

HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Health impact assessment addendum:
Euston station and approach area

September 2015

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Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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1 Introduction

1.1 The purpose of the Health Impact Assessment and this report

- 1.1.1 The purpose of a Health Impact Assessment (HIA) is to assess the health consequences of a policy, programme or project so that this information can be taken into account in the decision-making process. It also aims, through evidence-based recommendations, to maximise the positive and minimise the negative health outcomes.
- 1.1.2 An HIA (the main HIA) was produced to accompany the hybrid Bill for High Speed Two (HS2) Phase One between London and the West Midlands (the Bill), which was submitted to Parliament together with an Environmental Statement (ES) (the main ES) in November 2013.
- 1.1.3 Since the main HIA, the Department for Transport (DfT) has asked HS2 Ltd to give further consideration to the design of Euston station. This revised design has been submitted to Parliament as part of the Supplementary Environmental Statement 2 (SES2) and Additional Provision 3 (AP3) to the Bill and is hereafter referred to as the 'revised scheme'. The amendments and design changes described in the AP3 revised scheme are within the area encompassed by the Euston station and approach community forum area 1 (CFA1) through to Kilburn (Brent) to Old Oak Common (CFA5). The likely significant environmental effects of the amendments and design changes are described in SES2 and the AP3 Environmental Statement (AP3 ES), which accompanies the Additional Provision documents.
- 1.1.4 The high speed station will be constructed in two stages, the first to allow operation of HS2 Phase One services to commence in 2026 (following the completion of construction Stage A 2017–2026), and the second to provide additional platforms to allow for growth in services and to allow HS2 Phase Two services to commence in 2033 (following the completion of combined construction and operation Stage B1 2026–2033). Six high speed platforms will be provided by 2026 and 11 by 2033. The design and staged construction programme of the revised scheme has been planned to minimise disruption to the operation of the conventional station, but also to be compatible with its potential future redevelopment. Any such redevelopment would however be for Network Rail to progress outside of the Bill powers (this potential future redevelopment is referred to as construction Stage B2).
- 1.1.5 An HIA addendum (this report) has been prepared as part of the design and planning process for the revised scheme to accompany the submission of the SES2 and AP3 ES. The HIA addendum updates the Euston station scheme assessment set out in the main HIA. It reports HS2 Ltd's current evaluation of the health and wellbeing issues in the Euston station area and the measures that are proposed to avoid, reduce or compensate for them.
- 1.1.6 As with the main HIA, the HIA addendum has been prepared in accordance with established good practice for large infrastructure projects in the UK. In addition to providing decision makers with information about the design changes and amendments comprising the revised scheme, it is also intended to inform communities about issues with the potential to affect health and how these will be controlled.

- 1.1.7 The HIA addendum is neither a statutory requirement nor a requirement of the Private Business Standing Orders of the Houses of Parliament that identify what documents are required to accompany amendments to the Bill. It does not form part of the SES2 and AP3 ES, however, it will be submitted alongside the AP3 documentation as supporting information.
- 1.1.8 A number of amendments and design changes have been proposed in respect of other areas of the route in CFAs 2 to 5. However, it has been determined that those amendments and design changes would not materially alter the analysis of health impacts reported in the areas where they will take place. Therefore, this HIA addendum is confined to the assessment of health effects in CFA 1.

1.2 Evaluating health issues and effects

- 1.2.1 As with the main HIA, this HIA addendum is based on the World Health Organisation's (WHO) definition of health as 'a state of complete physical, mental and social wellbeing and not merely an absence of disease or infirmity'.
- 1.2.2 The state of the health of individuals and communities is determined by many factors including their circumstances and environment. To determine the potential impacts of the AP3 revised scheme on health the HIA addendum has evaluated the changes to a number of factors that can influence health (which are termed health determinants) and considered the effect of those changes. The health determinants include community and economic factors as well as the physical environment.
- 1.2.3 A person's response to such changes will also depend on very many factors including for example, the person's individual characteristics and behaviours, as well as other factors such as their income and social status (higher income and social status are linked to better health); their level of education (low education levels are linked with poor health); and their social support networks (greater support from families, friends and communities is linked to better health). It is therefore not appropriate to assess the potential effects on individuals, but rather to assess whether a change is likely to improve or worsen the general health characteristics of the general population who will experience the change.
- 1.2.4 The health determinants identified as causing potential health effects are described in Section 2.6. The assessment sections of this report are organised according to health determinants. A summary of the linkages between the determinant and the health outcome is given at the start of each assessment section, with further information in Appendix 3. It should be noted that for some determinants the evidence of consequential health impacts is limited. This is because of the complex nature of links between an aspect of the project, effects on community or environmental factors, and the causal pathway leading to a health outcome, which may be influenced by many other factors.
- 1.2.5 Differential and disproportionate effects on Protected Groups (as defined by the Equality Act, 2010) are assessed in the HS2 Equality Impact Assessment (EqIA) update (Euston station and approach area)¹. This report highlights differential effects that may specifically relate to health effects.

¹ HS2 Ltd (2015) HS2 London – West Midlands EqIA Update: Euston station and approach area.

- 1.2.6 Section 2 provides more information on how the scale of health effects has been evaluated.

1.3 Relationship to the AP3 Environmental Impact Assessment and Environmental Statement

- 1.3.1 The assessment of effects on health is based on the revised scheme description, the scope of the HS2 environmental impact assessment process and the information described in the SES2 and AP3 ES. The HIA addendum draws on the SES2 and AP3 ES description of environmental and community effects and measures to avoid, reduce and, if possible, remedy significant adverse effects. As with the main HIA, the HIA addendum does not use the same assessment process or significance criteria to judge the significance of effects. It uses a more qualitative approach to describe the potential effects on health.
- 1.3.2 As was the case with the main HIA, this HIA addendum has used baseline studies comprising desk-top research, drawing on publicly available information (presented in Appendix 4). The baseline profile of communities affected by the revised scheme builds on the original community profile presented in the main HIA and updates it using relevant new and updated information from national, regional and local datasets released up to the end of June 2015.
- 1.3.3 The composition of communities affected by the scheme will change over time, in accordance with demographic trends, as well as the influence of wider government policy and economic factors. Like the main HIA, the HIA addendum does not include a future baseline profile of communities due to the limited availability and reliability of data.
- 1.3.4 The assessment has used information and maps produced as part of the SES2 and AP3 ES and has drawn on the reported environmental effects, particularly residual community, socio-economic, landscape and visual, noise, air quality and transport effects.

2 HIA process

2.1 Overview

- 2.1.1 As there is no prescribed methodology for undertaking an HIA, the approach used for this HIA addendum has drawn on best practice, key elements of published guidance and proven techniques from previous major infrastructure projects. This is the same approach to that taken for the main HIA published in support of the main ES.
- 2.1.2 A variety of HIA toolkits and guidance documents have been drawn on, including:
- Department of Health, 2010: Transport and Health Guidance;
 - Health Scotland, 2007: Health Impact Assessment for Transport: A Guide;
 - National Mental Wellbeing Impact Assessment Collaborative 2011: MWBIA Toolkit;
 - Healthy Urban Development Unit Planning for Health , 2013: Rapid Health Impact Assessment Tool; and
 - London Health Observatory, 2006: A Guide to Reviewing Published Evidence for use in Health Impact Assessment.
- 2.1.3 Since the publication of the main HIA, no new guidance has been published that would have resulted in a material change to the HIA process undertaken for the revised scheme.
- 2.1.4 The key stages undertaken in completing this HIA addendum are described below.

2.2 Evidence base

- 2.2.1 Using available literature, including individual research articles and recently published literature reviews, an evidence base has been collated to identify links between health determinants and likely health effects. This evidence base underpins the qualitative assessment of likely health effects in this HIA addendum. A summary of the published evidence reviewed is presented in Appendix 3.
- 2.2.2 The evidence base has been taken from the main HIA and updated using current research and recent Government evidence reviews where available, to provide a basis for the assessment. The strength of evidence linking environmental and community effects to health effects varies across the different issues considered. Where the evidence for an association is weak, this does not necessarily mean that the health effects will be small – but rather that existing published research does not provide strong evidence for an association.

2.3 Community profiles

- 2.3.1 Information has been gathered from a variety of published sources in order to provide a profile of the existing community around Euston station, the focus of this HIA addendum. This information covered the socio-economic, demographic and health characteristics of the communities.

- 2.3.2 The community profile has used the most detailed and up to date information available from publicly accessible sources. The level of spatial detail varies between different data sets used, ranging from small localised areas of around 150 households (lower super output areas) to regional level data.
- 2.3.3 Where reasonably practicable, as part of the community health profiling exercise, available information on existing vulnerable groups has been collated. This has focused on:
- whether a community is vulnerable to health effects due to existing deprivation (as defined by the Indices of Multiple Deprivation² and other data); and
 - groups of people who may be particularly susceptible to health effects due to characteristics such as age or disability.

2.4 Consultation and engagement

- 2.4.1 The extensive consultation undertaken as part of the main HIA identified all relevant issues relating to health and wellbeing and these continue to be relevant for the revised scheme.
- 2.4.2 The ongoing process of responding to petitions resulting from the consultation on the submitted Bill has helped to inform the development of additional provisions. The way in which these petitions have been addressed has helped to pre-empt future issues associated with development in the area around Euston station and how avoidance and mitigation measures can be included within the emerging design process.
- 2.4.3 HS2 Ltd has been undertaking ongoing engagement with the London Borough of Camden (LBC) since the main HIA has been published, including discussions on the potential relocation of residents adversely affected by the revised scheme.
- 2.4.4 The EQIA has included targeted consultation with key stakeholders within the Euston station area. This consultation identified similar concerns relating to health and wellbeing as a result of the revised scheme, as those already identified during consultation undertaken as part of the main HIA, including access to employment for the local community and potential amenity impacts of the revised scheme.
- 2.4.5 The feedback from these processes has informed the assessment of health impacts.

2.5 HIA scoping

- 2.5.1 The scope of this HIA addendum has been informed by the scoping undertaken for the main HIA. All previously identified issues are considered relevant to this assessment. The spatial and population scope of the HIA addendum has been informed by the amendments and design changes in the revised scheme and the scope of the SES2 and AP3 ES within CFA1.

² This is an overall measure of multiple deprivation experienced by people living in an area.

2.6 Assessment of health effects

- 2.6.1 As with the main HIA, a qualitative assessment of health effects has been undertaken for this HIA addendum. This has involved the identification of potential effects on environmental and community health determinants, the levels of exposure to these changes and the general characteristics of the communities affected.
- 2.6.2 Research evidence for links between changes in the health determinant and resulting health effects have been used to underpin the assessment – for example, lack of physical activity is known to be associated with obesity, cardiovascular health and depression. The term 'associated' when used in an epidemiological³ context describes a potential or likely causal link that has been established through scientific research. This does not imply that all individuals exposed to a certain change will experience a health effect; rather that there will be an increased risk of health effects occurring within the exposed population.
- 2.6.3 Health effects have been considered at varying spatial levels according to the extent of change to the determinant.
- 2.6.4 In undertaking the qualitative assessment of potential health effects, the following criteria have been considered:
- the strength of evidence for a link (or 'association') between a change in health determinant and a health outcome, based on the review of published evidence;
 - the nature of the change in an environmental or community factor (or 'health determinant') resulting from the revised scheme;
 - the duration of the change in a health determinant (operational effects are assumed to be permanent in most cases; construction effects are defined as short-term if under six months, medium-term if six months to two years, or long-term if more than two years in duration);
 - the 'extent' of exposure, i.e. the size of the population exposed to the change;
 - the 'intensity' of exposure, i.e. the intensity at which the exposed population is likely to experience the change in a health determinant, taking into account factors such as the magnitude and duration of the effect;
 - the sensitivity of the affected population, based on the community profiles. This includes consideration of the vulnerability of the population as a whole, based on deprivation indicators, and particular vulnerable groups within the population;
 - the effects of perception, which may influence the way in which people experience or react to a change in health determinant; and
 - the extent to which the change in a determinant can be reduced or controlled in order to minimise the risk of adverse health effects, or enhancement of

³ The study of the occurrence and distribution of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems.

beneficial effects.

2.6.5 This methodology provides a mechanism for identifying the likelihood of potential health effects occurring within a population. In most cases, the linkages identified in the scientific research literature, that have been summarised in the evidence review, do not provide sufficient information on exposure-response relationships to enable the magnitude of health effects to be assessed.

2.6.6 Health is influenced by a wide range of factors, making the process of attributing a specific health effect to a single causal factor complex and potentially unreliable. In addition, health effects may be triggered or exacerbated by perceptions about development. These may comprise mental or psychological effects, such as:

- increased levels of anxiety for local residents arising from concern, such as reduced desirability of the areas near a development affecting local property markets, or crime and antisocial behaviour associated with construction sites; and
- health effects resulting from behavioural changes, such as a decrease in the number of people walking and cycling due to road safety concerns, resulting in reduced levels of physical activity; and reluctance to use community services and facilities, resulting in a reduction in social interaction.

2.7 Mitigation of health effects

2.7.1 Health issues have been considered alongside environmental, community and socio-economic issues in the assessment of the revised scheme. The outcomes of this assessment have helped define measures that are included in the design described in the SES2 and AP3 ES. Through this process, adverse effects on health determinants have been reduced.

2.7.2 Measures to reduce the risk of adverse health effects and enhance health benefits will continue to be developed in collaboration with third parties. HS2 Ltd has put in place mechanisms to facilitate this process, as described in Section 3.

3 Mitigation

3.1 Introduction

- 3.1.1 The following general mitigation measures, which HS2 Ltd has committed to, will serve to reduce the potential adverse health effects and enhance the beneficial effects of the revised scheme.

3.2 Measures incorporated into the AP3 revised scheme design

- 3.2.1 Consideration of potential health issues has been an integral part of the planning and design of the revised scheme, alongside consideration of other environmental, community and economic issues. Examples of the outcomes of this process include the design of the revised scheme to reduce the loss of access to businesses and community assets as far as reasonably practicable and the incorporation of landscape design and screening.

3.3 Environmental management

- 3.3.1 HS2 Ltd will require its contractors to comply with the environmental management regime for the revised scheme, which will include the following core documents:

- the CoCP, which will provide a generic basis for route-wide construction environmental management and will be the means of controlling the construction works associated with the revised scheme to ensure that the effects of the works upon people and the natural environment are kept to a practicable minimum; and
- local environmental management plans (LEMP), which build on the general environmental requirements provided in the CoCP and will set out how the project will adapt and deliver the required environmental and community protection measures within each relevant local authority area.

3.4 Ongoing engagement and mitigation

- 3.4.1 HS2 Ltd will put in place an on-going process of assessment, engagement and communication throughout the detailed planning, construction and operation of the revised scheme to continue to identify and mitigate adverse effects.

3.5 Community liaison

- 3.5.1 The draft CoCP commits the Nominated Undertaker and its contractors to produce and implement a stakeholder engagement framework and provide experienced community relations personnel to implement it. The Nominated Undertaker will engage with the community, particularly focusing on those that may be adversely affected during construction. The Nominated Undertaker and its contractors will ensure that local residents, occupiers, businesses and local authorities affected by the proposed construction works, as outlined in the SES2 and AP3 ES, will be informed in advance of works taking place, by methods identified in the framework. The notifications will detail the estimated duration of the works, the working hours and the nature of the works. In addition the draft CoCP commits the project to produce a LEMP which will set out local arrangements for construction activity.

- 3.5.2 The stakeholder engagement framework will be implemented during the stages up to the commencement of construction. This will focus on communicating potential effects and mitigation measures, with the aim of minimising concern.
- 3.5.3 As specified in the draft CoCP, information for the public will be provided using a variety of methods such as social media, email alerts, local radio and newspapers as appropriate. The service will also be available in different languages, on a case by case basis as agreed by the Nominated Undertaker.

3.6 Additional mitigation

- 3.6.1 Additional mitigation measures to reduce adverse environmental effects associated with health, such as noise, visual effects and loss of community assets are referred to in this HIA addendum. Further details on these mitigation measures are described in the SES2 and AP3 ES.

4 Potential health effects

4.1 Introduction

- 4.1.1 This section of the HIA addendum report describes the potential effects on health arising from changes in health determinants resulting from the construction and operation of the revised scheme in the area around Euston station.

4.2 Employment and income

- 4.2.1 The beneficial and adverse socio-economic effects of the revised scheme are reported at two different levels within the SES2 and AP3 ES. Effects on levels of employment are reported at a route-wide level in Volume 3 of the main ES, with minor updates to the assessment in Volume 3 of the SES2 and AP3 ES. Localised effects on businesses and observations on potential local economic effects are reported in the CFA 1 report in Volume 2 of the SES2 and AP3 ES. The findings of these two sets of documents has informed the assessment of health effects associated with employment and income.
- 4.2.2 The main ES reported that beneficial effects on employment were likely to be most concentrated around London and Birmingham, at either end of the scheme, and this is still considered to be the case after the successive design changes and amendments to the scheme. Beneficial effects are therefore considered likely to result directly from the revised scheme within the area around Euston station. The area in which Euston station is located includes communities with relatively poor health associated with high levels of deprivation. The revised scheme does provide an opportunity to reduce these levels of deprivation, although it is anticipated that some potential job losses in existing local businesses will also occur in this area during the construction phase.

Links to health effects

- 4.2.3 There is strong evidence of links between employment and income and health status. Being in employment is associated with social and psychological wellbeing, with work being an important aspect of individual identity and social status. Unemployment is a significant risk factor for physical and mental health, and is a major determinant of health inequalities. Increasing material wealth provides increased opportunities for participation in society and increased access to healthier lifestyle choices, which are associated with improved mental and physical health. However, these relationships are complex, and compounded by many other variables.
- 4.2.4 Changes to employment status and income associated with the revised scheme have the potential to influence the health of the communities in the area around Euston station, both positively and negatively.
- 4.2.5 Evidence for the links between economic and employment status and health is presented in Appendix 3.

Construction employment

- 4.2.6 HS2 Ltd's Information Paper on training and employment⁴ sets out how it will facilitate the take up of employment opportunities along the scheme by local

⁴ HS2 Ltd (June 2015) Information Paper G4: Approach to Training and Employment.

residents. The strategy will consider local employment, apprenticeships and education initiatives when recruiting staff. This includes engaging with unemployed people along the line of route.

