Moseley Old Hall Lane, Featherstone	65	61	51	65	61	48	61	61	50
R02 - Penderell Close, Featherstone	65	57	52	60	57	47	55	55	48
R03 - Jackson Close, Featherstone	65	55	50	60	54	44	55	54	46
R04 - South View Close, Featherstone (South)	65	**57**	57	60	57	49	55	55	50
R05 - South View Close, Featherstone (North)	65	**55**	56	60	54	46	55	52	46
R06 - Cannock Road, Featherstone (South)	75	71	69	68	68	61	63	63	61
R07 - South Crescent, Featherstone	65	**57**	58	60	55	48	55	54	52
R08 - Cannock Road, Featherstone (Central)	75	**70**	70	67	67	60	62	62	61
R09 - Olde Hall Road, Featherstone	65	**56**	59	60	54	52	55	**53**	53

Receptor ID	Daytime L_{Aeq} dB (façade)			Evening/ weekend L_{Aeq} dB (façade)			Night L_{Aeq} dB (façade)		
	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level
R10 - Cannock Road, Featherstone (North)	75	71	70	68	68	63	**64**	**64**	64
R11 - Hilton Road, Featherstone	65	55	53	60	53	43	55	50	43
R12 - Dark Lane, Featherstone	**70**	**64**	73	65	61	47	57	57	47
R13 - Park Road, Featherstone	65	**54**	62	60	53	49	55	52	49
R14 - Tower House Farm, Hilton Lane, Essington	65	**62**	62	65	61	53	61	61	54
R15A - The Shrubbery, Hilton Lane, Shareshill (Facing Scheme)	65	**55**	61	60	**54**	56	**55**	**52**	56
R15B - The Shrubbery, Hilton Lane, Shareshill (Facing Hilton Lane)	**65**	**57**	65	60	**55**	56	**55**	**54**	56
R16 - Hilton Lane, Shareshill (South East)	**65**	**62**	70	**65**	**59**	68	**55**	**55**	69
R17A - Hilton Lane, Shareshill (Central - Facing Scheme)	65	**55**	61	60	**54**	54	**55**	**52**	64

Receptor ID	Daytime L_{Aeq} dB (façade)			Evening/ weekend L_{Aeq} dB (façade)			Night L_{Aeq} dB (façade)		
	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level	SOAEL	LOAEL	Max Level
R17B - Hilton Lane, Shareshill (Central - Facing Hilton Lane)	**65**	**61**	68	**65**	**58**	66	**55**	**55**	66
R18A - Hilton Lane, Shareshill (North West - Facing Scheme)	65	**58**	64	60	56	54	**55**	**54**	56
R18B - Hilton Lane, Shareshill (North West - Facing Hilton Lane)	**65**	**62**	68	65	60	55	**55**	**55**	55
R19 - Brookfield Farm, Cannock Road, Shareshill	**65**	**54**	68	60	53	45	55	50	45
R20 - Wolverhampton Road, Shareshill (South)	70	**65**	66	65	63	60	59	59	55
R21 - Wolverhampton Road, Shareshill (North)	70	67	62	65	65	59	61	61	54
R22 - Mill Lane, Shareshill	65	**56**	56	60	55	54	55	53	43

11.9.3 Of the 22 selected construction noise assessment locations:

- 15 are predicted to experience construction noise levels which are at or above the LOAEL during the daytime period in one or more months, of which 6 would also be at or above the SOAEL.

- For the evening/weekend period, 3 receptors are predicted to be at or above the LOAEL, of which 2 would also be at or above the SOAEL.
- For the night-time period, 6 receptors are predicted to be at or above the LOAEL, of which 5 would also be at or above the SOAEL.

11.9.4 A discussion of the construction noise assessment data as summarised in Table 11.14 is provided below. With regard to duration, a conservative approach has been adopted in reporting the number of months during which noise levels at or above the SOAEL are anticipated. The noise level at or above the SOAEL may not be for all of each month identified, it may be for a much shorter period within a month.

- At receptor R10 (A460 Cannock Road, Featherstone (North)) night-time levels at or above the SOAEL are predicted in 1 month and are limited to the period of works to surface the new carriageway in close proximity to this receptor.
- At receptor R12 (Dark Lane, Featherstone) daytime levels at or above the SOAEL are predicted in 1 month and are limited to the period of works to construct the turning head at Dark Lane in close proximity to this receptor.
- At receptor R15A (The Shrubbery, Hilton Lane, Shareshill (Facing Scheme)) night-time levels at or above the SOAEL are predicted in 1 month and are limited to the period of works to create the tie in of the temporary road to the existing road network in close proximity to this receptor.
- At receptor R15B (The Shrubbery, Hilton Lane, Shareshill (Facing Hilton Lane)) daytime levels at or above the SOAEL are predicted in 1 month and are limited to the period of works to remove the existing farm track in close proximity to this receptor. Night-time levels at or above the SOAEL are predicted in 1 month and are limited to the period of works to create the tie in for the temporary road.
- At receptor R16 (Hilton Lane, Shareshill (South East)) daytime levels at or above the SOAEL are predicted in 2 months and are limited to the periods of work to create and remove the temporary road and the period of earthworks on the bridge approaches in close proximity to this receptor. Evening, weekend and night-time levels at or above the SOAEL are predicted in 2 months and are limited to the periods of work to create and remove the tie in for the temporary road.
- At receptor R17A (Hilton Lane, Shareshill (Central – Facing Scheme)) night-time levels at or above the SOAEL are predicted in 2 months and are limited to the periods of work to create and remove the tie in for the temporary road.
- At receptor R17B (Hilton Lane, Shareshill (Central – Facing Hilton Lane)) daytime levels at or above the SOAEL are predicted in 3 months and are limited to the periods of work to excavate the Scheme and borrow pit, to create the temporary road, earthworks on the approaches to the bridge and to surface the approaches and bridge deck in proximity to this receptor. Evening and weekend levels at or above the SOAEL are predicted in 1 month and are limited to the period of work to construct the tie in for the temporary road. Night-time levels at or above the SOAEL are predicted in 2 months and are

limited to the periods of work to create and remove the tie in for the temporary road.

- At receptor R18A (Hilton Lane, Shareshill (North West – Facing Scheme)) night-time levels at or above the SOAEL are predicted in 2 months and are limited to the periods of work to create and remove the tie in for the temporary road.
- At receptor R18B (Hilton Lane, Shareshill (North West – Facing Hilton Lane)) daytime levels at or above the SOAEL are predicted in 2 months and are limited to the periods of work to clear the Scheme and to surface the bridge decks and approaches in proximity of this receptor. Night-time levels at or above the SOAEL are predicted in 1 month and are limited to the period of work to create the tie in for the temporary road.
- At receptor R19 (Brookfield Farm, Cannock Road) daytime levels at or above the SOAEL are predicted in 4 months and are limited to the periods of work to clear and excavate the Scheme, to place bulk fill within the Scheme, and earthworks on approaches to the bridge in close proximity to this receptor.

11.9.5 As detailed in Section 11.4, the construction assessment is based on the construction information that is currently available, with advice being provided by Highways England's appointed buildability advisors. Given that the exact details of construction activities and the duration of the various works are not fully known, a conservative approach has been adopted and all the identified levels at or above the SOAEL are assumed to be at risk of exceeding the duration criteria set out in Section 11.3 of 10 or more days (or 10 evenings, weekends or nights) in any consecutive 15, or 40 or more days (or 40 evenings, weekends or nights) in any consecutive six month period. On this basis, significant adverse construction noise effects are identified at the closest receptors to the construction works in the vicinity of Dark Lane, Hilton Lane and Brookfield Farm. However, it is noted that the evening/weekend/night-time works to create and remove the tie in for the temporary road at Hilton Lane, which are the source of the majority of the identified significant adverse effects in the evening/weekend/night-time periods, is currently anticipated to be completed in considerably less than the duration criteria.

11.9.6 Once specific details of the construction works are available, the potential to reduce the magnitude of construction noise impacts, for example, through the use of localised site hoarding, will be determined through the requirements in the CEMP. In some locations where the exceedances of the SOAEL are small this may result in the removal of significant effects. Where exceedances of the SOAEL are larger the provisions of the noise insulation and temporary re-housing policy may apply.

Construction vibration

11.9.7 The activities with the potential to generate vibration during Scheme construction are works using vibratory rollers (earthworks, road construction (pavement), pilling platform construction and road strengthening); installation and removal of sheet piles using a vibratory piling rig; and use of a rotary bored piling rig during bridge and retaining wall construction.

11.9.8 Vibration levels during works using vibratory rollers have been calculated in accordance with the procedures set out in BS 5228-2 Table E.1 (Ref 11.17). Source data for a typical large and medium sized vibratory roller has been taken from TRL Report 429 (Ref 11.20).

11.9.9 With regards to structural damage, the PPV due to vibratory rollers would be well below the lowest cosmetic building damage criteria of 6 mms^{-1} at any receptors during start-up and run-down, assuming a minimum 50 m separation distance is used for the large (approximately 13 tonnes) roller, and 20 m for the medium sized twin drum and towed rollers (approximately 3.5 tonnes).

11.9.10 For human receptors the LOAEL for vibration annoyance is defined as a PPV of 0.3 mms^{-1}, this being the point at which construction vibration is likely to become perceptible. The SOAEL is defined as a PPV of 1.0 mms^{-1}, this being the level at which construction vibration can be tolerated with prior warning.

11.9.11 The predicted PPV due to the steady state operation of vibratory plant is estimated to exceed the SOAEL for vibration annoyance within approximately 50 m of works using a large (approximately 13 tonnes) roller, and approximately 20 m for the medium sized twin drum roller and medium sized towed roller (approximately 3.5 tonnes). Approximately 77 residential buildings are located within 50 m of works using a large vibratory roller – these being located along the section of A460 which is modified by the Scheme, at the proposed Dark Lane turning head, along Hilton Lane and at Brookfield Farm. Approximately 64 residential buildings are located within 20 m of works using a medium sized twin drum vibratory roller – these being located along the section of A460 which is adjusted by the Scheme, at the proposed Dark Lane turning head and along Hilton Lane. Approximately nine residential buildings are located within 20 m of works using a medium sized towed roller – these being located at the proposed Dark Lane turning head. All of these receptors are also within 50 m of the works using a larger vibratory roller. Potential significant construction vibration annoyance effects are, therefore, identified at approximately 77 residential buildings.

11.9.12 Rotary bored pilling would be required at the M54 Junction 1 bridge, the Shareshill bridge (over Watercourse 5) and for the abutments at the M6 Junction 11 bridges, as well as for the retaining walls at Junction 1 of the M54. The measured piling vibration data in BS 5228 (Ref 11.17) indicates that at a distance of more than 10 m typical PPV levels from the boring works do not exceed the LOAEL. PPV levels due to ancillary works, such as driving in the pile casing, do not exceed the SOAEL at distances of more than 10 m. No piling works are anticipated within 10 m of a potentially sensitive receptor. On this basis, vibration impacts due to rotary bored piling at the new bridges and retaining walls are not anticipated to result in significant adverse effects.

11.9.13 Pilling using a vibratory pilling rig would be required to install and remove sheet piles during construction of the M54 Junction 1 (Featherstone bridge) and Shareshill bridge. The closest approach of vibratory pilling works to any identified potentially sensitive receptor is anticipated to be approximately 210 m. Empirical prediction

methods based on Table E.1 of BS 5228-2 are valid to a distance of 100 m only, as significant effects are not anticipated beyond this distance.

11.9.14 Given the above, there is the potential for combined significant effects from construction noise and vibration during the construction works at receptors located in close proximity to the works along the section of A460 which is modified by the Scheme, at the proposed Dark Lane turning head, along Hilton Lane and at Brookfield Farm.

Construction traffic

11.9.15 During the Scheme construction phase, additional traffic would be generated by the construction works directly. Details regarding construction traffic and temporary traffic management measures are detailed in the Outline Traffic Management Plan [TR010054/APP/7.5]. At this stage specific details of the traffic management required during the works are not available, however it is anticipated that one lane of the eastbound M54 at Junction 1 would be re-routed via the existing slip-roads and roundabout for various phases of the works (refer to the Outline Traffic Management Plan [TR010054/APP/7.5]). No long term re-routing of mainline traffic is anticipated to be required at M6 Junction 11. It is assumed that the traffic management scheme for the works provides sufficient capacity to prevent significant re-routing onto alternative routes.

11.9.16 No regular night-time road closures are currently anticipated with the exception of short periods to set up traffic management and safety barriers, tie in the Scheme to the existing road network and to install the new bridge decks at M54 Junction 1 and M6 Junction 11.

11.9.17 The same traffic noise model as developed for the operational traffic noise assessment has been utilised to assess the impact of construction traffic. The construction traffic noise assessment is based on estimated construction traffic for the busiest period of the construction works and the period of traffic management on the M54 when one lane of eastbound traffic is diverted via the eastbound off/on slip-roads. The construction traffic impact is compared to the 2024 Do-Minimum scenario. The results indicate that the vast majority of identified potentially noise sensitive receptors are anticipated to experience no more than a negligible increase in traffic noise due to construction traffic. Five properties at the western end of Hilton Lane, are anticipated to experience a minor increase (maximum increase +1.2 dB) during the busiest period of the works to build the new Hilton Lane bridge, and assuming the worst case option of all construction traffic using the western end of Hilton Lane to both access and exit the bridge works. This is considered a worst case assumption as some vehicles are likely to use the haul road along the Scheme alignment instead, which is more remote from residential receptors. On the basis of the worst case, a negligible/minor magnitude of change in noise resulting from construction traffic is not anticipated to result in any significant adverse effects.

Operation

11.9.18 All the operational traffic noise comparisons reported herein are based on the façade at each building which undergoes the greatest adverse change, or the least

beneficial change in traffic noise level as a result of the Scheme. The results are provided for the top floor of each building, for example, 1.5 m for a one storey house, 4.0 m for a two storey house. Further details of the noise model set-up and assumptions are provided in Appendix 11.4 [TR010054/APP/6.3].

11.9.19 All the noise difference contour plots (refer to Figures 11.4 and 11.5 [TR010054/APP/6.2]) are based on free-field traffic noise levels at first floor level (4.0 m above ground) using a 10 m x 10 m grid and are provided for illustration purposes.