- 4.2.7 HS2 Ltd's Information Paper on Equality, Diversity and Inclusion⁵ identifies a framework to encourage opportunities for local businesses to tender for work contracts and to promote the use of local suppliers, goods and services.
- 4.2.8 The construction sites for the revised scheme will generate significant demand for workers, ranging from unskilled and low skilled jobs to technical and managerial roles. The SES2 and AP3 ES predicts the approximate peak number of construction personnel at all construction sites at Euston to be 1,960 between mid-2022 to end 2026 in construction Stage A, with a second peak of 2,050 in construction Stage B1 between mid-2030 to end 2033. In addition, a further 400 HS2 Ltd project staff will be present at Euston for the duration of the construction phases.
- 4.2.9 The construction works are likely to generate additional employment opportunities outside the worksites, as well as indirect demand for goods and services through the business supply chain and expenditure effects of workers which could deliver business opportunities and generate further employment. Uptake of jobs from within local communities is likely to be predominantly in lower-skilled roles, as contractors will generally appoint the majority of skilled and managerial staff from their existing workforce. The jobs created will be located within the area around Euston station for the duration of the works, which will last for several years in many cases. After this, the training, skills and experience gained may improve future employment prospects in the construction sector.
- 4.2.10 The construction of the revised scheme will introduce new training and employment opportunities. Young people may benefit from construction related training and apprenticeship opportunities, which will be particularly valuable in the LBC area.
- 4.2.11 The extent of beneficial health effects within the local communities in the area around Euston station will depend on the number of people who are able to, and choose to, take up opportunities for construction employment and training. For those who do, this may result in improved income, employment status and self-esteem, and associated health benefits.
- 4.2.12 Given the above, the intensity and extent of exposure to the beneficial effects of gaining construction employment associated with the revised scheme are considered to be high intensity and high extent.

Job losses and displacement during construction

- 4.2.13 The construction of the revised scheme will result in the demolition of a number of commercial premises, particularly around Euston station. Further information on demolitions in the area around Euston station is reported in Volume 2, Chapter 2 of the SES2 and AP3 ES (CFA1 report). In most cases it is anticipated that companies will relocate to alternative premises within the local area, and most jobs will be retained (the SES2 and AP3 ES assumes, based on evidence from the London 2012 Olympic Games, that 88% of businesses will be successfully relocated). The SES2 and AP3 ES

⁵ HS2 Ltd (June 2015) Information Paper G5: Equality, Diversity and Inclusion Policy.

has predicted approximately 2,610 jobs will be displaced or potentially lost within the area around Euston station.

- 4.2.14 There are also permanent effects during the construction stages (Stage A and Stage B1) associated with the provision of retail uses, which are assessed to have beneficial effects on health for those local people in the area around Euston station who take up new HS2 related work opportunities and new retail employment opportunities at the station. This may particularly benefit people who were previously unemployed as there is strong evidence to suggest that employment is associated with beneficial social and psychological wellbeing, with work being central to individual identity, social roles and social status.
- 4.2.15 During construction there will be a net benefit in overall employment in the Euston area, taking into account potential job losses from businesses affected by the construction of the revised scheme and employment generated by construction.
- 4.2.16 Businesses required to relocate due to the construction of the revised scheme will be eligible for compensation under the Compensation Code. However, HS2 Ltd recognises the importance of businesses being able to relocate to new premises and will therefore provide additional support over and above statutory requirements to facilitate this process and to reduce and/or offset the effects of the revised scheme.
- 4.2.17 Businesses with specific requirements, such as the need for a particularly large site or proximity to a railhead, are less likely to find suitable alternative premises close to their existing site and may have to relocate further afield. In these instances, although the total number of jobs may remain the same, some local workers, particularly in the lower paid positions, may be unable to commute to the new location, resulting in the loss of their job.
- 4.2.18 The displacement and potential loss of jobs gives rise to the potential that some individuals may experience long-term effects on their employment status, leading to potential adverse health effects.
- 4.2.19 Given the above, the intensity and extent of exposure to the adverse effects of losing employment because of the revised scheme are considered to be high intensity and low to medium extent.

Local economic effects during construction

- 4.2.20 As described above, the direct employment generated in the construction phase will lead to additional indirect employment through demand for goods and services through the business supply chain and expenditure by workers. Depending on skill levels required and the skills of local people, these opportunities are potentially accessible to residents in the locality and to others living further afield, particularly given the location of the works at/close to an inner London transport hub. This has the potential to benefit local communities, through local residents who work in these businesses.
- 4.2.21 The potential for goods and services to be procured locally will depend on the availability of appropriate local suppliers and will be governed by contractual and financial considerations.

- 4.2.22 Disruption during construction also has the potential to adversely affect the trade of local businesses. Road closures and diversions, and construction traffic on local roads, may restrict vehicle access. Road and footpath closures may also reduce footfall and passing trade. Additionally, the trade of some businesses such as cafes and restaurants may be affected by noise and visual effects which will alter the ambience of the dining experience. Individual businesses may experience effects intermittently or for the duration of the construction works, and business owners may experience anxiety relating to uncertainties about the nature and timing of effects and how these could affect their trade.
- 4.2.23 The intensity and extent of exposure to the beneficial effects of indirect employment and gaining business because of the revised scheme are considered to be high intensity and high extent.
- 4.2.24 Given the above, the intensity and extent of exposure to the adverse effects of losing business because of the revised scheme are considered to be medium to high intensity and low extent.

Job gains during operation

- 4.2.25 The SES2 and AP3 ES has estimated the approximate gross direct employment for Euston station and train operations at the enhanced station may amount to approximately 500 jobs by 2033.
- 4.2.26 The SES2 and AP3 ES also reports that operation of the revised scheme will create indirect employment opportunities at locations in the area around Euston station. These indirect jobs will result from expenditure on supplies and services necessary for the operation of the revised scheme, expenditure by those directly employed as part of operations on the revised scheme and expenditure by workers employed by suppliers contracted to the revised scheme.
- 4.2.27 Given the above, the intensity and extent of exposure to the beneficial effects of gaining operation phase employment associated with the revised scheme are considered to be high intensity and low extent.

Regeneration around stations during operation

- 4.2.28 The revised scheme is expected to generate demand for property development around Euston station, which could provide substantial new employment space and new homes.
- 4.2.29 Since submission of the Bill, in consultation with key stakeholders, HS2 Ltd undertook a wide-ranging review of the delivery of HS2 Phase One, as set out in HS2 Plus, published in March 2014. This confirmed HS2 Ltd's commitment to ensuring that the revised scheme at Euston would enable the delivery of the wider vision in the Euston Area Plan (EAP)⁶. The adopted EAP provides a strategic vision for the redevelopment and wider regeneration of the Euston area, including the site of the conventional and high speed stations.
- 4.2.30 As described above, employment is associated with wide-ranging mental and physical health benefits. The areas around Euston station are characterised by relatively high

⁶ London Borough of Camden (2015) adopted Euston Area Plan, which is also Supplementary Planning Guidance to the London Plan.

levels of deprivation and unemployment (see Appendix 3). By attracting employment and regeneration to these areas, the revised scheme has the potential to provide opportunities to those sectors of the community most in need, thereby helping to reduce social and economic inequalities. This in turn has the potential to reduce health inequalities.

- 4.2.31 Given the above, the intensity and extent of exposure to the beneficial effects of gaining regeneration-related employment associated with the revised scheme are considered to be high intensity and high extent.

4.3 Residential property

Links to health effects

- 4.3.1 There is moderate to strong evidence on the links between housing and health, relating to the quality and security of housing, and also to the effects of involuntary relocation.
- 4.3.2 Relocation of people from their homes has been shown to influence health outcomes, as disturbance to people's living and social environment and routine may precipitate stress and related symptoms. Moving home involves significant disruption, uncertainty and changes to social networks and familiar environments and routines.
- 4.3.3 The degree of health effect associated with moving will depend on the vulnerability and resilience of the individuals affected. Age is a common factor in determining the ability of people to adapt to the effects of relocation. Older people are likely to find it more difficult to adapt to the effects of relocation, as are disabled people, or those with existing mental or physical health conditions. Young families may need to move their children to different schools, or face longer journeys to school.
- 4.3.4 Evidence for the links between housing and health is presented in Appendix 3.

Relocation of residents

- 4.3.5 Individuals whose properties have to be acquired for the construction of the revised scheme will be eligible for compensation pursuant to the provisions of the Compensation Code. Similarly, compensation will also be available under the Code once the new railway is in operation for people who find that the value of their homes is reduced as a result of certain physical effects of the operation of the scheme (for example by noise from the railway). The Government is committed to providing a discretionary package of compensation measures, going above and beyond the Compensation Code, which addresses cases of exceptional hardship.
- 4.3.6 The need to sell (NTS)⁷ scheme replaces the Phase One exceptional hardship scheme, which was introduced in August 2010. This scheme will run until 12 months after the railway is first open for public use.
- 4.3.7 The NTS scheme recognises the importance of providing assistance to those who have a compelling reason to sell their property but are unable to do so – other than at a significant loss – due to HS2, or whom if unable to sell their property would face an unreasonable burden in the near future.

⁷ HS2 Ltd (January 2015) Property Schemes For the London-West Midlands HS2 route: Need to sell scheme – Guidance notes and application form.

- 4.3.8 The number of properties affected in the area surrounding Euston station is 220 dwellings, of which 193 social rented and private residential properties are located within or adjacent to the social housing block at Regent's Park Estate. The remaining 27 private residential properties are situated on Cobourg Street, Euston Street, and Melton Street.
- 4.3.9 The majority of residents whose properties are required for the construction of the scheme are likely to experience some degree of adverse effect resulting from the disruption and stress of moving. For many this may include emotional responses to the loss of their home. The onset of adverse effects will occur before the acquisition of properties, with uncertainty and concerns regarding timescales for the purchase and the impacts and logistics associated with the move.
- 4.3.10 The largest number of residential relocations required for the revised scheme occurs within the area around Euston station and will predominantly affect social housing tenants within Regent's Park Estate. The demolitions and relocations will affect a large number of tenants from a community which has relatively poor overall health associated with high levels of deprivation, making people potentially less resilient to the effects of moving. Additionally, there is evidence to suggest that social housing tenants may be particularly vulnerable to the effects of involuntary relocation, due to a lack of control around the move and a lack of choice about where they are relocated. Exposure to the potential adverse effects of involuntary relocation was assessed to be of high extent and high intensity for the affected residents on the Regent's Park Estate in the main HIA.
- 4.3.11 Since November 2013, HS2 Ltd has engaged with local residents and LBC on relocation issues, e.g. alternative provision, compensation, and likely timeframes of any relocation. It has been agreed that LBC will take responsibility for the implementation of the relocation process and procurement of alternative accommodation provision for those in social housing, with HS2 Ltd providing financial assistance to facilitate this.
- 4.3.12 Hs2 Ltd has reached an agreement with LBC to fund the reprovision of 136 social rented homes that are to be lost during construction. These replacement homes will be provided as part of two new developments within Camden. These developments are being promoted, delivered and managed by LBC. These developments are as follows:
- 66 homes will be provided as part of the redevelopment of Regent's Park Estate (planning application reference 2015/3076/P), which will involve the development of eight sites in two phases; and
 - 70 homes will be provided as part of the redevelopment at Netley Primary School (committed development CFA1/12).
- 4.3.13 It is intended that this new accommodation will be available prior to the demolition of any social rented housing and will allow time for residents to visit their new properties prior to relocation.
- 4.3.14 There is also a potential for beneficial effects where social renting tenants are provided with modern purpose-built housing to replace the existing, ageing blocks. The degree of benefit will depend on the quality of design and build, and the space

standards applied in the new housing provision. The information contained within the planning application (2015/3076/P) contains objectives to create high-quality homes that meet or exceed the requirements of the London Housing Design Guide⁸, provide quality open space provision and contribute to LBC's wider regeneration strategy for the area.

4.3.15 Given the above, the intensity and extent of exposure to the adverse effects of relocation are considered to be low intensity and high extent.

4.3.16 In addition, the intensity and extent of exposure to the beneficial effects of moving to new homes are considered to be low to medium intensity and high extent.

Relocation and community effects

4.3.17 Where a significant number of properties are lost from within a community, such as the loss likely to be experienced as part of the revised scheme, there is a potential for the remaining community to experience changes to their social environment and loss of social networks (see Section 4.11 for further discussion of effects on 'social capital'). For example, at Euston, the scale of relocations is likely to alter the social environment for remaining residents in the northern part of the Regent's Park Estate.

4.3.18 There is a potential for the erosion of social networks, which could in turn result in a reduction of the beneficial health effects that are gained through social contact and support. As the majority of residents will be relocated within LBC's administrative area and within the same locality, the adverse effects from the erosion of social networks specifically due to relocation is likely to be small.

4.3.19 For those residents of properties who are not being relocated, but whose properties are in proximity to construction sites (including one block of reprovided housing at Newlands), there is the potential for construction activity to adversely affect the residential amenity⁹ of these properties. Significant impacts on the amenity of residential properties at specific locations during construction are predicted within the SES2 and AP3 ES in CFA1 to occur at:

- Regent's Park Estate/Newlands (295 residential properties affected for up to five years);
- Cobourg Street and Starcross Street (10–20 residential properties affected for up to five years);
- Robert Street (100 dwellings affected during peak construction months in 2023);
- Varndell Street (70 dwellings affected during peak construction months in 2018);
- Amptill Square Estate (130 residential properties for up to two years);
- Park Village East (at least 50 residential properties for two years);
- Mornington Terrace (90 residential properties for two years); and

⁸ Mayor of London (August 2010) London Housing Design Guide: Interim Edition, London Development Agency.

⁹ The benefits of enjoyment and wellbeing which are gained from a resource in line with its intended function. Amenity may be affected by a combination of factors such as: sound, noise and vibration; dust/air quality; traffic/congestion; and visual impacts.

- A401 Parkway and Delancy Street (35 residential properties for up to 18 months).

4.3.20 In addition, intermittent amenity impacts are likely to be experienced by residents in the following areas:

- A4201 Albany Street, A501 Euston Road (Euston Circus slip), A41 Baker Street (Park Road to Marylebone Circus) and A41 Park Road (junction with A5025 to junction with Rossmore Road);
- Bidborough Street and Cartwright Gardens;
- Mabledon Place (near Bidborough Street); A400 Gower Street/Bloomsbury Street (Euston Road to Torrington Place); Grafton Way and Coram Street;
- Mornington Place, Mornington Crescent and Albert Street; and
- Plender Street (Camden High Street to Bayman Street) and Mornington Street (Albert Street to Arlington Street).

4.3.21 Adverse effects from changes in amenity can lead to stress, anxiety, sleep disturbance and disruption to daily routines.

4.3.22 During the relocation of residents to new homes, given the above, the intensity and extent of the exposure to the adverse effects of erosion of social networks are considered to be low to medium intensity and high extent. After the first year it is considered that social networks are likely to be rebuilt over time and the beneficial effects of having good social networks are likely re-emerge.

4.3.23 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of changes in amenity are considered to be medium to high intensity and high extent. During the operation phase, the intensity and extent of the exposure to the adverse effects of changes in amenity are considered to be low intensity and extent e.g. those living near the realigned roads and the new taxi rank.

4.4 Local environment

4.4.1 This section assesses issues affecting the quality of public space and the local environment, including:

- changes to the natural and built environment, including changes to landscape and townscape character and effects on the quality of views;
- access to open space and natural environments, including parks, public open space and countryside; and
- fear of crime and anti-social behaviour.

Links to health effects

4.4.2 There is moderate evidence that people have a preference for views of natural environments over man-made environments, and that exposure to views of natural environments is associated with wellbeing. There is moderate to strong evidence that access to green space and natural environments is beneficial for health, including associations with mental wellbeing and reduced stress in addition to other related

issues such as physical activity. The attractiveness and quality of greenspace is important in determining how this space is used and its potential health benefits.

- 4.4.3 The link between health and the aesthetic value of the public realm is not well understood but there is evidence to suggest that an attractive urban environment, including buildings and public space, can improve people's enjoyment and sense of wellbeing. Conversely, stressful and poor-quality urban environments have been shown to have negative effects on people's health.
- 4.4.4 Increased fear of crime can occur as a result of the presence of construction sites and the associated influx of workers. Fear of crime has been linked to health effects such as anxiety, and changes in behaviour such as reduced participation in activities that are beneficial to health.
- 4.4.5 Evidence for the links between the quality of the local environment, green space, fear of crime and health is presented in Appendix 3.

Visual effects and changes to local character

- 4.4.6 Due to the scale of the revised scheme, the construction works and permanent infrastructure will be visible from a large number of locations. In some areas around Euston station, effects on the townscape may affect residents' perceptions of the quality and character of their local environment. The perception of a more stressful and poor quality environment, particularly during construction, may contribute to adverse health effects.
- 4.4.7 Adverse effects from views of construction sites will mainly occur during the peak construction phase, which will be long-term at sites within the area around Euston station. In urban areas where the route is not in tunnel there will be changes to the character of the townscape resulting from the presence of worksites and construction plant, hoarding, demolitions and the loss of vegetation.
- 4.4.8 Loss of screening vegetation and green spaces will result in adverse effects on views and on the perceived quality of the local environment. These effects will lessen after construction in many cases, as replacement planting becomes established and open spaces are reinstated. There is a potential for long-term beneficial effects as a result of planting and reinstatement.
- 4.4.9 There is also a potential for beneficial effects resulting from the presence of permanent infrastructure around Euston station. These will be highly visible from the public realm and may be considered to be either beneficial or adverse depending on individuals' responses to the final design of the high speed station. However, it is considered that the visual effects will generally be considered to be beneficial as the high speed station will be of a higher architectural quality than the current mixture of buildings.
- 4.4.10 Negative visual effects in the area around Euston station are likely to occur as a result of the loss of existing townscape features and the presence of new infrastructure. Positive visual effects are likely to occur through the creation of new public space and the improved accessibility to Euston station.

- 4.4.11 Certain elements of the revised scheme will have a positive impact on the character of parts of the Euston Road Commercial Area Landscape Character Area (LCA), including:
- the revised scheme includes public realm improvements and reinstatement, including the main entrance forecourt south of the station and a partly landscaped public forecourt at the Cobourg Street station entrance;
 - improved accessibility of the station forecourt achieved by removing steps and barriers to allow better pedestrian circulation and way finding;
 - creation of pedestrian access routes linking across to Euston Square Gardens;
 - provision of new north-south and east-west pedestrian links through the high speed station;
 - the restoration of Euston Square Gardens, including replacement tree planting and associated public realm improvements. The relocation of the bus access to Melton Street will also unite the gardens into a single space; and
 - the provision of active frontages along the western station façade, which will be representative of regeneration in the area, creating more pedestrian activity but also potentially adversely affecting the tranquillity of the local area.
- 4.4.12 However, these positive elements will also be set in the context of other substantial changes within the LCA which will have a more notable effect on the character of the area, including:
- the permanent loss of buildings, including Grant Thornton House and One Euston Square;
 - the addition of the new high speed station to the overall station facilities at Euston, which will result in an increase in the footprint of station facilities at Euston by approximately a third compared to the existing conventional station. The assessment assumes that the maximum height of the high speed station spine building will be 60m Above Ordnance Datum, equivalent to between 35 and 40m above existing ground levels. The three-storey high speed station accommodation buildings used temporarily during Stage B1 of construction on the Cobourg Street frontage will provide the base levels to potential over-site development. The overall scale of the combined station facilities at Euston will be considerably larger than the surrounding built elements, resulting in the:
 - loss of the existing smaller scale street pattern;
 - permanent loss of St. James's Gardens; and
 - permanent loss of street trees along Melton Street and Cardington Street.
- 4.4.13 These effects have been minimised through the design process.