Short-term changes

11.9.20 Table 11.15 summarises the short-term change in predicted traffic noise levels in 2024 between the Do-Minimum (no Scheme) and the Do-Something (with Scheme) scenarios at both residential buildings and other sensitive receptors within the 600 m study area. The short-term traffic noise changes from the Do-Minimum 2024 to Do-Something 2024 are presented as noise difference contour plots in Figure 11.4 [TR010054/APP/6.2].

Table 11.15: Short-term change in predicted Do-Something traffic noise levels (DM 2024 to DS 2024)

Change in noise level		Daytime	
		Number of residential buildings	Number of other sensitive receptors
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 0.9	1222	7
	1.0 - 2.9	250	1
	3.0 - 4.9	2	0
	≥5	0	0
No change	0	225	0
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 0.9	258	1
	1.0 - 2.9	126	0
	3.0 - 4.9	14	0
	≥5	4	0

11.9.21 An estimated total of 2101 residential buildings are located within the study area (as shown on Figure 11.1 [TR010054/APP/6.2]).

11.9.22 A total of nine non-residential sensitive buildings are located within the study area, consisting of Mosley Old Hall, a place of worship, school and village hall in Shareshill, a church, health centre, community centre and school in Featherstone, and a nursery off the A460 south of the M54 Junction 1, as shown on Figure 11.1 [TR010054/APP/6.2].

11.9.23 In the daytime in the Scheme opening year of 2024, 58% of residential buildings are anticipated to experience a negligible (0.1 - 0.9 dB) increase in traffic noise levels

due to the Scheme. A further 12% are anticipated to experience a minor (1.0 - 2.9 dB) increase in traffic noise levels. The overall trend in the study area is for a slight increase in traffic flows, and therefore traffic noise, as the operation of the Scheme resolves the existing congestion on the A460, attracting traffic to the area. Two residential properties (0.1%) are anticipated to experience a moderate (significant) increase in traffic noise levels on the worst affected facade.

11.9.24 One of these properties is at Brookfield Farm, where the worst affected façades facing the Scheme are predicted to experience a moderate increase. Mitigation in the form of a 2.5 m noise barrier is included in the design at this location which would reduce the magnitude of the impact from major to moderate. The western façade facing the existing A460 is anticipated to experience a minor reduction in traffic noise. The worst case impact at the other residential property at Brookfield Farm is minor as it is located further back from the Scheme, closer to the existing A460.

11.9.25 The other property which undergoes a moderate increase is located to the west of the Scheme on Hilton Lane. This increase is a due to a combination of noise from the Scheme, and the large increase in 18hr traffic flows on Hilton Lane from around 1,200 in the 2024 Do-Minimum scenario to 3,500 in the 2024 Do-Something scenario, which is due to the loss of the connection between Dark Lane and Hilton Lane with the Scheme in place. Currently traffic on Hilton Lane to the east of the Scheme uses Dark Lane to access the A460, in preference to the western end of Hilton Lane as the presence of traffic lights at the Dark Lane junction with the A460 enables traffic to join the A460 more easily. With the Scheme in place, whilst an overall reduction in traffic on Hilton Lane is anticipated this traffic must use the western end of Hilton Lane to access the existing A460.

11.9.26 Both the Do-Minimum and Do-Something traffic flows on Hilton Lane are very low. The ‘low flow’ correction in the CRTN traffic noise prediction methodology amplifies the resulting magnitude of the noise change in such small flows. When combined with noise generated by the presence of the Scheme to the east of this property this results in a significant adverse effect. Mitigation is incorporated into the design of the Scheme in this location through locating the Scheme in a cutting of approximately 6 m, and through the reduction in speed limit from 60 mph to 30 mph on this section of Hilton Lane. The addition of a noise barrier on the top of the cutting has been considered but provides only negligible additional benefit and does not remove the significant adverse effect at this property.

11.9.27 No change or a reduction in traffic noise levels is anticipated at 30% of residential buildings. The magnitude of the traffic noise level reduction is moderate beneficial (significant) at 14 residential buildings and major beneficial (significant) at a further four. All of the significant reductions in traffic noise are located on the existing A460, due to the large reduction in traffic on the A460 as the majority transfers onto the Scheme.

11.9.28 With the mitigation measures in place the majority of properties in Featherstone experience a negligible change in traffic noise. A negligible increase in traffic noise is anticipated on The Avenue running east to west through Featherstone, the general trend towards an increase in traffic in the area around the Scheme e.g. on the M54

also contributes. The proposed noise barriers along the M54 eastbound off slip ensure no properties in Featherstone experience a minor increase in traffic noise. Decreases in traffic noise are anticipated on the eastern edge of Featherstone along the existing A460 bypassed by the Scheme, and the northern and western edges along New Road and East Road, which undergo a reduction in traffic due to the Scheme. Currently traffic wishing to access the existing A460 predominantly uses the junction at New Road, as this is signalised, rather than The Avenue as the lack of signals and high traffic flows on the A460 make using this junction more difficult. With the Scheme in operation the difficulty of accessing the A460 from The Avenue is removed, hence the reduction in traffic on New Road and the increase on The Avenue.

11.9.29 With a noise barrier in place along the Scheme in proximity to Dark Lane the worst case increases in traffic noise at Dark Lane and Park Road are reduced from major (without barrier) to minor (with barrier). Facades which face directly onto Dark Lane experience a reduction in traffic noise due to the large reduction in traffic on Dark Lane as it becomes a cul-de-sac with the Scheme in place.

11.9.30 To the east of the Scheme the small number of individual properties off Hilton Lane, in the vicinity of Hilton Hall, are anticipated to experience a minor or negligible increase in traffic noise in the opening year.

11.9.31 The majority of properties in Shareshill experience a negligible change in traffic noise due to the Scheme, with decreases concentrated at the southern end of the village close to the existing A460. A small number of properties along Church Road experience a minor increase due to re-routing of traffic out of the village once the access on and off the A460 is improved due to the Scheme. A small number of properties at the closest approach to the existing A460 experience a minor decrease.

11.9.32 A total of 197 residential buildings have been identified as experiencing ‘high’ traffic noise levels (above SOAEL) in the do-something scenario and an increase of 1.0 dB or more in the short term (DM2024 to DS2024). These are all located on the A460 south of the M54. This road undergoes an increase in traffic due to the Scheme. As detailed in the methodology, further consideration of these properties has been undertaken to determine if a significant effect is anticipated.

11.9.33 The increase in traffic noise at the properties on the A460 south of the M54 is +1.1 to +1.2 dB in the opening year. Although there are no physical changes to the road network and the magnitude of the increase is only marginally above the criterion for the onset of a potentially significant effect, the increase in 18hr traffic flows of around 5400, from approximately 14,100 to 19,500 in the opening year is likely to be noticeable to residents, therefore a significant adverse effect has been identified.

11.9.34 Housing Allocation Site 168, west of Featherstone, is anticipated to experience a change in traffic noise in the opening year ranging from negligible decrease to negligible increase. Therefore, the Scheme would not affect the development of this site for housing.

11.9.35 The majority of non-residential sensitive receptors experience a negligible increase in traffic noise due to the Scheme. The exceptions are the place of worship in Featherstone on the corner of The Avenue and the A460 bypassed by the Scheme, which experiences a negligible reduction, and the nursery close to the A460 south of the M54, which experiences a minor increase. Based on the magnitude of change due to the Scheme and the nature of the receptors no significant effects on non-residential potentially sensitive buildings have been identified.