- 4.4.14 Adverse effects from negative visual effects and changes to the local character can exacerbate stress and reduce opportunities for relaxation, physical activity, children's play and social interaction.
- 4.4.15 During the construction phase, given the above, the intensity and extent of the exposure to adverse effects from negative visual effects and changes to the local character are considered to be medium to high intensity and high extent.
- 4.4.16 During the operation phase, given the above, due to the enhancement of the area surrounding Euston station, the intensity and extent of the exposure to the beneficial effects from positive visual effects and changes to the local character are considered to be low to medium intensity and medium to high extent.

Schools and care facilities

- 4.4.17 Pupils at schools in the area around Euston station may be more sensitive to changes in the environment, including visual effects.
- 4.4.18 The SES2 and AP3 ES has identified significant adverse noise effects at the Maria Fidelis Convent School (Lower) in North Gower Street.
- 4.4.19 There will also be amenity impacts relating to heavy goods vehicle (HGV) movements and air quality at the Christ Church Primary School on Redhill Street; Francis Holland School on Ivor Street; and North Bridge Preparatory School on Gloucester Avenue.
- 4.4.20 HS2 Ltd will work closely with the Maria Fidelis Convent School; the Christ Church Primary School; the Francis Holland School; and the North Bridge Preparatory School to identify further measures to mitigate amenity effects, where reasonably practicable, with a view to producing a satisfactory outcome. Where appropriate, HS2 Ltd will set out specific working practices in the LEMP to provide further mitigation.
- 4.4.21 No care homes are likely to be affected as a result of the redevelopment of Euston station.
- 4.4.22 During the construction phase, given the above, the intensity and extent of the exposure of schools to the adverse effects of amenity are considered to be medium to high intensity and high extent.
- 4.4.23 During the operation phase, there are expected to be no negative amenity effects on schools because of the revised scheme.

Public open space

- 4.4.24 The construction of the revised scheme will require the acquisition of land including areas of public open space. Some land will be acquired permanently, whereas other areas will be returned and reinstated as public open space after the construction phase has ended. During the construction phase, the remaining areas of open space close to the works will be subject to amenity impacts which may affect their quality and desirability.
- 4.4.25 HS2 Ltd will support the dissemination of information on public open space closures via the use of community liaison officers and measures contained within the draft CoCP.

- 4.4.26 Where the SES2 and AP3 ES reports a significant community effect resulting from the temporary or permanent loss of public open space the options for the mitigation of temporary and permanent effects are:
- improvements or alterations to the remaining portion of the public open space (in instances where the public open space is partially occupied so as to limit a primary use), such as reconfiguring pitch layouts or relocating play areas;
 - improvements to other existing public open spaces in the area that could reduce the effect;
 - improving accessibility to other existing public open space; and/or
 - identifying land owned by the relevant local authority that could be brought into use as public open space with their agreement.
- 4.4.27 A number of these spaces will be lost during the construction of the revised scheme, including:
- temporary closure of Euston Square Gardens, to the front of Euston station;
 - permanent closure of St James's Gardens during the construction works;
 - permanent loss of Hampstead Road Open Space; and
 - permanent loss of Eskdale play area.
- 4.4.28 During construction, the effects on St James's Gardens, Hampstead Road Open Space and Eskdale play area are likely to adversely affect people's perceptions about the quality of their living environment, and will reduce ease of access to green space, which has a range of health benefits. The area is densely populated, and alternative sites for re-provision of open space within the Regent's Park Estate are limited. HS2 Ltd and LBC intend to provide replacement public open spaces within Regent's Park Estate in order to mitigate the effects.
- 4.4.29 Public open spaces will be created and reinstated within the Euston station area. These include:
- Euston Square Gardens will be reinstated after construction is completed in 2033;
 - St James's Gardens will be reprovided after construction on a site in the north-east of the Regent's Park Estate: the proposed open space north of Langdale (see Map CT-o6-001, Volume 2 CFA1 Map Book). Though a smaller area will be reprovided, this will include a multi-use games area, children's play area, landscaped areas and benches. The new areas of open space are further north than the original St James's Gardens but will remain accessible to residents in Regent's Park Estate; and
 - New public open spaces will be provided north of Langdale, in the Regent's Park Estate; the Amphil Estate; and north of Euston station.
- 4.4.30 During the construction phase, given the above, the intensity and extent of the exposure to adverse effects from the loss of public open space are considered to be medium to high intensity and medium to high extent.

- 4.4.31 During the operation phase the intensity and extent of the exposure to the beneficial health effects from the re-provision of public open space are considered to be medium to high intensity and medium to high extent (i.e. similar to the existing baseline).

Fear of crime and antisocial behaviour

- 4.4.32 Construction sites are sometimes perceived as having the potential to attract activities such as vandalism, fly-tipping and theft of materials. Those living adjacent to construction compounds may experience increased fear of crime associated with the presence of the site. Additionally, the diversion of footpaths around construction sites has the potential to affect actual or perceived personal safety, both in terms of road safety and environmental changes such as sight lines and lighting.
- 4.4.33 The extent and intensity of fear of crime and antisocial behaviour resulting from the revised scheme is likely to be low, as construction sites will be appropriately fenced and secured, and the potential for crime and anti-social behaviour will be minimised through the measures set out in the draft CoCP (Section 5).
- 4.4.34 During the construction phase, the intensity and extent of the exposure to the adverse effects from fear of crime and antisocial behaviour are considered to be low intensity and low extent.
- 4.4.35 During the operation phase, there are expected to be no increase in fear of crime and antisocial behaviour because of the revised scheme.

4.5 Air quality

Links to health effects

- 4.5.1 The SES2 and AP3 ES provides an assessment of the likely significant effects on local air quality arising from the construction and operation of the revised scheme, covering nitrogen dioxide (NO₂), particulate matter (PM₁₀)¹⁰ and dust.
- 4.5.2 The links between road traffic emissions and health are well established. There is strong evidence of the health damaging effects of PM₁₀ and NO₂. Particulate matter may be deposited within the lungs, with smaller particles having a greater chance of reaching the deeper parts of the lungs, affecting lung function.
- 4.5.3 The effects of road traffic related NO₂ on health are less well understood than the effects of PM₁₀. There is now scientific consensus that NO₂ can cause respiratory problems, with short-term acute exposure likely having a greater adverse effect than a longer term exposure at lower concentrations.
- 4.5.4 It is generally accepted that large particulate matter (dust) does not penetrate the lungs to cause respiratory health problems. However, dust can cause eye, nose and throat irritation and lead to nuisance effects.
- 4.5.5 Evidence for the links between air quality and health is presented in Appendix 3.

¹⁰ PM₁₀ describes airborne particles that can be inhaled and therefore are of concern for human health. The designation refers to particles of size less than 10 microns in diameter.

Construction dust

- 4.5.6 Emissions to the atmosphere from construction activities including dust and emissions from on-site plant and equipment will be controlled and managed through the route-wide implementation of the draft CoCP. The draft CoCP includes a range of mitigation measures that are accepted by the Institute of Air Quality Management as being suitable to reduce impacts to as low a level as reasonably practicable. It also makes provision for the preparation of LEMP which will set out how the project will adapt and deliver the required environmental and community protection measures within each area.
- 4.5.7 With the implementation of mitigation measures contained within the draft CoCP, including the use of LEMP in places where receptors are very close to sources of dust, the assessment of air quality impacts arising from dust emissions in the SES2 and AP3 ES has concluded that no significant effects are anticipated. The basis for this conclusion can be found in Volume 5: SES2 and AP3 ES Appendix AQ-001-001 where the scale of dust emissions and their proximity to receptors is fully described. It is therefore expected that health impacts at nearby receptors is unlikely to result in health effects.
- 4.5.8 The consultations undertaken by HS2 Ltd as part of the main ES identified public concern relating to the potential health effects of construction dust, particularly from people with existing respiratory conditions such as asthma. There is no evidence to suggest that dust at levels expected near to the construction sites could exacerbate these conditions. Furthermore, at the low levels of effects predicted in the SES2 and AP3 ES, any irritation of the eyes, nose and throat is unlikely to occur. However, it is recognised that the perceived health effects of dust may cause anxiety to some individuals.
- 4.5.9 Since no significant effects relating to dust emissions were predicted in the SES2 and AP3 ES, and the probable short term nature, the intensity and extent of exposure to the adverse effects of construction dust are considered to be low.

Construction traffic

- 4.5.10 Assessment of the potential air quality impacts of NO₂ and PM₁₀ from road traffic emissions has been undertaken for the SES2 and AP3 ES, based on the change of pollutant concentrations and whether air quality standards are exceeded. In order to reduce emissions from construction traffic, there is a commitment from HS2 Ltd to ensure that cleaner engines meeting Euro VI standards, are used for all HGVs used for the transportation of excavated material.
- 4.5.11 The SES2 and AP3 ES identifies a number of receptors where there may be temporary moderate or substantial air quality impacts, some adverse and some beneficial. These impacts arise from construction-related traffic changes, including additional emissions from construction traffic, and re-routing of traffic due to road closures and diversions. Temporary road closures will result in some roads becoming busier (experiencing increases in emissions), whilst others become quieter (experiencing corresponding decreases in emissions).
- 4.5.12 As reported in the SES2 and AP3 ES, locations where reductions in NO₂ concentrations are predicted to result in beneficial air quality effects include:

Drummond Street, Gordon Street, Granby Terrace, Tavistock Square, Bedford Way, North Gower Street, Mornington Street and Mornington Place.

- 4.5.13 As reported in the SES2 and AP3 ES, locations where increases in NO₂ concentrations are predicted to result in adverse air quality effects include:
- Grays Inn Road, Euston Road, Marylebone Road and A5 Edgware Road;
 - to the south of Euston Road, at Gower Street, Hallam Street, Whitfield Street, Carlisle Street, Romilly Street, Hollen Street, Woburn Place, Hunter Street and Judd Street;
 - to the west of Euston station, at Aberdeen Place, St John's Wood Road, Outer Circle, Albany Street, Park Road, Augustus Street, Hampstead Road, Robert Street, Varndell Street, Park Village West, Stanhope Street, North Gower Street and Park Square East;
 - to the east and northeast of Euston station, at Eversholt Street, Polygon Street, Phoenix Road, Ossulston Street and Chalton Street; and
 - to the north of Euston station, at Mornington Crescent, Harrington Square, Barnby Street, Parkway, Delancey Street, Prince Albert Road, Bayham Street and Arlington Road.
- 4.5.14 As reported in the SES2 and AP3 ES, locations where reductions in short-term PM₁₀ concentrations are predicted to result in beneficial air quality effects include Gordon Street.
- 4.5.15 Locations where increases in short-term PM₁₀ concentrations are predicted to result in adverse air quality effects include Dukes Road, Euston Road, Euston Square, Euston Street and Upper Woburn Place.
- 4.5.16 As detailed in the SES2 and AP3 ES SMR Addendum 3 (Volume 5: Appendix CT-001-000/04), the air quality assessment provides information on changes in pollutant concentrations that can be used to assess health effects, flagging up locations and impacts, which may merit further consideration. However, a significant air quality effect does not necessarily denote a significant health effect.
- 4.5.17 There are many receptors in the study area given its urban nature and the proximity of many residential properties and commercial premises to construction sites and roads where traffic flows will change. The predicted increases in NO₂ and PM₁₀ at assessed receptors, due to the revised scheme during Stage A construction, are mostly less than 4% of the predicted future baseline of these pollutants (absolute increases between 0–3 µg/m³ annual mean NO₂ and 0–0.7 µg/m³ annual mean PM₁₀). The predicted levels of NO₂ and PM₁₀ at these assessed receptors provide an indication of the likely range of the changes in air pollution on the wider community in the Euston station area.
- 4.5.18 Given the above, in terms of community-wide health effects the exposure to the increases in traffic emissions during Stage A of construction are considered to be negligible to low intensity and medium to high extent. The exposure to the reductions in traffic emissions during Stage A construction are considered to be negligible to low intensity and low to medium extent.

- 4.5.19 The community health effects as a result of changes in emissions associated with the revised scheme during Stage A construction are considered to be small. There may be anxiety caused by perceived health impacts from increased traffic emissions, particularly for people with existing respiratory conditions.

Combined construction and operational traffic

- 4.5.20 The SES2 and AP3 ES air quality assessment identifies a number of receptors where there may be moderate or substantial air quality impacts, some adverse and some beneficial. The findings are as follows:
- Locations where reductions in NO₂ concentrations are predicted include: Bloomsbury Place, Endsleigh Gardens, Gordon Street, Southampton Row, Russell Square and Tavistock Place;
 - Locations where increases in NO₂ concentrations are predicted include: Euston Road, Marylebone Road, Upper Woburn Place, Albany Street, Hampstead Road, Euston Street, Gower Street, Grays Inn Road and Eversholt Street; and
 - No beneficial or adverse effects for PM₁₀ concentrations are predicted to occur.
- 4.5.21 The predicted increases in NO₂ and PM₁₀ at assessed receptors, due to the revised scheme during Stage B1 construction and operation, are mostly less than 5% of the predicted future baseline of these pollutants without the revised scheme; with a few locations having increases of between 5–10% (absolute increases between 0–4.1 µg/m³ annual mean NO₂ and 0–0.5 µg/m³ annual mean PM₁₀). The predicted levels of NO₂ and PM₁₀ at these assessed receptors provide an indication of the likely range of the changes in air pollution on the wider community in the Euston station area.
- 4.5.22 Given the above, in terms of community-wide health effects the exposure to the increases in construction and operation traffic emissions during Stage B1 construction and operation are considered to be negligible to low intensity and medium to high extent. The exposure to the reductions in traffic emissions during Stage B1 construction and operation are considered to be negligible to low intensity and low to medium extent.
- 4.5.23 The community health effects as a result of emissions changes associated with the revised scheme during Stage B1 construction and operation are considered to be small. There may be anxiety caused by perceived health impacts from increased traffic emissions, particularly for people with existing respiratory conditions.

Operational traffic

- 4.5.24 Changes in NO₂ and PM₁₀ arising during operation, from 2033 onwards, are expected to be smaller than for Stage B1, which includes both construction and operation. This is because construction related activities are predicted to be the dominant contributor to changes in NO₂ and PM₁₀ concentrations in Stage B1.

4.6 Noise and vibration

Links to health effects

- 4.6.1 There is moderate to strong evidence of the health effects from noise, in terms of sleep disturbance, annoyance, cardiovascular effects and learning impairment in children. There is also an established link between vibration and annoyance.
- 4.6.2 In the case of cardiovascular effects and cognitive impairment of children when at school, the evidence relates primarily to long term exposure to aviation noise and also road traffic noise, rather than railway noise.
- 4.6.3 In general, an increase in reported sleep disturbance at night is unlikely if the level of noise from the railway¹¹ is lower than existing levels. Railway noise from the revised scheme might be expected to result in an increased risk of reported sleep disturbance if it exceeds the existing ambient noise levels and if exposure is above 40dB at night¹². There is a greater risk of sleep disturbance at higher levels of exposure and the level of disturbance will depend upon a number of factors including:
- maximum noise levels;
 - number of noise events which people already experience;
 - how the level, composition and character of the noise at night will change as a result of the revised scheme; and
 - whether windows to bedrooms are open or closed¹³.
- 4.6.4 In general, there is a greater potential for adverse effects if the change occurs at locations where there are higher ambient noise levels.
- 4.6.5 There is evidence to suggest an association between exposure to noise and cardiovascular effects. A broad indication of a potential for increased risk of cardiovascular effects may be given where:
- the exposure to noise is relatively high¹⁴; and
 - noise from the revised scheme is equal to or exceeds the existing ambient noise levels.
- 4.6.6 Evidence for the links between noise and health, and specifically the effects of high speed rail noise compared to other noise sources such as aviation noise for example, is presented in Appendix 3.

¹¹ Unless otherwise stated noise levels for the night period refer to the 8 hour night (23:00 to 07:00) equivalent continuous sound pressure level, LpAeq,8hr.

¹² Below 40dB sound from transportation (railways, road traffic and aircraft) would not generally be expected to give rise to an observed adverse effect at night (see Appendix 3: HIA evidence base).

¹³ The 40dB criterion assumes that windows are open for much of the year.

¹⁴ Indicated by daytime noise levels exceeding 60dB LpAeq,(07:00 to 23:00).

Construction

- 4.6.7 Construction noise and vibration will be controlled and managed in accordance with the draft CoCP and the noise insulation and temporary rehousing policy¹⁵. The principles of the control and management processes in the CoCP are based on best practicable means as defined by the Control of Pollution Act 1974¹⁶. This includes control of noise and vibration at source; use of screening; and provision of noise insulation or ultimately temporary rehousing.
- 4.6.8 The proposed measures for the control and management of construction noise and vibration will reduce the risk of annoyance and sleep disturbance inside residential properties.
- 4.6.9 The measures also reduce the construction noise effects on acoustic character outdoors in the majority of residential communities, although it is recognised that some level of disturbance will occur. Community areas, including "shared community open areas"¹⁷ that are particularly affected by noise from construction activities are reported in the SES2 and AP3 ES, including information on exposure levels and the duration of construction works.
- 4.6.10 A number of education, healthcare and cultural facilities; a community centre; and a place of worship close to the construction worksites may be affected by construction noise for varying durations. The affected locations are reported in Volume 2 of the SES2 and AP3 ES and are as follows:
- the Euston Mosque in Starcross Street ;
 - the NHS Centre and Maria Fidelis Convent (Lower) School in North Gower Street;
 - the Regent's Park Children's Centre nursery in Augustus Street;
 - the School of Arts on Euston Road;
 - the Surma Community Centre on Robert Street;
 - the Ort House Conference Centre, the Jewish Museum and Friends of the Hebrew University on Albert Street; and
 - the Arrow Dental Surgery on Robert Street.
- 4.6.11 A number of workplaces are also potentially affected by a combination of noise and vibration impacts.
- 4.6.12 HS2 Ltd will work closely with affected facilities and workplaces to identify measures to mitigate noise effects, where reasonably practicable, including discretionary measures identified in the draft CoCP. Where appropriate, HS2 Ltd will set out specific working practices in the LEMP to provide further mitigation.

¹⁵ HS2 Ltd (2014) Information Paper E23: Control of Construction Noise and Vibration, Appendix B - Noise insulation and temporary re-housing policy.

¹⁶ Control of Pollution Act 1974.

¹⁷ 'shared community open areas' are those that the National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park or local green space) that is nearby.

- 4.6.13 Given the above, the intensity and extent of the exposure to the adverse effects of construction noise are considered to be low to medium intensity and medium to high extent.

Operation

- 4.6.14 HS2 trains will be quieter than the relevant current European Union specifications. The track will be specified to reduce noise, as will the maintenance regime.
- 4.6.15 The design of the revised scheme, including the vertical alignment and noise barriers and tunnel portal arrangements, will take account of the need to control levels of noise and vibration.
- 4.6.16 Given the above, for the few properties close to the route that remain exposed to levels of noise that will result in an adverse noise impacts indoors, either during the day or night, noise insulation will be offered if the qualifying criteria are met and, if accepted, this will minimise any adverse effect.

Airborne noise

- 4.6.17 The SES2 and AP3 ES has identified that Cartmel, Coniston, Langdale and Augustus House will experience an increase in noise levels during both the daytime and night time, but only Cartmel will experience noise levels that triggers the criteria for noise insulation.
- 4.6.18 Given the above, the intensity and extent of the exposure to the adverse effects of operation noise are considered to be low to medium intensity and low to medium extent.

Combined noise and vibration

- 4.6.19 The SES2 and AP3 ES has not identified any sensitive receptors within the area around Euston station that are likely to experience significant effects from vibration.

4.7 Physical activity

Links to health effects

- 4.7.1 Environmental factors have been shown to have an influence on participation in physical activity, which in turn affects health. This includes issues such as the accessibility of facilities for physical exercise, perceived safety and, to a lesser degree, the aesthetic features of the environment and parks. Evidence shows that physical activity can be encouraged by improving accessibility to green spaces, and by ensuring green spaces are attractive and of a high quality.
- 4.7.2 There is strong evidence on the link between physical activity and health benefits. Exercise is known to reduce the risk of many chronic conditions including coronary heart disease, stroke, type 2 diabetes, cancer, obesity, mental health problems and musculoskeletal conditions. Relatively small increases in physical activity are associated with some protection against chronic diseases and improved quality of life.
- 4.7.3 The health benefits to children from physical activity are particularly important. These include building bone density, avoidance of weight gain, and establishing positive habits which improve health status in later life.

- 4.7.4 Evidence for the links between physical activity and health is presented in Appendix 3.

Sports and leisure facilities

- 4.7.5 The construction of the revised scheme will result in the whole or partial loss of a number of facilities used for sports and physical activity, as well as indirect effects such as increased journey times to facilities during construction. In some cases the facilities will be reinstated following the construction period. However in cases where land is required for the construction of new infrastructure there will be a permanent effect on the function of the facilities, resulting in reduced opportunities for people to partake in physical activity.
- 4.7.6 The SES2 and AP3 ES identifies sports and recreational facilities that will be affected by the construction of the revised scheme. For the purposes of this HIA addendum these have been considered from the point of view of effects on physical activity, taking into account the types of activity undertaken, the nature and duration of disruption, and other factors such as whether the facility is used by the community or paying members.
- 4.7.7 Those facilities where it is considered that the revised scheme has the potential to result in reduced opportunities for physical activity include children's play grounds and outdoor sports courts around Euston station.
- 4.7.8 The temporary or permanent reduction in levels of physical activity at these facilities will reduce opportunities for local communities to benefit from the positive health effects associated with physical activity.
- 4.7.9 Effects on sports and leisure facilities will be mitigated in accordance with effects on community facilities, as described in Section 4.11.
- 4.7.10 For those facilities that are assessed to be particularly affected in terms of potential health impacts, further detail is provided below.

Play spaces at Euston

- 4.7.11 The Eskdale play area on the Regent's Park Estate will be lost permanently as a result of the construction works. This facility includes children's climbing frames and swings, and serves the people living in the surrounding residential blocks. The revised scheme will also result in the permanent loss of Hampstead Road Open Space on the west side of Hampstead Road – including a children's playground. The nearest alternative children's play area for those living in the northern part of the estate will be approximately 500m to the south at Cumberland Market.
- 4.7.12 Some of the existing users of these play areas are likely to be those living in the adjacent blocks that will be demolished, reducing demand for these facilities. However there is likely to be an overall loss of access to play facilities for remaining residents during the construction period. The revised scheme will also result in the permanent closure of St. James's Gardens Open Space. This site includes a multi-use games area.
- 4.7.13 In addition to the reprovision of open space that forms part of the design of the revised scheme, HS2 Ltd and LBC intend to improve existing public open spaces within Regent's Park Estate and on the Ampt Hill Estate in order to mitigate the permanent loss of open space at St James's Gardens, Hampstead Road Open Space

and the Eskdale play area. Areas identified include Cumberland Market, Munster Square, Clarence Gardens, Hope Gardens and Tolmers Square.

- 4.7.14 There are few opportunities to create new open space in Regent's Park Estate. However, there may be opportunities to bring existing open spaces into the public realm. In addition, appropriate measures for wayfinding from Regent's Park Estate to Regent's Park will be provided.
- 4.7.15 HS2 Ltd proposes to relocate the playground equipment at Wellesley House, Lancing Street, to an adjacent area of vacant land (just to the north of the existing playground), outside the land required for construction of the revised scheme.
- 4.7.16 The loss of play space within the Regent's Park Estate has the potential to result in a reduction in access to the beneficial effects of physical activity. As an area of high deprivation, access to private sports facilities and clubs for residents on the Regent's Park Estate is limited and many people are dependent on free facilities such as football and basketball pitches. Although the loss of access to these facilities will be temporary, the duration of impact may be significant, particularly for children, depending on how soon replacement facilities are provided. As described in Appendix 3, children and young people are particularly vulnerable to the effects of reduced physical activity.
- 4.7.17 The revised scheme will also result in the loss of the children's playground at Lancing Street to the east of Euston station to make way for a satellite compound. The playground serves the surrounding residential blocks on the Churchway Estate and there are few alternatives nearby.
- 4.7.18 HS2 Ltd proposes to relocate the playground equipment at Wellesley House, Lancing Street, to an adjacent area of vacant land (just to the north of the existing playground), outside the land required for construction of the revised scheme.
- 4.7.19 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of the loss of play space are considered to be high intensity and medium to high extent.
- 4.7.20 During the operation phase, given the above, given the reprovision of play space lost or unavailable during construction, the intensity and extent of the exposure to the beneficial health effects of the reprovision of play space are considered to be medium to high intensity and medium to high extent (i.e. similar to the existing baseline).

Public open space and rights of way

- 4.7.21 Public rights of way (PRoW) provide opportunities for walking and cycling, both as a form of recreation on leisure routes and as a means of travel between communities, shops, services and employment sites. The construction of the revised scheme will not require the temporary closure or diversion of PRoW.

Active travel on the road network

- 4.7.22 During construction there may be some effects on the number of active travel journeys (cyclists and pedestrians) as a result of increased volumes of HGV traffic on parts of the road network. Fear of traffic is identified as the most common barrier to cycling. Fear of walking on footpaths and crossing roads with increased HGV traffic is also likely to deter walkers, particularly those with young children.

- 4.7.23 These issues have the potential to reduce levels of active travel during the construction period.
- 4.7.24 During operation, improved cycle parking for commuters and additional bike hire stations at Euston station are expected to have a beneficial effect on commuters at either end of the route, facilitating active travel journeys.
- 4.7.25 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of the potential reduction in active travel are considered to be low to medium intensity and low to medium extent.
- 4.7.26 During the operation phase, given the improved accessibility, the intensity and extent of the exposure to the beneficial effects of the improved accessibility are considered to be low to medium intensity and low to medium extent.

4.8 Access to services

Links to health effects

- 4.8.1 There is strong evidence linking access to healthcare facilities with health outcomes, and there is also evidence to suggest that transport problems are a key barrier to people's ability to access these services. Therefore changes in journey times to healthcare services have the potential to result in adverse health effects, if the delays are sufficient to deter people from attending appointments or seeking advice.
- 4.8.2 There is weak to moderate evidence to suggest that access to shops and other local services can affect health. This is based on a range of factors affecting quality of life, and includes issues such as reducing feelings of isolation and enabling participation in society, as well as accessing basic needs such as food shopping.
- 4.8.3 Evidence for the links between access to services and health is presented in Appendix 3.

Health service capacity

- 4.8.4 During the construction phase, temporary workers from outside the local area may reside in the vicinity of the revised scheme.
- 4.8.5 It is considered that the majority of these workers who live outside of the area will continue to be registered with their existing general practitioner (GP) rather than registering with a GP in the local area. Those workers who may choose to relocate to the area and register with a GP will be accommodated within the existing healthcare funding systems, which allocates funds to local health authorities on the basis of population size. Workers choosing to live in the local area for the purpose of accessing construction employment will remain in the area on a long term, though temporary basis, for the duration of the works and will not contribute to overall population growth.
- 4.8.6 HS2 Ltd or the Nominated Undertaker will provide occupational health care to temporary workers, including health assessment, health monitoring, preventative treatment where necessary, and first aid. This is expected to help to reduce additional demand for local services, including accident and emergency (A&E) services.

- 4.8.7 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of additional demand on GP and other healthcare services are considered to be low intensity and low extent.
- 4.8.8 During the operation phase, given the above, it is expected that there will be no additional demand on GP and health care services because of the revised scheme.

Emergency services

- 4.8.9 The construction of the revised scheme will result in road closures and diversions and increased traffic flows in the vicinity of emergency services in one location along the route; at the University College London Hospital A&E department, close to the Euston station construction site.
- 4.8.10 HS2 Ltd is working with emergency services to ensure that emergency response times are not adversely affected by construction traffic, road closures and diversions. This will include consideration of strategies for temporary and permanent traffic arrangements and construction routes, to minimise any potential effects.
- 4.8.11 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of disruption to emergency services are considered to be low intensity and low extent.
- 4.8.12 During the operation phase, it is considered that there will be no disruption to emergency services as a result of the revised scheme.

Access to local shops and services

- 4.8.13 The construction of the revised scheme will result in road closures, diversions and increased congestion at some junctions, which will increase some journey times to shops and services by car and bus (see section 4.9 below).
- 4.8.14 Based on information contained in the SES2 and AP3 ES on the locations of key services within the area around Euston station, it is considered that no communities will experience increased difficulty in accessing shops, local facilities and health services during construction.

4.9 Traveller stress

Links to health effects

- 4.9.1 Government guidance has identified 'traveller stress' as an outcome of transport delays and disruption, affecting both drivers and public transport users. This comprises feelings of discomfort, annoyance, frustration or fear, culminating in physical and emotional tension that detracts from the quality and safety of a journey.
- 4.9.2 Evidence for the links between traveller stress and health is presented in Appendix 3.

Private car users during construction

- 4.9.3 The main aspect of the construction of the revised scheme affecting private car users will be the stopping up and diversion of roads within the area around Euston station to enable the construction of crossings, and other works such as utilities. The extent to which this may lead to traveller stress will depend on the length of diversion and increase in journey time and the duration of the closure. Increased traffic flows and

congestion, particularly around junctions, will also contribute to increased journey times.

- 4.9.4 The revised scheme will result in 13 permanent road closures and two pedestrian route closures as a result of an extended station footprint or permanent highway works. The majority of other road closures will be short-term, with many half day and overnight closures having very little effect on road users. In other cases, roads will remain open, with lane closures resulting in minor delays. Diversions will generally be short, with marginal increases in journey times. However, the SES2 and AP3 ES has identified some routes that will be subject to significant increases in traffic flows and/or diversions for the medium to long term, which may contribute to traveller stress.
- 4.9.5 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of private car traveller stress due to disruption and changes to access are considered to be low intensity and low to medium extent.

Private car users during operation

- 4.9.6 No public car parking will be provided at the high speed station, in order to promote sustainable travel. However, improved access for private cars will be provided to facilitate more efficient passenger drop-offs at A400 Hampstead Road/Cobourg Street and on A4200 Eversholt Street.
- 4.9.7 During the operation phase, given the above, the intensity and extent of the exposure to the beneficial effects of private car traveller stress due changes to access are considered to be low intensity and low to medium extent.

Public transport users during construction

- 4.9.8 During construction Stage A, works will require the temporary closure of bus lanes and the relocation of some existing bus stops/facilities, including temporary removal of the southbound bus lane on A4200 Eversholt Street; removal of the northbound and southbound bus lanes on A400 Hampstead Road Bridge; and removal of the eastbound and westbound bus lanes on A501 Euston Road.
- 4.9.9 The removal of bus lanes on A4200 Eversholt Street is not predicted to increase bus journey times by more than 10% therefore the effects on this road will not be significant.
- 4.9.10 Eight additional bus stands will be constructed to the north of the conventional station with access provided off A4200 Eversholt Street. The effect of these works will not be significant.
- 4.9.11 The closure of bus lanes on A501 Euston Road and A400 Hampstead Road , as well as some additional bus delay on each route as a whole result in the following significant effects:
- route 10 (eastbound) – moderate adverse significant effect in the AM and PM peak hour;
 - route 24 (northbound) – moderate adverse significant effect in the AM and PM peak hour;
 - route 29 (northbound) – moderate adverse significant effect in the AM and PM

peak hour;

- route 73 (northbound) – moderate adverse significant effect in the AM and PM peak hour;
- route 134 (northbound) – moderate adverse significant effect in the AM and PM peak hour;
- route 390 (northbound) – moderate adverse significant effect in the AM and PM peak hour;
- route 14 (northbound) – moderate adverse significant effect in the AM and PM peak hour; and
- route C19 (westbound) – minor adverse significant effect in the AM peak and moderate adverse effect in the PM peak hour.

4.9.12 The relocation of bus stops and bus facilities are not generally expected to have a significant effect as alternative facilities will be available to passengers within 100m for most roads. The exception is a moderate adverse significant effect on two bus stops on the A400 Hampstead Road Bridge (near Silverdale, Regent's Park Estate), which may have to be relocated by more than 200 metres or temporarily suspended.

4.9.13 Stage B1 construction and operation (of HS2 Phase One) between 2026 and 2033 will lead to public transport delay due to bus route changes and diversions, as well as some additional bus delay, on the following bus routes: route 10 (eastbound), route 24 (northbound), route 29 (northbound), route 73 (northbound), route 134 (northbound), route 390 (northbound), route 14 (northbound) and route C19 (westbound). These effects can be mitigated through changes to signal control as part of adaptive control measures.

4.9.14 The process of demolition/renovation at western end of the existing Euston station will adversely affect passenger access to, and movements through, the station and interchanges with London Underground (LU), buses and taxis. At the beginning of the Euston station enabling works, there will also be effects on some national rail services into Euston station for a period of up to eight months. There will also be effects on access to LU services during construction resulting in disruption to passengers during these periods with re-routing onto alternative underground services, increases in journeys on foot from adjacent stations and increases in short-distance bus journeys.

4.9.15 During the construction phase, given the above, the intensity and extent of the exposure to the adverse effects of public transport traveller stress due to disruption and changes to access are considered to be low to medium intensity and high extent.

Public transport users during operation

4.9.16 The revised scheme will lead to public transport delays due to bus route changes and diversions, as well as some additional bus delays, on the following bus routes: route 10 (eastbound), route 24 (northbound), route 29 (northbound), route 134 (northbound), route C19 (westbound). These effects can be mitigated through changes to signal control as part of adaptive control measures.

- 4.9.17 Additional demand on the LU network will lead to some increased crowding and consequential delay on LU on the Circle, Hammersmith & City and Metropolitan lines at Euston Square underground station.
- 4.9.18 Changes in traffic flows will result from permanent road closures, changes to the local road network and relocated and increased taxi operations. Increases in traffic flows will mainly be concentrated on some roads to the east of conventional station in the Somers Town and King's Cross area between A4200 Eversholt Street and A5203 York Way, to the immediate west of the high speed station, including A400 Hampstead Road and the permanent taxi pick-up and set-down facility, as well as in the Regent's Park and Camden Town areas. In addition, there will be increases in traffic on some roads to the south of the A501 Euston Road, particularly A400 Gower Street, B504 Judd Street, A5200 Gray's Inn Road and A201 Farringdon Road.
- 4.9.19 Reductions in traffic flows will result in improvements for pedestrians crossing some roads. The diversion impacts of road closures result in decreases in traffic which will mainly be concentrated on some roads to the south of A501 Euston Road between Gordon Street and A4200 Upper Woburn Place, in the Bloomsbury area, and in the Camden Town area between A400 Camden Street and A5202 St. Pancras Way.
- 4.9.20 During the operation phase, it is expected that the improved accessibility and station will reduce traveller stress. There may be some overcrowding on some LU platforms, which would require management measures designed in order to mitigate any effects. Given the above, the intensity and extent of the exposure to the beneficial effects of reduced public transport traveller stress due to improved permeability and station accessibility are considered to be low to medium intensity and high extent.

4.10 Road safety

Links to health effects

- 4.10.1 Road safety is linked to rates of injuries and deaths of motorised and non-motorised road users. The HGV content of traffic can affect road safety, particularly for walkers, cyclists and equestrians. However, the rate of fatal or serious accidents involving HGVs is reducing significantly due to improved awareness and safety measures, with fatal or serious accidents involving HGVs falling by more than half between 2000 and 2007.
- 4.10.2 Evidence relating to road safety is presented in Appendix 3.

Pedestrians and cyclists

- 4.10.3 The construction of the revised scheme will increase the amount of HGV traffic on some roads which, if not properly managed, has the potential to adversely affect safety for pedestrians and cyclists. HS2 Ltd will discuss with local authorities measures to provide for road safety for the public and construction staff during construction works. The Nominated Undertaker, in line with the draft CoCP, will produce traffic management plans which will include measures to address road safety and reduce the risks to non-motorised users from HGVs on the roads.
- 4.10.4 Reductions in traffic flow due to traffic diversions are expected and will result in improvements for pedestrians crossing the road. The impacts will mainly be concentrated on roads to the south of Gordon Street in the Bloomsbury area, in

particular, on Gordon Street, Gordon Square, Woburn Place and Southampton Row; to the immediate west of the existing Euston station as a result of the closure of Cardington Street; and in the Regent's Park Estate to the north-west of the existing Euston station.

- 4.10.5 Reductions in traffic flows during operation will result in improvements for pedestrians crossing some roads. The diversion impacts of road closures result in decreases in traffic which will mainly be concentrated on some roads to the south of A501 Euston Road between Gordon Street and A4200 Upper Woburn Place, in the Bloomsbury area, and in the Camden Town area between A400 Camden Street and A5202 St. Pancras Way.
- 4.10.6 The revised scheme includes improvements to cycle and walking routes on roads surrounding the station which lead to reductions in delay and improvements to amenity and ambience.
- 4.10.7 Given the above, the intensity and extent of the exposure to the adverse effects of reduced road safety for pedestrians and cyclists due to the increase in HGV traffic are considered to be medium to high intensity and low extent.
- 4.10.8 Given the above, the intensity and extent of the exposure to the beneficial effects of increased road safety for pedestrians and cyclists due to reductions in traffic flows and improvements to cycle and walking routes are considered to be medium intensity and low extent.