11.9.36 A number of PRoW are located in the study area, (see Figure 11.1 and Figure 12.2 [TR010054/APP/6.2]) which experience a range of impacts. A section of Featherstone 3 is relocated slightly along the new westbound on slip at M54 Junction 1, this section experiences a minor increase in the opening year and the remainder to the south a negligible increase. Featherstone 9 towards the north of Featherstone experiences a negligible change. The various PRoW around Shareshill generally experience a negligible change in traffic noise due to the Scheme, though Shareshill 2, 6 and 7 experience a minor, moderate or major decrease in traffic noise at the south/east ends of the PRoW as they approach the existing A460.

11.9.37 PRoW to the east of the M6, including Saredon 9, 10 and 13 and Chesyln Hay 2 generally experience a negligible change in traffic noise due to the Scheme. A short section of the southern end of Saredon 13 experiences a minor increase in the vicinity of the northern end of the Scheme north of M6 Junction 11. Saredon 8 is relocated slightly to follow the edge of the Scheme at the approach to M6 Junction 11, due to its proximity to the new road at the base of the embankment it experiences a moderate increase in traffic noise. Similarly, Shareshill 3 and 4 run roughly parallel to the Scheme to the east and experience a range of impacts from major to minor increases. Shareshill 1 and 5 both cross the route of the Scheme and are therefore relocated along the Brookfield Farm accommodation bridge and the realigned Hilton Lane respectively.

11.9.38 The magnitude of the change in traffic noise along Shareshill 1 ranges from major decrease close to the existing A460 to major increase where it crosses the Scheme. The range of impact along Shareshill 5 is from negligible increase at the eastern end to major increase where it crosses the Scheme.

11.9.39 Given the linear nature of PRoWs, the range of noise impacts along them, the absolute traffic noise levels, and the transient usage of a PRoW, a material change in the experience of using the PRoWs as a whole, which could affect people's health or quality of life, is not anticipated and no significant adverse or beneficial effects on PRoWs have been identified.

11.9.40 The Noise Important Area 11490 on the existing A460, which is bypassed by the Scheme, would experience a reduction in traffic noise. Noise Important Area 7364 to the east of the A460, north of M6 Junction 11, would experience an increase due to the increase in traffic on the A460 (north of Junction 11), however a noise barrier and thin surfacing system are included as part of the Scheme to reduce the magnitude of the worst case impact at nearby properties, which ranges from negligible decrease to negligible increase. Noise Important Area 7365 on the M54

to the west of the Scheme would experience a negligible increase in the opening year due to the general trend to attract traffic to the Scheme.

Long-term changes

11.9.41 Table 11.16 summarises the long-term change in predicted traffic noise levels between the 2024 Do-Minimum and 2039 Do-Something scenarios. The long-term traffic noise changes from Do-Minimum 2024 to Do-Something 2039 are presented as a noise difference contour plot in Figure 11.5 [TR010054/APP/6.2].

Table 11.16: Long-term change in predicted Do-Something traffic noise levels (DM 2024 to DS 2039)

Change in noise level		Daytime		Night-time
		Number of residential buildings	Number of other sensitive receptors	Number of residential buildings
Increase in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 2.9	1876	8	335
	3.0 - 4.9	29	0	0
	5.0 - 9.9	3	0	0
	≥10	0	0	0
No change	0	13	0	4
Decrease in noise level Daytime $L_{A10,18h}$ dB Night-time $L_{night,outside}$ dB	0.1 - 2.9	165	1	96
	3.0 - 4.9	13	0	4
	5.0 - 9.9	2	0	0
	≥10	0	0	0

11.9.42 In the long-term (2024 Do-Minimum to 2039 Do-Something) the same general pattern of traffic noise level change is observed as in the short-term as described above. The majority of increases and decreases at residential properties in the long-term daytime are negligible or minor (not significant). The two moderate decreases in traffic noise are located on the existing A460 bypassed by the Scheme. The three moderate increases are all located on the western end of Church Road in Shareshill. This impact is unrelated to the Scheme, it is due to the operation of the proposed West Midlands Interchange located to the north-west of the noise study area in Four Ashes, which is included in the 2039 traffic data. The operation of the Scheme reduces the number of properties predicted to experience a moderate adverse effect from 10 to three. However as discussed above for the Do-Minimum situation, it should be noted that both the 2024 Do-Minimum and 2039 Do-Something 18 hour traffic flows on this road are very low, increasing from around 700 vehicles in 2024 Do-Minimum to around 1500 vehicles in 2039 Do-Something. The 2024 flow of 700 vehicles is below the lower cut off of 1000 vehicles per 18 hour day for the CRTN prediction methodology. The 2039 flow of 1500 is classed as a 'low flow' in the CRTN methodology. Therefore, the magnitude of the predicted increases in traffic noise levels should be treated with some caution.

11.9.43 At night all residential buildings are predicted to experience a negligible, minor or no change in traffic noise.

11.9.44 As with the short term the majority of non-residential sensitive receptors would experience a negligible increase in traffic noise due to the Scheme. The exception is the place of worship in Featherstone on the corner of The Avenue and the A460 bypassed by the Scheme, which would experience a negligible reduction.

Annoyance

11.9.45 Table 11.17 outlines the worst case change in annoyance due to the Scheme.

Table 11.17: Worst-case change in traffic noise annoyance

Change in % annoyed		Daytime
		Number of residential buildings
Increase in annoyance level	<10%	737
	10% <20%	904
	20% <30%	263
	30% <40%	2
	≥40%	0
No change	0%	15
Decrease in annoyance level	<10%	179
	10% <20%	1
	20% <30%	0
	30% <40%	0
	≥40%	0

11.9.46 In line with the change in traffic noise levels discussed above, the majority of receptors would experience a slight increase in annoyance. It should be noted that a 0.1 dB increase in traffic noise levels equates to a 9.8% increase in annoyance in the short-term.

Receptors between 600 m and 1 km

11.9.47 For receptors that are within 1 km of the Scheme and the section of the A460 bypassed by the Scheme, but not within 600 m of an affected route, only negligible increases and decreases in traffic noise levels are expected in both the short and long-term.

Receptors above SOAEL

11.9.48 Table 11.18 details the number of residential buildings in the 600 m study area which would have one or more facades above the daytime or night-time SOAEL for the four assessment scenarios.

Table 11.18: Number of residential buildings above the SOAEL

Scenario	Day	Night
2024 Do-Minimum (DM)	349	369
2039 Do-Minimum (DM)	370	403
2024 Do-Something (DS)	275	309
2039 Do-Something (DS)	301	368

11.9.49 The Scheme would result in a reduction in the overall number of residential buildings above the SOAEL in the Scheme opening year (2024) and in the future assessment year (2039) during both the day and night.

11.9.50 The majority of residential buildings which are above the SOAEL are in close proximity to the A460 south of the M54, and the A460, New Road and The Avenue in Featherstone. With the Scheme in operation some of the properties on these roads would fall below the SOAEL as traffic transfers onto the Scheme. In addition, a small number of properties in Shareshill, Hilton Lane, east of the A460 north of Junction 11 and various individual properties would be above the SOAEL both with and without the Scheme.