4.11 Social capital

Links to health effects

- 4.11.1 Social capital comprises connections between the individuals within communities, and the inclination that arises through these networks for individuals to feel valued, to feel a sense of belonging, to have companionship and to tangibly support each other.
- 4.11.2 There is moderate evidence that participation in social activities is very important to people's quality of life and can play a major part in improving health. Social networks and connections provide emotional support that can help people to cope with stressful life events. This type of support has also been shown to exert positive physiological effects on the body's hormonal and immune systems, and reduce susceptibility to mental and physical illness.
- 4.11.3 Evidence for the links between social capital and health is presented in Appendix 3.

Community isolation

- 4.11.4** During Stage A construction, the demolition and replacement of Mornington Street Bridge will result in isolation effects as residents in Park Village East will not be able to gain vehicular access to and from the east, while those works are in progress. There will be continuing discussion with residents in Park Village East in order to identify ways to reduce the impacts of these works.
- 4.11.5** Given the above, the intensity and extent of the exposure to isolation for the duration of the construction works are considered to be of medium intensity and low extent.

Community facilities

- 4.11.6 The compulsory acquisition of community facilities, or issues affecting their usability, have the potential to affect social capital. The SES2 and AP3 ES has identified adverse effects on facilities including community halls, clubs, public houses, cultural centres and faith centres in the area around Euston station.
- 4.11.7 Where the SES2 and AP3 ES reports a significant community effect resulting from the temporary or permanent loss of a community facility the options for mitigation are:
- improvements or alterations to the remaining portion of the community facility;
 - improvements to other existing community facilities in the area that could reduce the effect;
 - improving accessibility to other community facilities; and/or
 - identifying land owned by the relevant local authority that could be brought into use as a community facility with their agreement.
- 4.11.8 Additionally, in relation to the permanent loss of community facilities, HS2 Ltd will consider whether appropriate compensation community facilities could be built into the design of the permanent works within Bill limits. Where none of these measures provide suitable mitigation HS2 Ltd will potentially acquire land for the mitigation of temporary or permanent loss of community facilities.
- 4.11.9 Where a community facility is owned and operated as a commercial enterprise (i.e. is provided by the market, is not in public or charitable ownership or does not provide publicly or charitably funded services) the above policies do not apply. In such cases, HS2 Ltd will work with the affected landowner to help them identify a solution which will enable them to continue to operate, on the basis that they will be eligible for compensation under the Compensation Code.
- 4.11.10 The loss, through demolition, of the recently refurbished Old Tenants Hall community building on Harrington Street and the Dick Collins Community Hall on Redhill Street, both on the Regent's Park Estate will remove important community venues. The loss of these venues will affect the community around Harrington Street and Redhill Street, which is an area of relatively high deprivation. A replacement hall will be provided as part of delivering the planning applications for replacement social rented housing (see 4.3.12).
- 4.11.11 Given the above, the intensity and extent of the exposure to the adverse effects of disruption to the use of or loss of community facilities are considered to be low intensity and low extent.

Temporary construction workforce

- 4.11.12 The revised scheme will require a large temporary construction workforce, which is likely to comprise a mixture of local people and workers from the London region and potentially beyond.

- 4.11.13 Many workers are likely to commute, though some workers who live outside commuting distance of the site may choose to seek accommodation within the local community in rental properties, hostels, and bed and breakfasts.
- 4.11.14 The presence of the construction workforce may result in a localised and temporary change in the demographic composition of the community in some locations. Such changes have the potential to affect community cohesion, often for the worse, for example due to mistrust of the incoming community. However, there is also a potential for the presence of the temporary workforce to have a beneficial effect on local communities through increased use of local services and opportunities for social interaction.
- 4.11.15 Given the above, the intensity and extent of the exposure to the adverse effects on social capital due to the construction workforce are considered to be low intensity and low extent.

5 Glossary and abbreviations

| | |
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| Additional Provision | The High Speed Rail (London – West Midlands) Bill, deposited in Parliament on 25 November 2013, provides powers for the construction and operation of Phase One of High Speed Two (HS2) (the 'Proposed Scheme'). The Additional Provision covers changes which involve the acquisition or use of land outside the original limits of the Bill, additional access rights, or other extensions of the powers conferred by the Bill. |
| Amenity | The benefits of enjoyment and wellbeing which are gained from a resource in line with its intended function. Amenity may be affected by a combination of factors such as: sound, noise and vibration; dust/air quality; traffic/congestion; and visual impacts. |
| BPM | Best practicable means |
| CoCP | Code of Construction Practice |
| CoPA | Control of Pollution Act 1974 |
| Compensation Code | The national compensation code is the collective term for the principles derived from both statute and case law, relating to compensation for compulsory acquisition, which ensures that when land is needed to build an infrastructure project, the owners receive compensation to help them to move house or to relocate a business. The code also ensures that those who experience real, physical events, for example vibration or noise, from a scheme once it is in operation are entitled to compensation. |
| dB | Decibels – The decibel (abbreviated dB) is the unit used to measure the intensity of a sound |
| EHS | Exceptional Hardship Scheme |
| EIA | Environmental Impact Assessment |
| EQIA | Equality Impact Assessment |
| ES | Environmental Statement |
| GP | General practitioner |
| HGV | Heavy goods vehicles |
| Health determinants | Factors affecting health, including the social and economic environment, the physical environment, and a person's individual characteristics and behaviours. |
| HIA | Health Impact Assessment |
| HS2 | High Speed Two |
| LB | London borough |

HIA Addendum Report HS2 | Potential health effects

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| LEMP | Local Environmental Management Plan |
| NO ₂ | Nitrogen dioxide |
| Nominated Undertaker | The body or bodies appointed to implement the powers of the hybrid Bill to construct and maintain the HS2 scheme. |
| PM ₁₀ | Airborne particles of less than 10 microns in diameter, which can penetrate the lungs. |
| Protected Characteristics Groups | Groups identified in the Equality Act 2010 as sharing a particular characteristic against which it is illegal to discriminate. |
| PRoW | Public Right of Way |
| Social capital | Social capital comprises connections between the individuals within communities, and the inclination that arises through these networks for individuals to feel valued, to feel a sense of belonging, to have companionship and to tangibly support each other. |
| WCML | West Coast Main Line |
| WHO | World Health Organisation |
| Wellbeing | Wellbeing is a general term for the condition of an individual or group, for example their social, economic, psychological, spiritual or medical state; high wellbeing means that, in some sense, the individual or group's experience is positive, while low wellbeing is associated with negative conditions. |

Appendix 1 Detailed assessment criteria

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1 Detailed assessment criteria

1.1 Introduction

- 1.1.1 The assessment of health effects is based on a set of criteria that has been developed using professional judgement and precedent from other large-scale HIAs. These criteria are described below.

1.2 Description of change

- 1.2.1 The change to the health determinant is described, including commentary on the following factors:

- the aspect of the revised scheme causing the change;
- a description of how the health determinant will change, including the direction of this change (beneficial or adverse); and
- the duration of change (operational effects are assumed to be permanent in most cases; construction effects may be short term if under six months, medium term if six months to two years, or long term if more than two years in duration).

- 1.2.2 Where relevant, reference has been made to the residual effects as assessed in the Supplementary Environmental Statement 2 and Additional Provision 3 Environmental Statement (SES2 and AP3 ES). (Residual effects take into account mitigation measures that have been explicitly committed to by HS2 Ltd).

1.3 Exposure

- 1.3.1 The degree of exposure of communities to changes in health determinants is qualitatively assessed in terms of the 'extent' of exposure and 'intensity' of exposure.

- 1.3.2 The extent of exposure is judged to be low, medium or high depending on the number of people in the affected community likely to be exposed to the change in a health determinant, based on the following examples:

- low extent of exposure: this may refer to effects on a small number of isolated rural properties/a small number of properties on the outskirts of a village or larger conurbation/a community resource or public space that is used sporadically or by a small number of people/effects likely to affect a small number of individuals within the population;
- medium extent of exposure: this may refer to a collection of rural properties/a group of properties within a village or on the outskirts of a larger conurbation/a community resource used regularly by a moderate number of people/a moderate number of individuals within a population; and

- high extent of exposure: a moderate to large number of residential properties (this will vary depending on the context, so in a small settlement 10–20 properties may be considered as high exposure, whereas in London the same number may not be considered high)/community resource used frequently by a large number of people/a large number of individuals, or a high proportion of a particular group of people within a community.

1.3.3 The intensity of exposure is judged to be low, medium or high. Factors such as the severity and duration of effect and/or the value of the affected resource will be taken into account when considering intensity. Where relevant, the level of effect identified in the SES2 and AP3 ES is also taken into account.

1.3.4 The extent and intensity of exposure are applied where practical to do so; in some cases, such as issues that could potentially affect an unknown number of individuals along the route as a whole, these criteria have not been applied.

1.4 Vulnerable groups

1.4.1 The sensitivity of the population exposed to the change in health determinant is considered in the assessment. 'Vulnerable groups' are sections of the population that for certain reasons may be more likely to be exposed to a change in a health determinant, or more likely to experience health effects as a result of this exposure.

1.4.2 Consideration of vulnerable groups takes into account: whether a health effect is shown (in scientific literature) to affect a particular community; whether the affected community is already facing existing deprivation (social, economic or environmental) that could make them more vulnerable; and individual characteristics such as age, health conditions, or other physical or mental characteristics that make people more vulnerable to health effects.

1.5 Strength of evidence

1.5.1 The evidence on which the link (or 'association') between a change in health determinant and a health effect is based is described as:

- weak:
 - a few peer-reviewed research studies to suggest an association; or
 - the studies show conflicting findings; and
- moderate:
 - a range of international (but not necessarily national) peer-reviewed research studies showing similar associations and strength of associations;
 - the association is widely accepted by the public health community; and
 - there may be debate about the specific causal factors, the mechanism of effect and/or the strength of association; and

- strong:
 - a wide range of national and international peer-reviewed research studies showing similar associations and strengths of association; and
 - the association is widely accepted by the public health community and there is consensus on the specific causal factors, the mechanism of effect and the strength of association.

1.5.2 It should be noted that a lack of research studies or lack of consensus among the public health community does not necessarily mean that the link between them does not exist, but that there is currently uncertainty in the assessment of the likely effect.

1.6 Perceived effects

1.6.1 Addressing perceived effects is important in reducing adverse effects on health, particularly mental wellbeing. Where there is known to be concern among the affected community about a potential health effect (based on consultation responses), this is taken into account in the assessment.

Appendix 2 Scoping

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1 HIA scoping

1.1 Introduction

1.1.1 The scope of this HIA addendum follows on from the main HIA and was set out at an early stage in an HIA Scope and Methodology Report, following a review of information on the original scheme, preliminary baseline and community data and consultation responses. The scope was then further refined, based on the findings of the main ES. The conclusions from that scoping process are described below, including a list of the determinants that were included in the main HIA and subsequently the HIA addendum, and a description of those determinants that were scoped out.

1.2 Health determinants scoped into the HIA addendum

1.2.1 The determinants proposed to be assessed in the HIA addendum are:

- economic determinants including job losses and gains and effects of regeneration;
- residential determinants including the relocation of residents, and associated social determinants;
- the local environment, including aesthetic quality, access to green space and perceived safety;
- air quality;
- noise and vibration;
- opportunities for physical activity;
- access to services including shops, health services and other local services;
- traveller stress; and
- social capital, including community isolation, community facilities and community cohesion.

1.3 Health determinants scoped out of the HIA addendum

1.3.1 Below is a description of the health determinants that have been scoped out of the HIA addendum, based on consideration of the potential health effects resulting from the revised scheme.

Occupational health and safety

1.3.2 The potential impacts on construction workers' health and safety whilst working on the project are not assessed within the HIA addendum. HS2 Ltd will prepare a health and safety plan for the revised scheme which will include actions to ensure all relevant health and safety issues are addressed.

Electromagnetic field impacts

- 1.3.3 Since potential electromagnetic effects can be 'designed out' of the revised scheme, specific assessment was not required as part of the EIA and has been scoped out of the HIA addendum.

Ground contamination

- 1.3.4 The potential effects of ground contamination on construction workers on site will be dealt with through occupational health and safety procedures, which are outside the scope of this HIA addendum. The current baseline and the post-construction ground conditions are likely to be similar. There may be improvements to ground conditions due to remediation of contaminated land in some locations. The risk to public health of ground contamination arising from the revised scheme is considered to be negligible and this determinant has therefore been scoped out of the HIA addendum.

Groundwater quality

- 1.3.5 The revised scheme crosses aquifers and some of the proposed works may have the potential to penetrate the aquifer and/or mobilise contaminants that could affect water quality. However, these effects are avoidable through appropriate site investigations, design and construction control measures that will be incorporated into the scheme. Groundwater quality is regulated by the Environment Agency and the project has a legal requirement to ensure that no contamination of aquifers results from the proposed works. The risk to public health of groundwater contamination arising from the revised scheme is considered to be negligible and therefore this determinant has been scoped out of the HIA addendum.

Appendix 3 Health evidence base

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1 Introduction

- 1.1.1 This AP3 HIA Addendum Appendix provides a summary of the key health impact research evidence that is relevant to AP3. Where the summary findings of the main HS2 HIA Health Evidence Base Appendix continues to be relevant for AP3 and also the latest research and policy evidence those findings are restated. Where relevant new evidence and information have been published since November 2013 additions and amendments have been made to the original evidence summary.
- 1.1.2 The health impact evidence summary presented in this appendix is based on scientific literature reviews, research papers and policy documents that describe the links between key health determinants and potential health outcomes. The information presented in this appendix underpins the assessment of health effects presented in the main part of this HIA addendum.

1.2 Summary findings from the review of relevant health research published since November 2013

- 1.2.1 No new relevant research on the health and wellbeing impacts of the construction and operation of high-speed rail was identified since the publication of the main HS2 HIA in November 2013. One laboratory study of the high speed rail noise on human participants in China has been reported, however this focused on the development of a new noise measure for in-combination effects of high speed and conventional rail noise based on research in a laboratory setting; given the early stage nature of this research this currently does not have direct relevance to HS2 or the AP3¹-revised scheme.
- 1.2.2 For employment and economy, research findings published since November 2013 on the the health effects of employment, income, job security and job relocation, and employment and vulnerable groups, are consistent with the research findings set out in the appendix of the main HIA and presented below. A Dutch study, linking to the finding discussed in 2.3.3, found that some vulnerable groups, e.g. older people, those with less education, flexible workers, are potentially less likely to take up work-related learning opportunities which in turn are likely to adversely affect their employability. No relevant new research was identified on the health effects of training and skills.
- 1.2.3 For housing research findings published since November 2013 on the health effects of housing quality, security of ownership, value and saleability, are consistent with the research findings set out in the appendix of the main HIA and presented below. A recent study has identified that learning outcomes in children may be particularly affected by housing quality, i.e. the relatively poorer quality of flats compared to houses in the social rented sector. A recent review though has identified that those who are only just able to own their

¹ Di GQ., Lin QL., Li ZG. And Kang J., 2014, Annoyance and activity disturbance induced by high-speed railway and conventional railway noise: a contrastive case study, Environmental Health, 13:12.

homes can suffer financial hardship and be at risk of failing to keep up with their mortgage payments, resulting in increased insecurity and poorer mental health. Three recent policy documents have highlighted the importance of residents' having a sense of control, and local authorities and development proponents having regular and ongoing communication on relocation and demolition activities, and an explicit relocation strategy. No relevant new research was identified on the health effects of housing on vulnerable groups.

- 1.2.4 For noise, research findings published since November 2013 on the health effects of high speed rail and transport related noise and vibration (annoyance, sleep disturbance, cardiovascular disease, mental illness, cognitive impairment in children) are consistent with the findings set out in the appendix of the main HIA and presented below. The World Health Organization (WHO) is currently developing Environmental Noise Guidelines for the European Region that will be a regional update to the 1999 WHO Community Noise Guidelines. WHO have not published a date for when the updated guidelines will be available.
- 1.2.5 For air quality, research findings published since November 2013 on the health effects of high speed rail and transport related air pollution are consistent with the findings set out in the appendix of the main HIA and presented below. There is now expert consensus that Nitrogen Dioxide (NO₂) is likely to have independent effects in its own right and is not just a marker for other types of air pollutants, e.g. particulate matter. There is also consensus that reductions in both primary (emitted directly from combustions sources) and secondary (created through chemical reactions in the atmosphere) particulate matter pollution is likely to be beneficial to health.
- 1.2.6 For local environment, research findings published since November 2013 on the health effects of green space and contact with nature, crime, and vulnerable groups are consistent with the findings set out in the appendix of the main HIA and presented below. No relevant new research was identified on the health effects of landscape, townscape and visual issues.
- 1.2.7 For physical activity, research findings published since November 2013 on the environmental influences on physical activity, physical health effects of physical activity, mental health effects of physical activity, and physical activity and vulnerable groups health are consistent with the findings set out in the appendix of the main HIA and presented below.
- 1.2.8 For access to services, research findings published since November 2013 on the health effects of access to health care and shops are consistent with the findings set out in the appendix of the main HIA and presented below. No relevant new research was identified on the health effects of leisure, faith, culture and recreational facilities and access and vulnerable groups.
- 1.2.9 For transport, road safety in relation to HGVs and traffic accidents has continued to reduce with fewer accidents occurring in 2013; 81 fatal or serious accidents involving HGVs per billion HGV vehicle miles (the latest year available).

- 1.2.10 For social capital, research findings published since November 2013 on the health effects of community consistency, crime and social capital, and vulnerable groups are consistent with the findings set out in the appendix of the main HIA and presented below. A report on social capital and resilience for the Housing Diversity Network stated that 'Housing providers can play an important role in providing space and opportunities for people from different backgrounds to mix and form the positive relationships necessary for a community to be cohesive and resilient.
- 1.2.11 These additional sources of evidence are reported in more detail in the sections below.

2 Employment and economy

2.1 Employment

- 2.1.1 Evidence for the links between employment and health is most commonly focused on the negative impacts of unemployment, although this can be used to infer the positive impacts associated with gaining employment.
- 2.1.2 The Marmot Review (2010)², which was commissioned by the Department of Health to look into health inequalities in England, looks at the differences in health and wellbeing between social groups. The report identifies six policy objectives for reducing health inequalities, one of which is to 'Create fair employment and good work for all'. The review identifies the importance of work for health: 'being in good employment is protective of health. Conversely, unemployment contributes to poor health'.
- 2.1.3 The London Health Commission's report: Health in London: Review of the London Health Strategy High Level Indicators (2005)³ describes unemployment as: 'a significant risk factor for poor physical and mental health, and a major determinant of health inequalities. It is associated with morbidity, injuries and premature mortality, especially through increased risk of coronary heart disease. It is also related to depression, anxiety, self harm and suicide'.
- 2.1.4 Employment is related to social and psychological wellbeing; a study commissioned by the Department of Work and Pensions(DWP)⁴ found that 'work meets important psychosocial needs in societies where employment is the norm' and that 'work is central to individual identity, social roles and social status'.
- 2.1.5 As acknowledged in a National Health Service (NHS) evidence review on the causal relationship between worklessness and health⁵, the relationship is complex and 'confounded by other variables such as educational attainment, the environment and economic circumstances'.
- 2.1.6 A review of the evidence since November 2013 is consistent with the findings discussed above. A systematic review published in 2014 found that employment as beneficial for health particularly for depression and general mental health.⁶ It found there was insufficient evidence on the benefits of employment on general health, physical health and mortality.