Noise Insulation Regulations

11.9.51 A preliminary consideration of properties which may qualify for noise insulation works under the Noise Insulation Regulations has identified one residential building, which is located on Hilton Lane to the west of the Scheme. The mitigation provided by the proposed noise barriers would reduce the impact of the Scheme to below the Noise Insulation Regulations criteria at a number of properties at the eastern end of Dark Lane closest to the Scheme and on Wolverhampton Road to the east of the existing A460 to the north of M6 Junction 11.

11.9.52 A complete Noise Insulation Regulations assessment would be completed at a later stage of the project when the Scheme design is finalised and in accordance with the timescales set out in the Regulations.

Vibration annoyance

11.9.53 A summary of the long-term change in annoyance due to airborne vibration from road traffic due to the Scheme is provided in Table 11.19.

Table 11.19: Long-term change in Do-Something traffic vibration annoyance (DM 2024 to DS 2039)

Change in % annoyed		Daytime
		Number of residential buildings
Increase in annoyance level	<10%	186
	10% <20%	0
	20% <30%	0
	30% <40%	0

Change in % annoyed		Daytime
		Number of residential buildings
	≥40%	0
No change	0%	122
Decrease in annoyance level	<10%	56
	10% <20%	1
	20% <30%	0
	30% <40%	0
	≥40%	0

11.9.54 49% of residential buildings would experience no change or a small decrease in annoyance level as they are located along the existing A460 bypassed by the Scheme or the affected route New Road north of Featherstone which undergoes a reduction in traffic due to the Scheme. 51% of residential buildings would experience a small increase in annoyance level, the majority of which are located on the A460 south of the M54, which undergoes an increase in traffic due to the Scheme.

11.9.55 The effect of the Scheme on operational airborne vibration impacts is classed as not significant.

Affected routes

11.9.56 Table 11.20 details the short-term (ST) and long-term (LT) change in the CRTN BNL at the identified affected routes beyond the 1 km wider study area due to the Scheme. The location of these roads is illustrated in Figure 11.2 [TR010054/APP/6.2].

Table 11.20: Affected routes beyond 1km - change in traffic noise levels

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
49632_49633	Whitehouse Lane	56	1 Place of worship	59.2	61.2	-1.3	0.7
50294_50296	A5 Telford to junction with Woodhouse Lane	44	0	68.8	69.4	+0.3	-1.2
50295_50296	A5 around junction Woodhouse Lane	0	0	68.8	69.4	+0.3	-1.2
50315_50295	A5 junction with Woodhouse Lane to junction with B4379	4	0	68.8	69.4	+0.3	-1.2

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
50315_50330	A5 junction with B4379 to junction with A41	9	0	69.2	70	+0.5	-1.1
50227_50228	A442 on-slip from Hollinswood Interchange	0	0	63.6	64.9	1.3	2.6
50240_50217	A442 on-slip from Greyhound Roundabout	6	0	58.3	62.6	-2.3	2
2043_15150, 15150_2043	A449 Stafford Road - At junction with A5	0	0	66.7	66.6	-1.6	-1.7
2045_2043, 15150_2043	A449 Stafford Road - South of Junction with A5	0	0	67.4	67.3	-1.7	-1.8
2045_2043, 2043_2045	A449 Stafford Road - Passing Marsh Farm	4	0	68.4	68.5	-1.9	-1.8
2045_2043, 2043_2045	A449 Stafford Road - Between Gravely Way and North of Station Drive	1	0	68.4	70.5	-1.9	+0.2
16015_2045, 2045_16015	A449 Stafford Road - North of junction with Station Drive	1	0	66.6	68.5	-1.7	+0.2
2047_16015, 16015_2047	A449 Stafford Road - South of junction with Station Drive	2	0	68.2	68.9	-1.5	-0.8
49753_2047, 2047_49753	A449 Stafford Road - Between South of Station Drive and Standeford	7	0	70.2	71.0	-1.6	-0.8

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
2048_49753, 49753_2048	A449 Stafford Road - South of Standeford	6	0	68.6	69.5	-1.6	-0.7
16014_2048, 2048_16014	A449 Stafford Road - South of roundabout to Poplars Farm Way	19	0	67.1	67.9	-1.3	-0.5
18516_90198	Vicarage Road - Between junction with A5 and North of Woodside Farm	2	0	64.6	68.4	-2.0	+1.8
18516_90198	Vicarage Road - Between North of Woodside Farm and junction with Straight Mile	7	0	64.6	66.8	-2.0	+0.2
90198_96068	Vicarage Road - Between junction with Straight Mile and Four Ashes	3	0	61.9	62.4	-1.4	-0.9
96074_16028	Hilton Lane – Between junction with A462 and junction with Dark Lane	2	0	64.0	64.3	-1.0	-0.7
2026_96074	Hilton Lane – Between junction with Dark Lane, passing into Wakeman's Wood	0	0	63.4	63.9	-1.0	-0.5
49753_49750	School Lane - Between Standeford and the junction with Light Ash Lane	78	1 Community Facility, 1 Educational Facility	63.8	64.4	-2.2	-1.6
95025_60715	Old Stafford Road – Between Cross Green and junction with New Road	11	0	61.1	61.4	-3.3	-3.0

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
16121_2049	Brewood Road – Off roundabout with Stafford Road, South East	13	0	60.7	62.2	-2.7	-1.2
2049_60715	Brewood Road – Between Cross Green and junction with The Nurseries	5	0	62.7	64.1	-2.5	-1.1
49648_16018	Brinsford Lane – Between junction with A449 and junction with Dark Lane	1	0	57.2	59.4	+2.0	+4.2
95025_49646	New Road – Between junction with Old Stafford Road and junction with Paradise Lane	2	0	63.3	63.7	-2.1	-1.7
49646_49645	New Road – Between junction with Paradise Lane and junction with Oaks Drive	6	0	63.0	63.5	-2.7	-2.2
49645_49643	New Road – Between junction with Oaks Drive and West of Featherstone Lane junction	10	0	62.5	62.9	-2.8	-2.4
39736_90173	M54 Jc2 Roundabout - A449-A4510-M54, North	5	0	70.7	71.3	+1.4	+2.0
39734_90169	M54 Jc2 Roundabout - A449-A4510-M54, South	0	0	66.3	66.6	+1.1	+1.4
90171_90172	M54 Jc2 Roundabout - A449-A4510-M54, West	0	0	71.4	72.0	+1.1	+1.7

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
39733_2002	M54 – Start of eastbound on-slip from Jc2 roundabout	0	0	70.6	71.6	+1.9	+2.9
2002_39729	M54 – End of eastbound on-slip from Jc2A449 roundabout	0	0	71.7	72.7	+2.0	+3.0
39730_2003	M54 – Start of westbound off-slip to Jc2 A449 roundabout	0	0	71.6	72.1	+1.4	+1.9
2003_90170	M54 – End of westbound off-slip to Jc2 A449 roundabout	0	0	69.8	70.2	+1.0	+1.4
96002_14736	Upper Sneyd Road	61	0	65.0	65.5	-1.0	-0.5
90135_14452	B4156 Hobnock Road - at junction with Bursnips Road	3	1 Place of Worship	63.3	63.3	-1.4	-1.4
90135_95042	B4156 Hobnock Road - West of junction with Bursnips Road, to junction with Bognop Road	34	1 Medical Facility	65.8	66.0	-1.3	-1.1
95043_96002	Kitchen Lane	228	0	62.6	64.2	-1.4	+0.2
49699_49698	Upper Ladywood Lane	66	0	59.9	60.1	-1.5	-1.3
1203_2054	M6 - Off-slip to Gailey Interchange	0	0	67.6	69.9	-1.0	+1.3
2056_1208, 1207_2055	A5 - Entry/Exit to Gailey Interchange, West	0	0	70.5	72.6	-1.0	+1.1
15150_2042	A5 – At junction with A449, East	4	0	69.7	70.1	-1.0	-0.6

Link ref.	Description	Number of receptors within 50m		BNL $L_{A10,18h}$ dB at 10m from the road			
		Residential	Non-residential	2024 DS	2039 DS	ST change	LT change
2042_12341	A5 – Between East of junction with A449 to East of Gailey	7	0	71.4	71.7	-1.0	-0.7
12341_45673	A5 – East of Gailey to East of Croft Lane	10	0	71.4	71.7	-1.0	-0.7

11.9.57 The majority of the affected links beyond 1 km would experience a minor decrease in traffic noise levels in the short-term, as traffic would use the M54 and the Scheme rather than alternative routes. This impact is classed as not significant.

11.9.58 One link (95025_60715 – Old Stafford Road) would experience a moderate decrease in traffic noise levels. Eleven residential properties have been identified along this link. This impact is classed as a significant beneficial effect.

11.9.59 A small number of affected links, which includes two slip roads and the roundabout at M54 Junction 2, would experience a minor increase in traffic noise levels in the short term, again a result of traffic being drawn to the Scheme. This impact is classed as not significant.

11.9.60 In the long-term all affected links would experience a negligible or minor change in traffic noise levels, which includes the effects of natural growth in traffic over time.

Summary of operational traffic environmental effects

11.9.61 A summary of the identified traffic noise environmental effects, including a summary of the justification for the effect significance conclusions are provided in Table 11.21.

Table 11.21: Summary of operational traffic environmental effects

Receptor	Magnitude of impact in short-term	Significance	Justification
One residential building on Hilton Lane west of the Scheme.	Moderate increase	Significant adverse	Moderate increase in traffic noise. Closure of connection from Hilton Lane to Dark Lane results in re-routing of Hilton Lane traffic onto western end of Hilton Lane. Absolute traffic flows low but large percentage increase in flow, impact amplified due to nature of the CRTN low flow correction procedure. Introduction of new road to east and realignment of Hilton Lane gives potential to change residents response to traffic noise.

Receptor	Magnitude of impact in short-term	Significance	Justification
One residential building at Brookfield Farm.	Moderate increase	Significant adverse	Moderate increase on façade facing the Scheme, levels below SOAEL. Mitigation reduces the magnitude of the impact from major to moderate. Combined with introduction of new road adjacent to the property potential to change residents response to traffic noise.
197 residential buildings on the A460 south of the M54.	Minor increase	Significant adverse	Minor increases in traffic noise, traffic noise levels 'high' (above SOAEL) and increase of just over 1.0 dB or more in the short term, due to increase in traffic on the A460 south of the M54 following reduction in congestion at M54 Junction 1 and on the existing A460 bypassed by the Scheme. Increase in 18hr traffic flows of over 5000 vehicles therefore potential to change residents response to traffic noise.
18 residential buildings on the existing A460 bypassed by the Scheme (Featherstone, Hilton and Villa Bungalow).	Moderate/ Major decrease	Significant beneficial	Moderate/ major reductions in traffic noise due to the transfer of traffic off the existing A460 onto the Scheme. Eight reduced to below SOAEL, eight remain above SOAEL with and without the Scheme due to close proximity to the A460. Large reduction in 18hr traffic flows has potential to change residents response to traffic noise.
1381 residential buildings and four non-residential sensitive buildings in Featherstone.	Negligible increase/ no change/ negligible or minor decrease	Not significant	Magnitude of change not significant. 44 reduced to below the SOAEL, 60 remain above the SOAEL with and without the Scheme and 18 on The Avenue increased to above SOAEL though magnitude of increase negligible. Unlikely to change residents and users of the non-residential receptors response to traffic noise.
77 residential buildings in Hilton, on Dark Lane, Park Road and existing A460 bypassed by the Scheme.	Negligible or minor increase/ no change/ negligible or minor decrease	Not significant	Magnitude of change not significant. Eight reduced to below the SOAEL, 15 remain above the SOAEL with and without the Scheme. Unlikely to change residents response to traffic noise.
300 residential buildings and 3 non-residential sensitive buildings in Shareshill.	Negligible or minor increase/ no change/ negligible or minor decrease	Not significant	Magnitude of change not significant. five reduced to below the SOAEL and seven remain above the SOAEL with and without the Scheme due to very close proximity to Church Road. Unlikely to change residents and users of the non-residential receptors response to traffic noise.

Receptor	Magnitude of impact in short-term	Significance	Justification
Nine residential buildings on Wolverhampton Road to the east of the existing A460 north of M6 Junction 11.	Negligible or minor increase/ negligible decrease	Not significant	Magnitude of change not significant. one reduced to below the SOAEL and seven remain above the SOAEL with and without the Scheme. Unlikely to change residents response to traffic noise.
117 individual and small groups of residential buildings, and two non-residential sensitive receptors (Moseley Old Hall and one educational building).	Negligible or minor increase/ no change/ negligible or minor decrease	Not significant	Magnitude of change not significant. Five reduced to below the SOAEL and 53 remain above the SOAEL with and without the Scheme and ten increased to equal to or just the above SOAEL in the future assessment year only. The magnitude of the long term change due to the Scheme is negligible. Unlikely to change residents and users of the non-residential receptors response to traffic noise.
11 residential properties along Old Stafford Road (outside detailed modelled area).	Moderate decrease	Significant beneficial	Moderate reduction in traffic noise levels on affected route. Potential to change residents' response to traffic noise.

Compliance with policy

11.9.62 The key policy within NPSNN of relevance to this assessment is in paragraph 5.195: 'The Secretary of State should not grant development consent unless satisfied that the proposals will meet the following aims, within the context of Government policy on sustainable development:

- Avoid significant adverse impacts on health and quality of life from noise as a result of the new development.
- Mitigate and minimise other adverse impacts on health and quality of life from noise from the new development.
- Contribute to improvements to health and quality of life through the effective management and control of noise, where possible.'

11.9.63 To maintain consistency with the DMRB terminology used throughout this assessment, the discussion below refers to adverse effects rather than impacts.

11.9.64 With regard to identifying sustainable noise mitigation measures, various factors have been considered – these include the cost versus the benefit, engineering practicality, generation of knock-on impacts (such as vegetation clearance, ecological effects, landscape and visual effects), and consultation and stakeholder engagement responses.

Construction

11.9.65 Significant adverse effects occur for construction noise and vibration levels above the SOAEL (see Table 11.2) which potentially occur for 10 or more days in 15 consecutive days, or 40 days in six consecutive months. Adverse effects occur at construction noise or vibration levels between the LOAEL and SOAEL. The requirement to effectively control and manage noise applies to all construction noise levels.

11.9.66 With regard to the first NPSNN aim, a significant adverse effect is predicted at receptors located in close proximity to the works along the section of A460 which is modified by the Scheme, at the proposed Dark Lane turning head, along Hilton Lane and at Brookfield Farm. At this stage a conservative approach has been taken, for example, any exceedances of the noise/vibration criteria are assumed to potentially exceed the duration criteria applied to identifying significant effects, and the potential benefit of site hoarding/enclosures for specific locations/activities/plant has not been included.