2 Marmot, M., Allen, J., Goldblatt, P., Boyce, T., McNeish D., Grady, M. and Geddes, I., 2010, Fair society, healthy lives: Strategic review of health inequalities in England post-2010, The Marmot Review.

3 Greater London Authority, 2005, Health in London: Review of the London Health Strategy High Level Indicators, London Health Commission.

4 Waddell, G., Burton, A. K., 2007, Is work good for your health and well-being?, The Stationery Office.

5 Mclean, C., Carmona, C., Francis, S., Wohlgemuth, C. and Mulvihill, C., 2005, Worklessness and health – what do we know about the causal relationship? Evidence review, NHS Health Development Agency.

6 van der Noordt, M., Jzelenberg H. I., Droomers M. and Proper K. I., 2014, Health effects of employment: a systematic review of prospective studies, Occupational & environmental Medicine, 71:730-736, Abstract accessed via <http://oem.bmj.com/content/71/10/730.abstract>.

2.2 Income

- 2.2.1 Income is a key factor through which employment status affects health and wellbeing. The DWP study found that 'employment is generally the most important means of obtaining adequate economic resources, which are essential for material well-being and full participation in today's society [...] employment and socio-economic status are the main drivers of social gradients in physical and mental health and mortality'.³
- 2.2.2 Research findings published since November 2013 are consistent with the findings discussed above.⁷ A review published in 2015 highlights the importance of income inequality on health.⁷ That wide distribution of incomes has greater negative effects on those on low incomes than a more narrowly distributed range of incomes within a community or society.

2.3 Job security and job relocation

- 2.3.1 The Marmot review highlights that, for the health benefits of employment to be realised, jobs must be secure: 'Insecure and poor quality employment is [also] associated with increased risks of poor physical and mental health. There is a graded relationship between a person's status at work and how much control and support they have there. These factors, in turn, have biological effects and are related to increased risk of ill health.
- 2.3.2 Involuntary or prompted job relocation, as well as causing financial concerns, can impact on people's home and family lives. Research has found that 'those who relocate initially experience two varieties of stress: operational stress, resulting from the new job and setting-up activities in the new community, and emotional stress resulting from family-related activities. It was found that those who relocate for work often face forced self-reliance, a lack of family support, and an increase in family demands, although the overall stress was reduced for persons taking white-collar or professional positions because of employer assistance. It was found that much of the initial stress dissipated with time...'.⁸
- 2.3.3 Research findings published since November 2013 are consistent with the findings discussed above. There is some recent evidence that enhanced employability, i.e. having skills and experience that increases the chances of getting another job, are likely to reduce the adverse health impacts of job insecurity.⁹

2.4 Training and skills

- 2.4.1 The Marmot review highlights the links between inequalities in educational outcomes and physical and mental health, and identifies 'Reducing the social

⁷ Pickett, K. E. and Wilkinson, R. G., 2015, *Social Science & medicine*, 128:316-326. Abstract can be access via <http://www.sciencedirect.com/science/article/pii/S0277953614008399>

⁸ Riemer, J. W., 2000, Job Relocation, source of stress and sense of home, *Community, Work and Family*, 3(2): 205–217. Abstract accessed via <http://www.tandfonline.com/doi/abs/10.1080/713658901?journalCode=ccwf20>

⁹ Otterback, S. and Sousa-Poza, A., 2014, Job insecurity, employability and health: an analysis for Germany across generations, Discussion Paper 88-2014, FZID, University of Hohenheim.

gradient in skills and qualifications' as a priority objective to reduce health inequalities. The main routes by which education affects health are identified in the review as employment, income, living standards and behaviours. The review makes policy recommendations including increasing lifelong learning opportunities, including work-based learning, to improve health outcomes.

- 2.4.2 No new research on this topic published since November 2013 was identified.

2.5 Vulnerable groups

- 2.5.1 Unemployment leads to adverse circumstances such as increased deprivation and isolation, which in turn can increase vulnerability to a wide variety of health effects.
- 2.5.2 Certain groups such as older people and disabled people may be more vulnerable to job losses, as these people may face greater difficulty in finding alternative employment.
- 2.5.3 Temporary workers are more likely to experience poor self-reported health, erosion of occupational safety and health procedures and strategies, psychological ill health associated with job insecurity, higher rates of job dissatisfaction, less access to training and worse working conditions.
- 2.5.4 Research findings published since November 2013 are consistent with the findings discussed above. A Dutch study, linking to the finding discussed in 2.3.3, found that some vulnerable groups e.g. older people, those with less education, and flexible workers, are potentially less likely to take up work-related learning opportunities which in turn are likely to adversely affect their employability.¹⁰

¹⁰ Storm, I., Uiters, E., Busch, M.C.M., den Broeder, L. and Schuit A.J., 2015, The relevance of work-related learning for vulnerable groups, Dutch case study of a health impact assessment with equity focus, *Health Policy*, 119 (7): 915-924.

3 Housing

3.1 Housing quality

- 3.1.1 Housing quality affects both physical and mental health. WHO research¹¹ has shown that 'increased housing satisfaction following housing improvement is strongly linked to improvements in mental health' and 'housing satisfaction may be linked to life satisfaction and mental health'.
- 3.1.2 Research findings published since November 2013 are consistent with the findings discussed above. A recent study has identified that learning outcomes in children may be particularly affected by housing quality i.e. the relatively poorer quality of flats compared to houses in the social rented sector.¹²

3.2 Security of ownership, value and saleability

- 3.2.1 Housing security provides financial and social stability, and the WHO study has identified links between secure home ownership and health: 'financially secure home ownership has been linked to improved health, which may be due to better housing quality and feelings of security'¹¹.
- 3.2.2 Research findings published since November 2013 are consistent with the findings discussed above. A recent review though has identified though that those who are only just able to own their homes can suffer financial hardship and be at risk of failing to keep up with their mortgage payments resulting in increased insecurity and poorer mental health.¹³

3.3 Involuntary and prompted relocation

- 3.3.1 Involuntary or prompted relocation of people from their homes has been shown to play a determinative role in health outcomes. Disturbance to people's living and social environment and routine may precipitate stress and health deterioration in relocated individuals.¹⁴
- 3.3.2 Moving house involves significant disruption, uncertainty and changes to social networks and familiar environments and routines. Thomson et al, 2003¹⁵ undertook a systematic review of evidence on health outcomes associated with housing interventions, including the effects of moving and relocation. This identified that 'moving house is considered to be a stressful, health damaging life-event'. In the case of social housing this has been attributed to a 'lack of

¹¹ Thomson, H. and Petticrew, M., 2005, Is housing improvement a potential health improvement strategy, World Health Organisation Europe.

¹² Basim, B., 2015, The association between social housing type and children's developmental outcomes, Institute of Education, UCL.

¹³ Byrne, E., Elliott, E., Green, L. and Lester J., 2014, Housing and health evidence review for health impact Assessment (HIA), Wales health Impact Assessment Support Unit (WHIASU).

¹⁴ Heller, T., 1982, The Effects of Involuntary Residential Relocation: A Review, American Journal of Community Psychology, 10 (4): 471-492, cited in BAA, 2008, The G2 Project: A Health Impact Assessment, Annex A. HIA Gateway, West Midlands Public Health Observatory.

¹⁵ Thomson, H., Petticrew, M and Douglas, M., 2003, Health impact assessment of housing improvements: incorporating research evidence.

opportunity to negotiate with the housing authority regarding control around the move’.

- 3.3.3 Research into elderly people’s experiences of forced relocation has identified a variety of emotional experiences, including loss of trust and feelings of insecurity, reduced sense of belonging, powerlessness and stress¹⁶. In the extreme, relocation has been implicated in increased mortality in highly vulnerable persons, such as the institutionalised elderly¹⁴.
- 3.3.4 While the majority of health outcomes associated with involuntary relocation are reported as negative, there may be potential for health benefits in some cases, for example by upgrading to a newer property with better standards of design, heating, security, or local facilities.
- 3.3.5 Research findings published since November 2013 are consistent with the findings discussed above.¹⁷ In addition a recently published London Assembly report on the challenges of estate regeneration and Tower Hamlets strategic guidance on the best way of managing relocation ensure that adverse health impacts are minimized, positive ones maximized and health inequalities reduced where possible.¹⁸ These three documents highlight the importance of resident’s having a sense of control and local authorities and development proponents having regular and ongoing communication on relocation and demolition activities and an explicit relocation strategy.

3.4 Vulnerable groups

- 3.4.1 Not all individuals are likely to be impacted by involuntary relocation in the same way or to the same degree. Age, income, physical health and disability are examples of factors that may influence the degree of impact from relocation.
- 3.4.2 For those living in social housing, the impact of moving house, which is considered to be a stressful, health damaging life-event, can be compounded by a lack of opportunity to negotiate with the housing authority regarding control of the move.
- 3.4.3 No relevant new research on this topic published since November 2013 was identified.

¹⁶ Ekstrom, M. 1994, Elderly people’s experiences of housing renewal and forced relocation: Social theories and contextual analysis in explanations of emotional experiences, *Housing Studies*, 9 (3): 369-391. Abstract accessed via <http://www.tandfonline.com/doi/abs/10.1080/02673039408720793?journalCode=chos20>.

¹⁷ Crawford, K., Johnson, C., Davies, F., Joo, S. and Bell S., 2014, Demolition of refurbishment of social housing? A review of the evidence, UCL Urban Lab and Engineering Exchange for Just Space and the London Tenants Federation.

¹⁸ London Assembly, 2015, Knock it up or do it up? The challenge of estate regeneration, Housing Committee.

4 Noise

4.1 Overview of noise effects

- 4.1.1 Sound is produced by mechanical disturbance propagated as a wave motion in air or other media. Noise is unwanted sound. According to the WHO, 'In some situations, but not always, noise may adversely affect the health and well-being of individuals or populations'¹⁹. More recently, the WHO has stated that 'Environmental noise is a threat to public health, having negative impacts on human health and well-being'.²⁰
- 4.1.2 Hearing loss does not occur from typical exposure to environmental noise, it is more commonly associated with occupational exposure to much higher noise levels. In the everyday environment, the response of an individual to both sound and noise is more likely to be behavioural or psychological (i.e. non-auditory) than physiological. There are a wide range of non-auditory health effects that may be associated with exposure to environmental noise, although the pathways, strength of association, and possible causal mechanisms for these are not fully understood. Examples of non-auditory health effects which have been linked to environmental noise include annoyance, sleep disturbance and other night-time effects, cardiovascular and physiological effects, mental health effects, reduced performance, communication and learning effects.
- 4.1.3 Previous reviews of the links between everyday noise exposure and longer-term health outcomes have proposed various conceptual "models" to try to simplify and describe the complexities of the subject and to help to design and improve future research. One such model that encompasses many of the known and suggested health outcomes is that proposed by Babisch in 2002 ²¹ and updated in 2013²², reproduced here as Figure 1.

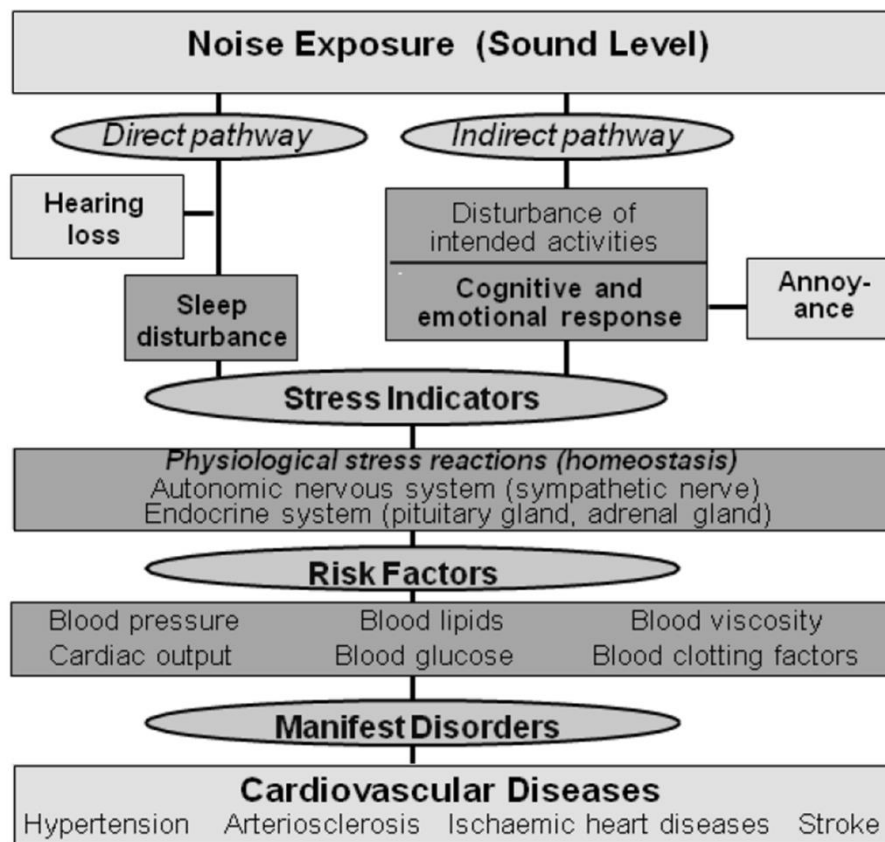
¹⁹ World Health Organisation (1995). Community Noise. Edited by B. Berglund & T. Lindvall.

²⁰ World Health Organisation (2009). Night Noise guidelines for Europe.

²¹ Babisch W (2002). The noise/stress concept, risk assessment and research needs. Noise Health 4(16):1-11.

²² Babisch W (2013). Exposure-response curves of the association between transportation noise and cardiovascular diseases - an overview. First International Congress on Hygiene and Preventative Medicine, Belgrade, Serbia.

Figure 1: Noise effects model (after Babisch)



- 4.1.4 The Babisch model seeks to simplify the cause-effect chain (i.e. noise – annoyance – physiological arousal – biological risk factors – disease). This theoretical model initially differentiates between the direct (non-conscious) and indirect (conscious and subjective) effect pathways, but both are depicted acting through an intermediate stress reaction stage which then, depending on individual risk factors, may ultimately lead to disease outcomes. To quote Babisch²³ 'Causality in epidemiology can never be proven. It is a gradual term of which evidence is increasing with increasing number of facts. However, the magnitude of effect, presence of dose-response relationship, consistency with other studies in different populations and with different methodology, and coherence (biological plausibility) are commonly accepted arguments for a causal relationship'.
- 4.1.5 The Government's Noise Policy Statement for England²⁴ acknowledges that noise can affect people's quality of life and that there is emerging evidence linking noise with direct health effects. The NPSE clearly states the long-term vision of Government noise policy which is 'to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development'.

²³ Babisch, W., 2006, Transportation Noise and Cardiovascular Risk - Review and Synthesis of Epidemiological Studies. Federal Environmental Agency, Germany.

²⁴ UK Department for Environment, Food & Rural Affairs (Defra), 2010, Noise Policy Statement for England.

- 4.1.6 Research findings published since November 2013 are consistent with the findings discussed in this section (Section 4, Sub-sections 4.1-4.10).^{25 26 27 28} The WHO is currently developing Environmental Noise Guidelines for the European Region that will be a regional update to the 1999 WHO Community Noise Guidelines. WHO have not published a date for when the updated guidelines will be available.²⁹

4.2 Relative effects of transport noise sources

- 4.2.1 The most common source of noise pollution in Europe is transport, and road traffic has been identified as being the major cause of human exposure to noise³⁰. There is significantly more literature available on the health and wellbeing effects of road traffic noise and air transport noise than of conventional rail noise, and relatively little research on the effects of high speed rail noise.
- 4.2.2 Establishing exposure-response relationships for environmental noise can be problematic and subject to significant uncertainty. The effects of exposure vary between different types of noise source and are compounded by other environmental factors, as well as personal factors such as sensitivity, attitude and pre-existing health conditions. There is a great deal of variation between individual responses to noise, and variation between studies. Typically there is no threshold of effect but the effect increases slowly with increasing noise exposure.
- 4.2.3 Notwithstanding the variability between individual studies, there have been 'meta-analyses' where the results of individual studies are combined. Figure 2 below is taken from the work of Miedema³¹ and subsequently formed the basis of the European Union Position Paper on exposure-response relationships between transport noise and annoyance,³² as well as underpinning other key WHO³³ and European Environment Agency³⁴ documents in this field. In Figure 2 the central curve in each case is the "mean curve", with the upper and lower curves indicating the uncertainty. The figure shows that, for a given noise level, the percentage of the community highly annoyed by rail noise is lower than that from the other transport sources. This finding is typical of such analyses which

25 Basner, M., Brink, M., Bristow, A., de Kluizenaar, Y., Finegold, L., Hong, J., Janssen S. A., Klæboe, R., Leroux, T., Liebl, A., Matsui, T., Schwela, D., Sliwiska-Kowalska, M. and Sörqvist P., 2015, ICBEN review of research on the biological effects of noise 2011-2014, Noise and Health, 17 (75):57-82.

26 Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., Stansfeld, S., 2014, Auditory and non-auditory effects of noise on health, The Lancet, Vol 383 (9925):1325-1332.

27 Netherlands national Institute for Public Health and Environment (RIVM), 2014, Health implications of road, railway and aircraft noise in the European Union: provisional results based on the 2nd round of noise mapping, RIVM Report 2014-0130, The Netherlands Ministry of Health, Welfare and Sport.

28 DEFRA, 2014, Environmental Noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet.

29 WHO, 2015, Development of WHO Environmental noise guidelines for the European Region, Available at <http://www.euro.who.int/en/health-topics/environment-and-health/noise/activities/development-of-who-environmental-noise-guidelines-for-the-european-region>.

30 World Health Organization, 2000, Transport, environment and health, WHO Regional Publications, European Series. No.89, pg.

31 H M E Miedema and H Vos. 1998, Exposure-response relationships for transportation noise, J. Acoust. Soc. Am., 104 (6), 3432-3445.