11.9.67 The assessment identifies a range of mitigation measures as detailed in Section 11.8 which would constitute BPM including: selection of quiet and low vibration equipment; review of construction programme and methodologies to consider low noise and low vibration methods; optimal location of equipment on site to minimise noise disturbance; the provision of acoustic enclosures around static plant and site hoarding around specific locations/activities, where necessary; use of less intrusive alarms, such as broadband vehicle reversing warnings; no start-up or shut down of large vibratory rollers within 50 m of receptors (15 m for medium sized rollers), implementation of a construction noise insulation and temporary re-housing policy, and compliance with the working hours as specified within the draft DCO (core working hours being 8am - 6pm Monday - Friday and 8am - 1pm Saturday, with no working on Sundays and Bank Holidays – refer to as set out in Chapter 2: The Scheme. These mitigation measures would be set out in the CEMP, as based upon the OEMP [TR010054/APP/6.11].

11.9.68 As detailed above, the construction contractors would review the proposed working methods to consider all sustainable mitigation measures, including identifying locations/activities/plant where site hoarding/enclosures would be installed to reduce the magnitude of the construction noise impact, with the aim of avoiding significant noise and vibration effects. However, there is the potential for some significant temporary adverse noise and/or vibration effects to remain. This is acceptable in the context of sustainable development as factors including engineering practicality, cost versus benefit etc., as outlined above must also be considered. On this basis, it is considered that, with the implementation of the mitigation measures outlined in the CEMP and in the context of sustainable development, the first aim of the NPSNN would be met during Scheme construction.

11.9.69 With regard to the second NPSNN aim, adverse effects between the LOAEL and SOAEL are predicted at a range of receptors. The mitigation measures outlined in Section 11.8 would be applied throughout the construction works, and therefore would benefit all receptors experiencing construction noise or vibration, including

those with levels between the LOAEL and SOAEL. Construction impacts between the LOAEL and SOAEL are acceptable in the context of sustainable development as factors including engineering practicality, cost versus benefit etc., as outlined above, must also be considered. On the basis of the above, with the effective implementation of the defined mitigation and minimisation measures, it is considered that the second NPSNN aim would be met during Scheme construction.

11.9.70 With regard the NPSNN third aim, construction by its nature introduces a new noise or vibration source into the existing environment and is temporary in duration. Therefore, the opportunities to improve existing noise levels during the Scheme construction phase are very limited.

Operation

11.9.71 Significant operational phase policy adverse noise effects would occur at traffic noise levels above the SOAEL as a result of the Scheme (see Table 11.6), whilst adverse effects would occur at traffic noise levels between the LOAEL and SOAEL as a result of the Scheme. The requirement of the third aim to improve where possible applies to all traffic noise levels. Table 11.18 details the number of residential buildings in the study area which are above the SOAEL both with and without the Scheme. An overall reduction in the number of buildings above the SOAEL is anticipated due to the Scheme. The majority of the remaining residential buildings in the study are between the LOAEL and the SOAEL during the daytime. At night all the remaining residential buildings are between the LOAEL and the SOAEL, both with and without the Scheme, as the night time LOAEL is set at a low level.

11.9.72 With regard to the first NPSNN aim, the Scheme is anticipated to reduce traffic noise levels from above the SOAEL (in either or both DM scenarios) to below the SOAEL (in both DS scenarios) at 71 residential buildings. These buildings are located predominantly on the existing A460 and New Road on the northern edge of Featherstone. The transfer of traffic from the existing A460 onto the Scheme, and local re-routing around Featherstone due to the large reduction in traffic on the A460 are the dominant source of the reductions to below SOAEL, with a small number being due to the reduction in speed limit from 60 mph to 30 mph on the realigned Hilton Lane, and the combination of thin surfacing and a noise barrier adjacent to the A460 north of the M6 Junction 11.

11.9.73 A total of 33 residential buildings are anticipated to experience an increase in traffic noise level which takes them from below the SOAEL (in both DM scenarios) to above the SOAEL (in either or both DS scenarios). Four are located on Hilton Lane, and experience a minor or moderate increase in traffic noise, with the minor increases being due to the closure of the connection from Hilton Lane onto Dark Lane, and the moderate increase being due to a combination of the closure of this connection, and noise generated by the Scheme itself. One of these properties is identified as likely to qualify under the Noise Insulation Regulations as the realignment of Hilton Lane forms part of the Scheme works. Mitigation is incorporated into the design of the Scheme in this location through locating the Scheme in a cutting of approximately 6 m, and through the reduction in speed limit from 60 mph to 30 mph on this section

of Hilton Lane. The speed limit reduction prevents a small number of properties which would otherwise be brought above the SOAEL by the Scheme from doing so. The remaining 29 residential buildings are predominantly located on The Avenue in Featherstone, and the A460 south of the M54. On The Avenue in Featherstone, only a negligible increase in traffic noise is anticipated but this is sufficient to take some properties from just under to just over the SOAEL. Traffic flows increase on The Avenue due to re-routing in Featherstone, currently traffic wishing to access the existing A460 predominantly uses the junction at New Road, as this is signalised, rather than The Avenue as the lack of signals and high traffic flows on the A460 make using this junction more difficult. With the Scheme in operation the difficulty of accessing the A460 from The Avenue is removed hence the reduction in traffic on New Road and the increase on The Avenue. On the A460 south of the M54 a minor increase in traffic noise levels is anticipated as a result of traffic being attracted to the area due to the Scheme. The noise barriers incorporated into the Scheme design prevent ten residential buildings experiencing an increase in traffic noise to above the SOAEL, these are predominantly located on Dark Lane in Hilton, and The Avenue in Featherstone

11.9.74 339 residential buildings are above the SOAEL both with and without the Scheme in operation, therefore the exceedance of the SOAEL is not due to the Scheme. Whilst experiencing a reduction in traffic noise due to the operation of the Scheme the very closest residential buildings to the existing A460 remain above the SOAEL. Other residential buildings which remain above the SOAEL are located on The Avenue in Featherstone, the eastern end of New Road in Featherstone, a small number of properties on Hilton Lane and on Church Road in Shareshill, Wolverhampton Road to the north east of M6 Junction 11, A460 Cannock Road south of the M54, and individual properties located close to roads such as the M54, M6, M6 Toll and the A462.

11.9.75 With regard to existing roads, the purpose of the Scheme to improve traffic conditions on the A460 by providing a bypass route would result in small increases in traffic on roads connecting to the Scheme, and re-routing from Dark Lane to the western end of Hilton Lane and within Featherstone. The introduction of noise mitigation measures such as noise barriers along existing roads which already experience high noise levels, to mitigate the effects of the Scheme, or to further increase the benefit from re-routing, is not sustainable. Such roads have residential buildings and other premises fronting onto the road, therefore mitigation measures such as barriers are not a practical engineering option and would have other adverse impacts (including visual impacts) whilst also causing significant access difficulties.

11.9.76 On the basis of the above discussion, it is considered that the first NPSNN aim to avoid exceedances of the SOAEL as a result of the Scheme, within the context of sustainable development, has been met.