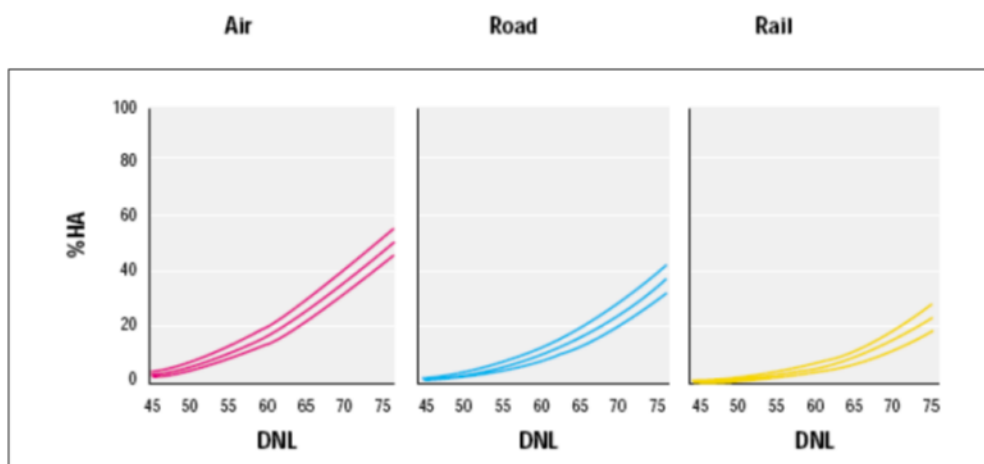
32 European Communities, 2002. Position paper on dose response relationships between transportation noise and annoyance. Luxembourg: Office for Official Publications of the European Communities. ISBN 92-894-3894-0, http://ec.europa.eu/environment/noise/pdf/noise_expert_network.pdf.

33 World Health Organization, 2011, Burden of disease from environmental noise. Quantification of healthy life years lost in Europe.

34 EEA (2010), Good practice guide on noise exposure and potential health effects, EEA Technical Report 11/2010.

frequently find that individuals and communities report less annoyance for rail noise all other things being equal. However, there are no high speed railways included in the Miedema research dataset.

Figure 2: Example dose-response relationships – % highly annoyed v noise level (after Miedema and Oudshoorn)



- 4.2.4 The Government's Transport Analysis Guidance³⁵ includes a 6dB differential between road and rail noise for equal levels of annoyance to take account of people's higher tolerance for rail noise. This effect is only observed at high noise levels so the differential is applied when daytime noise levels are above 60dB₃₆. This is based on research undertaken up to 1991 (summarised in the Mitchell Committee's report³⁷), and is based on conventional rail noise.
- 4.2.5 There is no international consensus on the relative effects of road and rail noise on sleep disturbance, although studies undertaken in some European countries have suggested that the effects of road noise are greater than rail at a given noise level, leading to the higher admissible limits of night noise from rail in several countries³⁸. Figure 3 below shows exposure-response relationships for night time noise derived by Miedema and Vos³⁹ using data from 24 field studies – rail traffic noise gives rise to a lower level of self-reported sleep disturbance compared to other transport sources. None of the studies considered by Miedema and Vos included high speed railways.

³⁵ UK Department for Transport, 2011, Transport Appraisal Guidance (Webtag), <http://www.dft.gov.uk/webtag/> (2011).

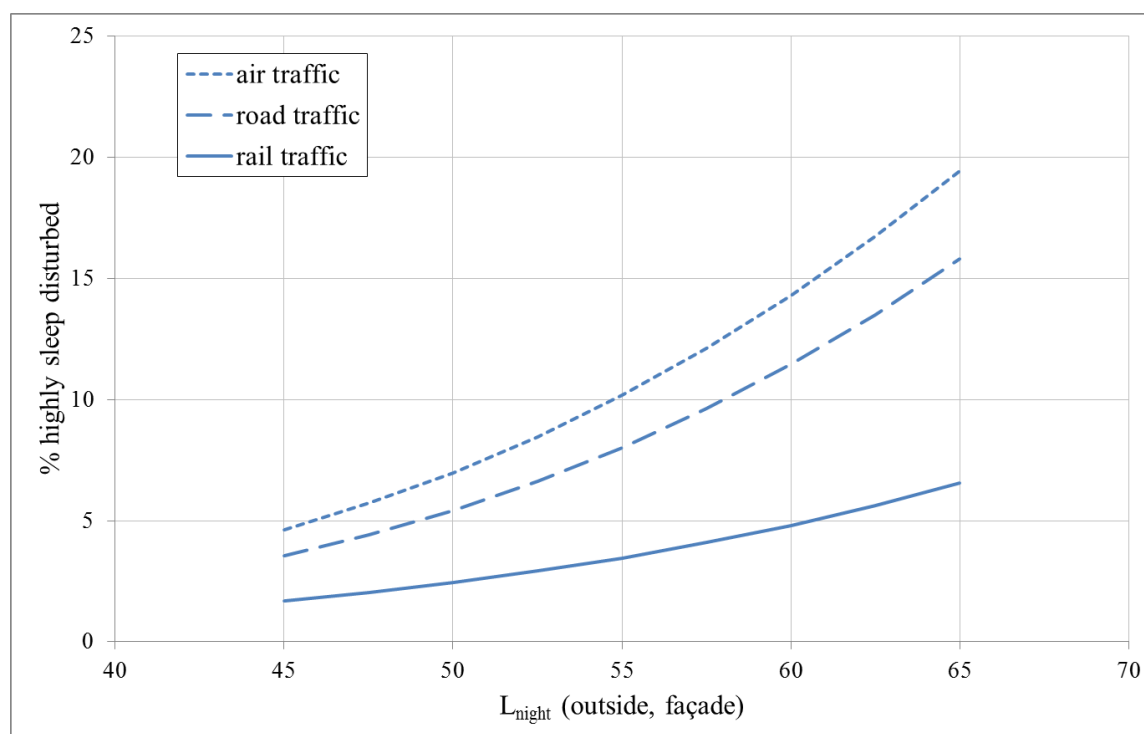
³⁶ Unless otherwise stated, quoted dB values for the daytime refer to the 16 hour daytime (07.00 to 23.00) equivalent continuous sound pressure level, L_{pAeq,16hr}.

³⁷ Department of Transport (1991), Railway Noise and Insulation of Dwellings, Report of the Mitchell Committee, HMSO.

³⁸ Griefahn, B., Schuemer-Kohrs, A., Schuemer, R., Moehler, U., Mehnert, P., 2000, Physiological, subjective, and behavioural responses to noise from rail and road traffic, *Noise & Health*, 3:59-71.

³⁹ Miedema, H.M.E., and Vos, H., 2007, Associations between self-reported sleep disturbance and environmental noise based on reanalyses of pooled data from 24 studies, *Behavioural Sleep Medicine*, 5(1), 1-20.

Figure 3: Percentage highly disturbed by noise at night (after European Commission Working Group)



4.3 Annoyance

4.3.1 Annoyance is the most frequently reported problem caused by exposure to transport noise and is often the primary outcome used to evaluate the effect of noise on communities. There is some evidence that attitudes and opinions about some sources of transport noise may have been changing over the past twenty or thirty years. A widely cited example is a study on people's attitude to aircraft noise by Jansen et al⁴⁰, who observed an increase in annoyance at a given level of aircraft noise exposure. There is, however, no equivalent study for conventional or high speed railway noise. On the other hand, there is some evidence from Grimwood et al^{41 42} and Notley et al⁴³ which suggests that people's attitude towards railway noise in the UK has not significantly changed since 1990. Notley reports the preliminary results emerging from the UK National Noise Attitude Survey undertaken during 2012 which indicate that around 30% of those who hear road traffic noise report being moderately, very or extremely bothered, annoyed or disturbed whereas about 2% of those who hear noise from trains or railway stations (albeit a much smaller sample in the study) report this same level of moderate, very or extreme disturbance.

40 Janssen, S., Vos, H., Eisses, A. and Pedersen, E., 2011, Trends in aircraft noise annoyance. J. Acoust. Soc. Am. 129 (4), pp 3746-3753.

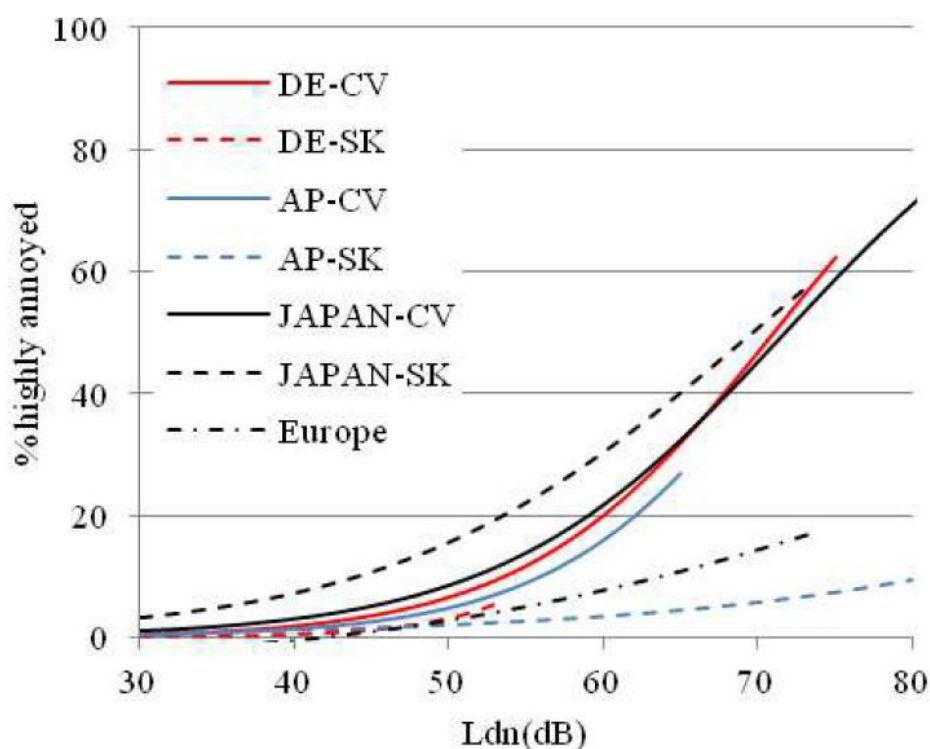
41 Grimwood, C., Skinner, C., and Raw, G., 2005, The UK noise climate 1990-2001: population exposure and attitudes to environmental noise, Applied Acoustics, Vol 66 (2), pp231-243.

42 Grimwood, C., Skinner, C. and Raw, G., 2002, The UK national noise attitude survey 1999/2000, Noise Forum Conference, <http://www.bre.co.uk/pdf/NAS.pdf>.

43 Notley, H., Grimwood, C., Raw, G., Clark, C., Van de Kerckhove, R. and Zepidou G., 2013, The UK national noise attitude survey 2012 – the sample, analysis and some results, Proc. Internoise.

- 4.3.2 The research on noise annoyance from high speed trains is relatively recent and a review paper by Fenech et al⁴⁴ reports significant variability between studies. No evidence was found that the different spectral content of high speed train sound might affect annoyance. Studies report no difference in noise annoyance between traditional and high speed rail for the same timetable frequency⁴⁵. In contrast, earlier studies from Japan report higher levels of annoyance than the Miedema synthesis curves predict, particularly amongst respondents living very close to high speed railways, although a higher level of annoyance response was also seen in other studies from China and Korea for people living very close to conventional railways. More recent studies from Japan have shown that annoyance from Shinkansen schemes with appropriate noise and vibration mitigation measures is comparable to that represented by the Miedema curve⁴⁶. These findings are reproduced in Figure 4.

Figure 4: Comparison of exposure-response relationships for conventional railway (CV) and Shinkansen (SK) railway in Japan. The curves marked DE (detached houses) and AP (apartments) are from a recent study by Oka et al.⁴⁶ carried out between 2008 and 2012. The curves marked Japan are average curves based on older datasets. The Europe curve represents the Miedema curve. After Oka et al⁴⁶



- 4.3.3 The ongoing research into noise annoyance from high speed rail suggests a number of modifying factors may be influencing response. These factors include distance from railway, onset rate, combined effects of noise and vibration, and number of train pass-bys (especially for people living very close to

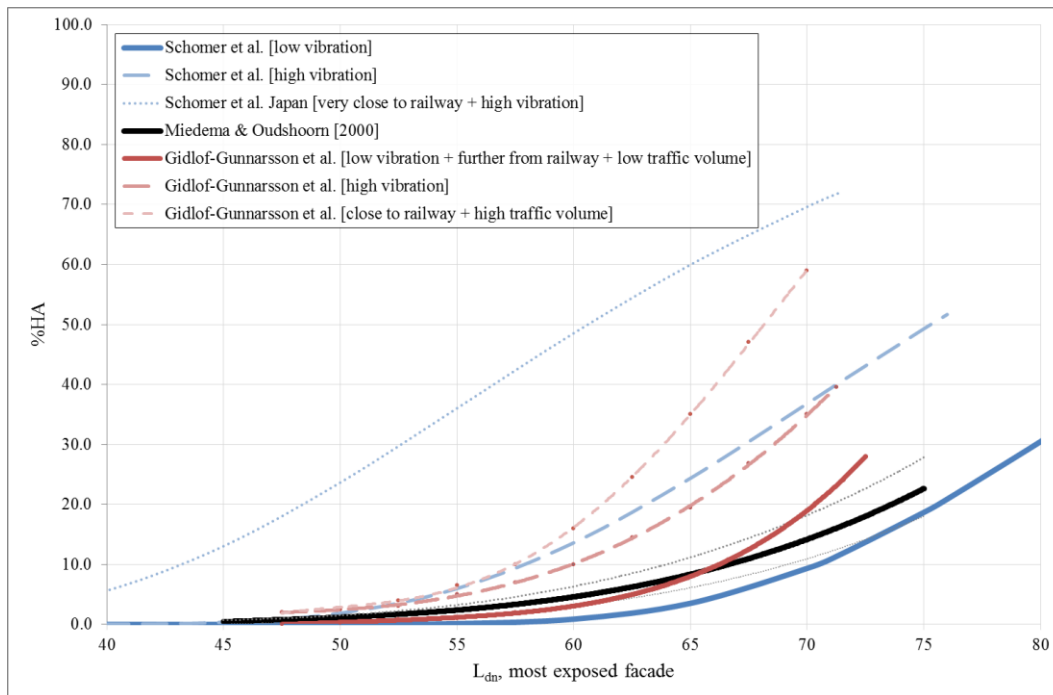
⁴⁴ Fenech, B., Cobbing, C., Greer, R. and Marshall, T., 2013, Health effects from high-speed railway noise - a literature review, Proc Intnoise.

⁴⁵ Botteldooren, D., De Coensel, B. and De Muer, T., 2005. Experimental investigation of noise annoyance caused by high speed trains, Proc. 12th International Congress on Sound & Vibration.

⁴⁶ Oka, S., Murakami, Y., Tetsuya, H. and Yano, T., 2013, Community response to a step change in railway noise and vibration exposures by the opening of a new Shinkansen Line, Intnoise.

the railway). For new railway schemes there is also evidence that uncertainty about the future may increase annoyance whilst subsequent habituation with the changed situation may reduce annoyance. In one study in France, 75% of the sample living close to TGV-Atlantique became accustomed to the noise within one year⁴⁴.

Figure 5: Comparison of exposure-response relationships for percentage of people highly annoyed (%HA), showing the modifying effect of vibration, distance to railway, and high traffic volumes to noise annoyance. After Fenech et al⁴⁴



4.3.4 In generating their synthesis curves for annoyance that were subsequently used in the European Commission Position Paper, Miedema and Oudshoorn⁴⁷ acknowledge the uncertainty associated with the predictability of annoyance. They argue that properly established confidence intervals can be used to describe and account for the variation between individuals as well as the variation between studies. Although the number of studies which cover high speed rail is relatively small, there is nothing to suggest that response to noise will fall outside the applicability of the Miedema and Oudshoorn synthesis curves, provided that any modifying factors are accounted for. The levels of exposure and numbers of events associated with the HS2 scheme are likely to fall within the range of exposures and numbers of events covered in their meta-analysis. It must be recognised that there is significant heterogeneity in the studies and possible factors which have been identified in the literature and which might be used to explain likely variability should be considered wherever possible.

⁴⁷ H.M.E. Miedema & C.G.M. Oudshoorn (2000), Elements for a position paper on relationships between transportation noise and annoyance, TNO Report PG/VGZ/00.052.

- 4.3.5 A recently published study by Oka et al⁴⁸ reports a case study (in Kumamoto, Japan) of changes in community response to railway noise exposure caused by a shift from conventional express trains to "super-express" high speed trains on the Kyushu Shinkansen Line. The authors report that the noise and vibration exposures were almost the same before and after the shift but that community annoyance decreased after the opening. The authors suggest this may have been due to the inclusion (and related communication) of effective noise and vibration countermeasures in the scheme.

4.4 Sleep disturbance

- 4.4.1 A WHO Report⁴⁹ cites numerous studies that detail the effects of transport noise on sleep. Studies have shown that noise can effect sleep in terms of immediate effects (e.g. arousal responses, sleep-state changes, awakenings, body movements, total wake time, autonomic responses), after effects (e.g. sleepiness, daytime performance, cognitive function) and long-term effects (e.g. self-reported chronic sleep disturbance). Sleep disturbances can be quantified either by subjective means or by monitoring physiological or behavioural awakenings. However, it is important to recognise that people are not conscious of their own bodies when asleep, and studies^{50,51} have reported inconsistencies between the physiological effects of noise exposure (objective measures) and the subjects' perceived disturbance. At least one study⁵² found no statistically significant relationship between the subjective assessment of perceived sleep quality and noise data (whole night averages and single event levels). In fact, self-reported sleep disturbance is often considered to be a poor indicator of actual sleep disturbance and associated health effects. Nonetheless, self-reported sleep disturbance is an important indicator of community perception of night noise effects.
- 4.4.2 Miedema and Vos⁵³ have undertaken an updated meta-analysis of 28 datasets from 24 field studies of self-reported sleep disturbance from transport noise using the outdoor night-time noise indicator. The results confirm earlier findings that at the same average night-time exposure levels, aircraft noise is associated with more sleep disturbance than road traffic noise, and road traffic noise is associated with more sleep disturbance than railway noise. Of the twenty eight datasets, five were for conventional railway noise and none were for high speed rail. This updated dataset is the best currently available for assessing self-reported sleep disturbance effects from land based transport noise.

48 S. Oka, Y. Murakami, H. Tetsuya, T. Yano (2013), Community response to a step change in railway noise and vibration exposures by the opening of a new Shinkansen Line, Proc Internoise 2013.

49 World Health Organisation Europe (2009) Night Noise Guidelines for Europe.

50 U. Moehler & L. Greven (2005), Community response to railway and road traffic noise - a review on German field studies. Internoise 2005.

51 M. Basner, U. Müller, E-M. Elmenhorst (2011), Single and combined effects of air, road and rail traffic noise on sleep and recuperation, SLEEP 34(1):11-23.

52 B. Griefahn, A. Schuemer-Kohrs, R. Schuemer, U. Moehler & P. Mehnert (2000), Physiological, subjective, and behavioural responses during sleep to noise from road and rail traffic. Noise Health 2000;3:59-71.