11.9.77 With regard to the second aim, a range of mitigation measures have been incorporated into the design as outlined in Section 11.8. These include maximising the depth of the cuttings in particular at Hilton Lane, maximising the distance between the eastern end of Dark Lane and the Scheme, use of a thin surfacing

system which results in lower levels of noise generation than a standard hot rolled asphalt surface at speeds at and above 75 km/hr; reduction of the speed limit on Hilton Lane; extension at the eastern end of the existing earth bund on the north side of the M54 eastbound off slip and inclusion of various noise barriers to reduce the magnitude of the impact at Featherstone, Dark Lane/ Park Road, Brookfield Farm, and Wolverhampton Road to the north of M6 Junction 11.

11.9.78 The inclusion of the above identified mitigation measures as detailed in Section 11.8 demonstrates that, within the context of sustainable development, at receptors between the LOAEL and the SOAEL, the Scheme meets the requirements of the second NPSNN aim.

11.9.79 No areas where additional mitigation would be appropriate, within the context of sustainable development, have been identified i.e. considering engineering practicality, cost, other potential impacts such as landscape and visual impacts, ecological considerations, and consultation responses.

11.9.80 Areas where additional noise barriers were considered include both the east and west sides of the Scheme at Hilton Lane, a longer barrier on the existing A460 north of M6 Junction 11 and a barrier at the southern end of the realigned A460 north of the dumbbell junction. At Hilton Lane the Scheme would be located in a deep cutting therefore an additional noise barrier (up to 3 m high) provides negligible additional mitigation at the closest properties to the east and west of the Scheme. In addition, it would not remove the moderate increase in traffic noise at the worst affected façade of the closest property to the west, as this is due to both the large percentage increase in traffic on Hilton Lane, and noise from the Scheme itself. On this basis, these additional barriers are not included in the Scheme design.

11.9.81 At Wolverhampton Road north of the M6 Junction 11, continuing the noise barrier south of the local access and around the eastern side of the roundabout provides negligible or minor additional benefit at facades facing away from the A460 which experience the worst case change due to the Scheme. This would not bring any additional properties below SOAEL. On the basis of the additional benefit of this barrier being small, this additional length of barrier is not included in the Scheme design.

11.9.82 At the southern end of the realigned A460 continuing the proposed noise barrier north of the dumbbell provides a negligible or minor benefit at the eastern façade of the closest properties in Featherstone, these facades of these properties already experience a major beneficial effect due to the relocation of the A460 further away and the transfer of traffic onto the Scheme. No change to exceedances of the SOAEL in Featherstone would occur. On this basis this additional length of barrier is not included in the Scheme design.

11.9.83 With regard to the third NPSNN aim to ‘improve where possible’, the large reduction in traffic on the existing A460 and the closure of Dark Lane as a through route, provide noise improvements in some areas. These improvements are not fully reflected within the DMRB analysis as reported herein which takes a worst-case approach focussed on the worst affected façade of each property. For example, the façades of properties facing the existing A460 would experience a major reduction

in traffic noise levels. However many of these properties experience a smaller reduction on other facades at the side or rear and therefore are not classed as experiencing a significant beneficial effect in the DMRB analysis. On this basis, it is considered that the third NPSNN aim has been met.

11.10 Monitoring

Construction

11.10.1 Given the significant construction noise and vibration effects as reported in Section 11.9, monitoring would be undertaken during the Scheme construction stage to ensure that the mitigation measures as detailed in Section 11.8 were being appropriately implemented. During the construction phase, surveys would be required which would include physical measurements and observational checks and audits to ensure that BPM were being employed at all times. The contractor would undertake and report noise and vibration surveys as is necessary to ensure and demonstrate compliance with all noise and vibration commitments and the requirements of the CEMP. As detailed in the OEMP [TR010054/APP/6.11], proposals for all survey locations would be set out in the CEMP.

Operation

11.10.2 As detailed in Section 11.9, the performance specification of specific operational mitigation measures would be confirmed at the Scheme detailed design stage to ensure the performance assumed in the assessment is achieved. Surveys would be undertaken to ensure that measures were installed as required. No further monitoring is proposed.

11.11 References

Ref 11.1 Highways Agency (2011) Design Manual for Roads and Bridges Volume 11, Section 3, Part 7 HD 213/11 – Revision 1. Noise and Vibration.

Ref 11.2 Highways Agency (2015) Interim Advice Note 185/15 Updated traffic, air quality and noise advice on the assessment of link speeds and generation of vehicle data into ‘speed-bands’ for users of DMRB Volume 11, Section 3, Part 1 ‘Air Quality’ and Volume 11, Section 3, Part 7 ‘Noise’.

Ref 11.3 Environmental Noise (England) Regulations 2006 (as amended).

Ref 11.4 Land Compensation Act 1973.

Ref 11.5 Noise Insulation Regulations 1975 (as amended 1988).

Ref 11.6 Highways Noise Payments and Movable Homes (England) Regulations 2000.

Ref 11.7 Environmental Protection Act 1990.

Ref 11.8 Control of Pollution Act 1974.

Ref 11.9 Department for Transport (2014) National Policy Statement for National Networks.

Ref 11.10 Ministry of Housing, Communities and Local Government (2018) National Planning Policy Framework.

Ref 11.11 Department for Environment, Food and Rural Affairs (Defra) (2010) Noise Policy Statement for England (NPSE).

Ref 11.12 Department for Communities and Local Government (2019) Planning Practice Guidance - Noise (PPG-N).

Ref 11.13 South Staffordshire Council (2012) South Staffordshire Core Strategy Development Plan.

Ref 11.14 Wolverhampton City Council (2006) Wolverhampton Unitary Development Plan 2001 – 2011.

Ref 11.15 Dudley MBC, Sandwell MBC, Walsall Council, Wolverhampton City Council (2011) Black Country Core Strategy.

Ref 11.16 Department of Transport, Welsh Office (1988) Calculation of Road Traffic Noise (CRTN).

Ref 11.17 British Standards Institution (2014) BS 5228: 2009+A1: 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites.

Ref 11.18 British Standards Institution (1993) BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration.

Ref 11.19 British Standards Institution (2003) BS 7445: 2003 Description and measurement of environmental noise.

Ref 11.20 Transport Research Laboratory (TRL) (2000) Report 429 Ground borne vibration caused by mechanised construction work.

Ref 11.21 ISO (2010) ISO 4866:2010 Mechanical vibration and shock. Vibration of fixed structures. Guidelines for the measurement of vibrations and evaluation of their effects on structures.

Ref 11.22 Transport Research Laboratory (TRL) (2002) Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping.

Ref 11.23 British Standards Institution (2014) BS 8233:2014 Guidance on sound insulation and noise reduction for buildings.

Ref 11.24 Defra (2015) NANR316 Possible Options for the Identification of SOAEL and LOAEL in Support of NPSE.

Ref 11.25 Association of Noise Consultants, Institute of Acoustic and Chartered Institute of Environmental Health (2017) ProPG: Planning & Noise, Professional Practice Guidance on Planning & Noise, New Residential Development.

Ref 11.26 WHO (1999) Guidelines for Community Noise.

Ref 11.27 WHO (2018) Environmental Noise Guidelines for the European Region.

Ref 11.28 WHO (2009) Night Noise Guidelines for Europe.

Ref 11.29 Highways England (2019) M54 to M6/M6 Toll Link Road, PCF Stage 3 EIA Scoping Report.

Ref 11.30 South Staffordshire Council (2008) Open Space Audit.