53 H. Miedema & H. Vos (2007), Associations between self-reported sleep disturbance and environmental noise based on reanalyses of pooled data from 24 studies, Behavioural Sleep Medicine 5(1), pp 1-20.

- 4.4.3 As with the research on noise annoyance, studies from the Far East seem to show large deviations from the Miedema and Vos dose-response relationships. For example, one study⁵⁴ found that in Korea, railway noise is associated with more sleep disturbance than road traffic noise. The authors suggest that this difference could be due to several factors, including shorter distances between homes and the railway and consequent increased vibration, high proportion of freight and heavy diesel locomotives and cultural and situational differences between Korea and the countries covered by the Miedema dataset.
- 4.4.4 Over the last four to five decades a lot of research has been carried out into noise-induced sleep disturbance using objective techniques such as electroencephalograms (EEGs) and polysomnography. In 1982, Rice and Morgan⁵⁵ published a synthesis of studies on noise-induced sleep disturbance, in which they concluded that: "Source-specific noise disturbance of sleep may be expected to become significant once the outdoor night-time (22:00-07:00 hours) L_{Aeq} exceeds 55dB providing the peak levels do not exceed about 75-80 dB. Higher L_{Aeq} values up to 60dB may be allowed providing the peak levels do not exceed 85 dB(A), and the number of such events is less than about 20 per night. In this latter context, special account also needs to be taken of the 22:00-24:00 hour going-to-sleep period, when particularly noisy events should be avoided." This conclusion was based on the best available studies at that time, and included data from social surveys, and laboratory and field studies using objective measures of awakenings (EEGs).
- 4.4.5 In 1992, findings from a study into aircraft noise and sleep disturbance commissioned by the Department of Transport were published⁵⁶. The results suggested that below outdoor event levels of 90 dBA SEL (about 80 dB L_{Amax}), aircraft noise events are most unlikely to cause any increase in measured sleep disturbance from that which occurs naturally during normal sleep. For those events above this level, the average arousal rate was about 1 in 30, corresponding to a wakening rate of about 1 in 75. This study used social survey methods together with actigraphy and EEG measurements on subgroups of participants.
- 4.4.6 According to the European Environment Agency⁵⁷, the best quantitative insight into awakenings observed using polysomnography comes from research undertaken by the German Aerospace Centre (DLR) on aircraft noise. In a similar and related study, Elmenhorst et al⁵⁸ carried out a field study investigating railway noise using the same methodology as the DLR study. Thirty three subjects were included, making it the largest polysomnographic study on awakenings from railway noise events to date.

54 J. Hong, J. Kim, C. Lim, K. Kim, S. Lee (2010), The effects of long-term exposure to railway and road traffic noise on subjective sleep disturbance. *J. Acoust. Soc. Am.* 128(5):2829-2835.

55 C.G. Rice & P.A. Morgan (1982), A synthesis of studies on noise-induced sleep disturbance, ISVR Memorandum No. 623.

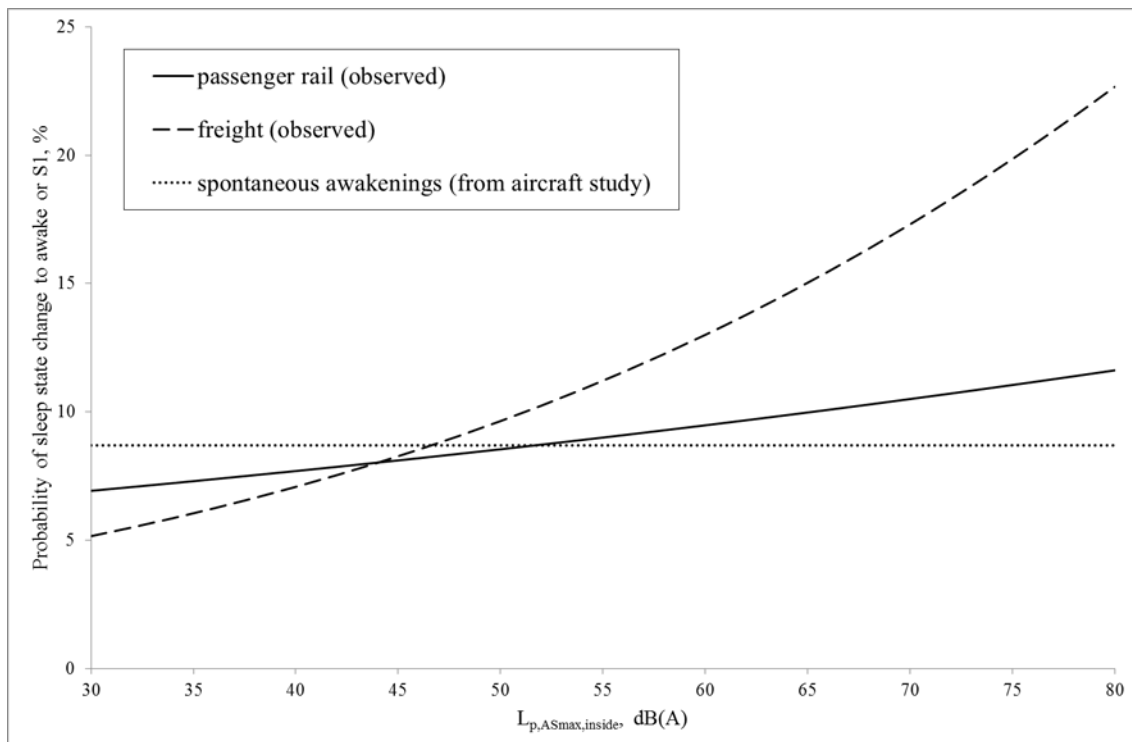
56 J.B. Ollerhead et al. (1992), Report of a field study of aircraft noise and sleep disturbance, Department of Transport.

57 EEA, 2010, Good practice guide on noise exposure and potential health effects, EEA Technical Report 11/2010.

58 Elmenhorst, E., Penning, S., Rolny, V., Quehl, J., Mueller, U., Maaß, H. and Basner, M., 2012, Examining nocturnal railway noise and aircraft noise in the field: sleep, psychomotor performance and annoyance, *Science of the total Environment*, 424, pp 48-56.

- 4.4.7 The reactions of sleeping humans to noise cannot be differentiated from spontaneous reactions using polysomnography. In the DLR aircraft noise study about 24 spontaneous awakenings on average were observed using (EEG awakenings). The relationships shown in Figure 6 show the total number of observed EEG awakenings (combination of spontaneous awakenings and noise induced awakenings). The figure also shows the probability of spontaneous awakenings without the influence of noise (reproduced from the Basner aircraft noise study). Noise induced EEG awakenings are predicted when the probability of an awakening is greater than the probability of spontaneous awakenings i.e. when the curves showing probability of sleep state changes exceed the baseline. Elmenhorst et al. found that railway noise did not lead to prolonged sleep latencies or to impaired sleep efficiency compared to normal population values. Important reported modifying factors include the number and duration of train passbys; passby sound rise time (onset rate); distance to railway; and incidence of perceptible vibration. The results of the Elmenhorst study are considered to provide the best available objective evidence for the assessment of awakenings associated with night time train event noise.

Figure 6: Probability of EEG awakenings due to noise from railway noise (after Elmenhorst et al)



- 4.4.8 The long-term health consequences of noise-induced EEG awakenings are not fully understood. There are some suggestions that humans may be able to adapt to a certain level of noise induced awakening without negative health consequences. In this context, it is necessary to consider the level of impact on sleep resulting from noise-induced EEG awakenings in comparison to those that would naturally occur in the absence of noise. For example, one additional

awakening per night is a value that has been suggested by Basner et al⁵⁹, and is currently used by the Leipzig/Halle airport in Germany, to manage the risk of sleep disturbances associated with aircraft noise⁶⁰.

4.4.9 In particular, Basner et al recommended that:

- (1) On average there should be less than one additional EEG awakening induced by aircraft per night,
- (2) Awakenings recalled the following morning should be prevented as much as possible, and
- (3) There should be no relevant impairment to the process of falling asleep again.

4.4.10 In order to prevent recalled awakenings, Basner et al proposed that the maximum noise level⁶¹ inside the bedroom should not exceed 65 dB. The impairment to the process of falling asleep again is suggested to be dependent upon the number of events and the time interval between events.

4.4.11 Assuming a sound level difference between indoors and outdoors of 15dB (representative of a bedroom façade with a partially open window), the most recent findings by Basner and Elmenhorst are generally consistent with the findings by Rice and Morgan in the 1980s and the aircraft study in the 1990s.

4.5 Cardiovascular disease

4.5.1 It has been shown that long-term exposure to road traffic noise may increase the risk of heart disease, which includes myocardial infarctions. Both road traffic noise and aircraft noise have also been shown to increase the risk of high blood pressure. It has been noted that there are few studies that exist regarding the cardiovascular effects of exposure to rail traffic noise⁶².

4.5.2 Van Kempen and Babisch carried out an extensive review and synthesis of epidemiological studies in order to derive a quantitative exposure-response relationship between road traffic noise exposure and the prevalence of hypertension. An earlier review and synthesis of studies by Babisch identified only one study referring to railway noise, and this found no significant association between hypertension and people exposed to high levels of railway noise.

4.5.3 According to the recent literature review by Fenech et al⁶³, there have been three further relevant studies of conventional railway noise to date, one of which found a statistical (non-significant) association between railway noise and hypertension, and two of which found no such association. There are no

59 Basner, M., Samel, A. and Isermann, U., 2006, Aircraft noise effects on sleep: Application of the results of a large polysomnographic field study, *J Acoust. Soc. Am*, 119(5), 2772-84.

60 Leipzig/Halle Airport, 2010, Current Noise Pollution Protection Programme.

61 Quoted dB values for the maximum noise refer to the LpAmax sound pressure level.

62 World Health Organisation, 2011, Burden of disease from environmental noise: quantification of healthy life years lost in Europe

63 Fenech, B., Cobbing, C., Greer, R. and Marshall, T., 2013, Health effects from high-speed railway noise - a literature review, *Proc Internoise*

reported studies that specifically investigate possible associations between cardiovascular disease and noise from high speed rail. It should also be borne in mind that hypertension is one of many risk factors for cardiovascular disease, other risk factors include genetic predisposition, age, sex, socio-economic status, lifestyle and risk-taking behaviour. Exposure to air pollutions may also be a relevant factor. Studies to date have not clarified whether noise exposure during the day or night (or total noise dose) are contributing to this health outcome.

- 4.5.4 Considering the results of these studies it is not possible to draw definitive conclusions about the presence or absence of an association between hypertension/cardiovascular disease and exposure to noise from conventional or high speed railways. Laszlo et al⁶⁴ have highlighted the uncertainties at lower levels of exposure and the problems associated with establishing the lowest observable adverse effect-levels for both hypertension and heart disease. Notwithstanding the uncertainties, it is clear that individuals exposed to higher levels of noise are exposed to the greater risk, especially at daytime noise levels above 60 dB. Moreover, to some extent the level of uncertainty is less important when considering relative risks, such as risk introduced by a planned development in comparison to the risk caused by existing levels of exposure. It is reasonable therefore to perform a high-level risk assessment considering daytime noise levels above 60 dB, with and without a scheme, as an approximation of relative risk.
- 4.5.5 There are still uncertainties on the relative importance of exposure during the day and night periods, and the importance of sleep disturbance as a mechanism that leads to cardiovascular diseases. Given these uncertainties it is considered that a risk assessment of railway noise and sleep disturbance may be more meaningful than a general consideration of health risk factors associated with exposure to noise at night.

4.6 Mental illness

- 4.6.1 Although environmental noise is not believed to be the direct cause of mental illness, studies suggest that it can accelerate and intensify the development of latent mental disorders. Studies on the adverse effects of environmental noise on mental health cover a variety of symptoms which include anxiety, emotional stress, nausea, and headaches as well as general psychiatric disorders e.g. neurosis, psychosis and hysteria. Longer-scale population studies have shown an association between noise exposure and various mental health indicators, e.g. single rating of well-being, standard psychological symptom profiles, intake of psychotropic drugs and the consumption of tranquilizers and sleeping pills⁶⁵.
- 4.6.2 Recent reviews on noise effects and mental health have concluded that there is no direct association between environmental noise and mental health, in both

⁶⁴ Laszlo, H., Berry, B, Abbott, P. and Hansell, A., 2012, Environmental noise and cardiovascular disease - observations on a well known dose response relationship, Proc. Internoise

⁶⁵ World Health Organisation, 1995, Community Noise, Edited by Berglund, B. and Lindvall, T.

adults and children. Noise annoyance is consistently found to be an important mediator. Evidence for an effect of noise on psychological health suggests that, for both adults and children, noise is probably not associated with serious psychological ill-health, but may affect quality of life and well-being⁶⁶.

4.7 Cognitive impairment in schoolchildren

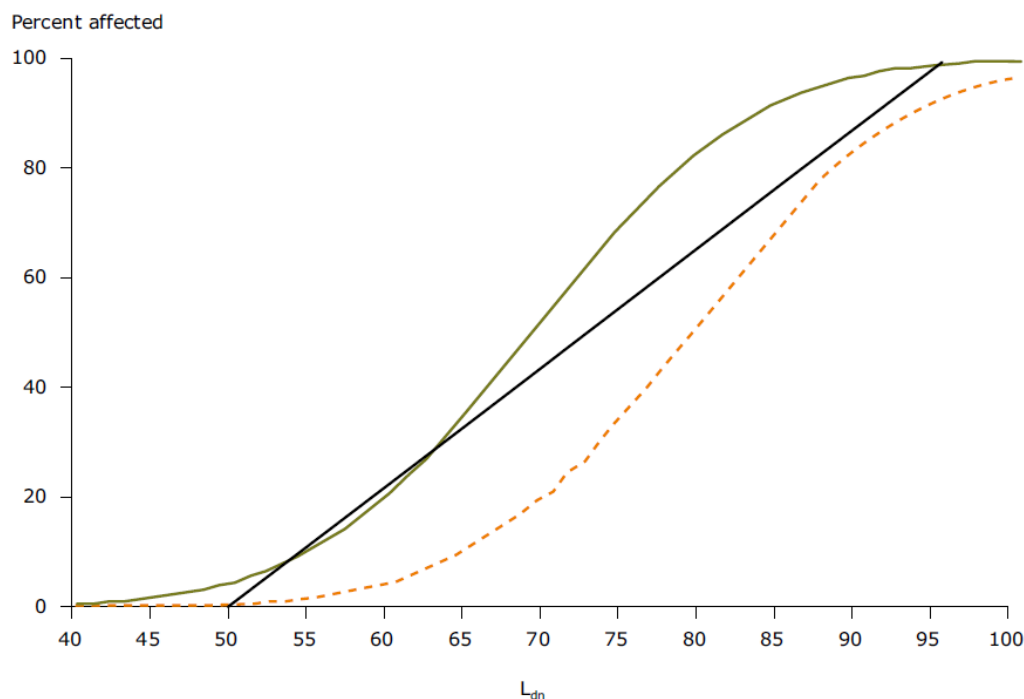
- 4.7.1 A WHO document on Burden of Disease⁶⁷ references three European studies on cognitive impairment in schoolchildren from transport noise. Of the three studies, only one included railway noise within scope, and this was in a specific narrow Alpine valley setting where it was difficult to separate road and rail noise. There is evidence from the other two studies (Munich and RANCH) of an association between aircraft noise exposure and cognitive performance in schoolchildren (reading comprehension and recognition memory), but the same association was not seen for road traffic noise. Neither aircraft noise nor road traffic noise affected sustained attention, self-reported health or mental health issues.
- 4.7.2 The Burden of Disease document and a separate document by the European Environment Agency (EEA)⁶⁸ present a hypothetical exposure – response for cognitive impairment based upon these studies. The relationship assumes 100% of children are cognitively impaired at a very high noise level (95 dB L_{dn}) and that none are affected at a safe low level (50 dB L_{dn}). Within this range cognitive impairment is assumed to follow a sigmoidal function, as shown in Figure 7.

66 van Kamp, I., van Kempen, E., Balias, C. and D. Houthuijs, D., 2013, Mental health as a context rather than health outcome of noise: competing hypotheses regarding the role of sensitivity, perceived soundscapes and restoration, Proc. Internoise.

67 World Health Organization, 2011, Burden of disease from environmental noise: quantification of healthy life years lost in Europe.

68 European Environment Agency, 2010, Good practice guide on noise exposure and potential health effects, EEA Technical Report No 11/2010.

Figure 7: Hypothetical association between aircraft noise level and cognitive impairment in children, assuming all children are cognitively impaired at 95 dB Ldn and that none are affected at 50 dB Ldn. A straight line connecting the two points would be an underestimation of the real effect, which is assumed to follow a sigmoidal distribution (dashed yellow curve). The assumed association (solid green curve) shows that the percentage of children affected is 20% at 55-65 dB Ldn, 45-50% at 65-75 dB Ldn and 70-85% above 75 dB Ldn. After European Environmental Agency⁶⁸



- 4.7.3 Data from the Munich and RANCH studies was reanalysed by Stansfeld et al⁶⁹, who concluded that night-time aircraft noise exposure did not appear to add any cognitive performance impairment to the cognitive impairment induced by daytime aircraft noise alone. Based on the data from the two studies, the authors suggested that the school should be the main focus of attention for protection of children against the effects of aircraft noise on school performance.
- 4.7.4 It has been suggested that the intensity, location of source, variability and unpredictability of aircraft noise is likely to result in a greater effect on children's reading than road traffic noise, which was of a more constant level in the studies. Whilst railway sound occurs as events, and may therefore be considered more similar to aircraft exposure than road traffic noise exposure, there are important differences between railway and aircraft noise events. For an equivalent distance, high speed train sound levels are lower than aircraft. Trains operate on fixed tracks and therefore train sound events are more repeatable than aircraft where flight paths will vary due to a range of factors, particularly meteorological conditions. For modern passenger railways, the character of the train sound is consistent and regular as the train approaches the listener and after it passes. For aircraft, the character not only changes as it passes as a function of the type of plane, but also for each type of plane the sound character will vary as the pilot/aircraft responds to meteorological

69 Stansfeld, S., Hygge, S., Clark, C. and Alfred, T., 2010, Night time aircraft noise exposure and children's cognitive performance, *Noise Health*, 24 (49).

conditions (e.g. change in engine speed due to varying wind conditions during approach to an airport). The duration of an audible aircraft sound event is longer than for a train due to differences in the directivity of the two sources and also because topography, building, vegetation and noise barriers screen train sound.

- 4.7.5 The weakness in the evidence relative to railway noise means that it will not be possible to quantify this effect. However, the absence of evidence does not mean that there is an absence of effect or that there is not a potential risk. Consequently, a high-level risk assessment based upon noise exposure levels above 50 dB day (07:00-23:00)⁷⁰ outside schools as a result of the HS2 scheme, where noise levels from the scheme would be equal to, or higher than existing noise levels, would be appropriate.

4.8 Vibration

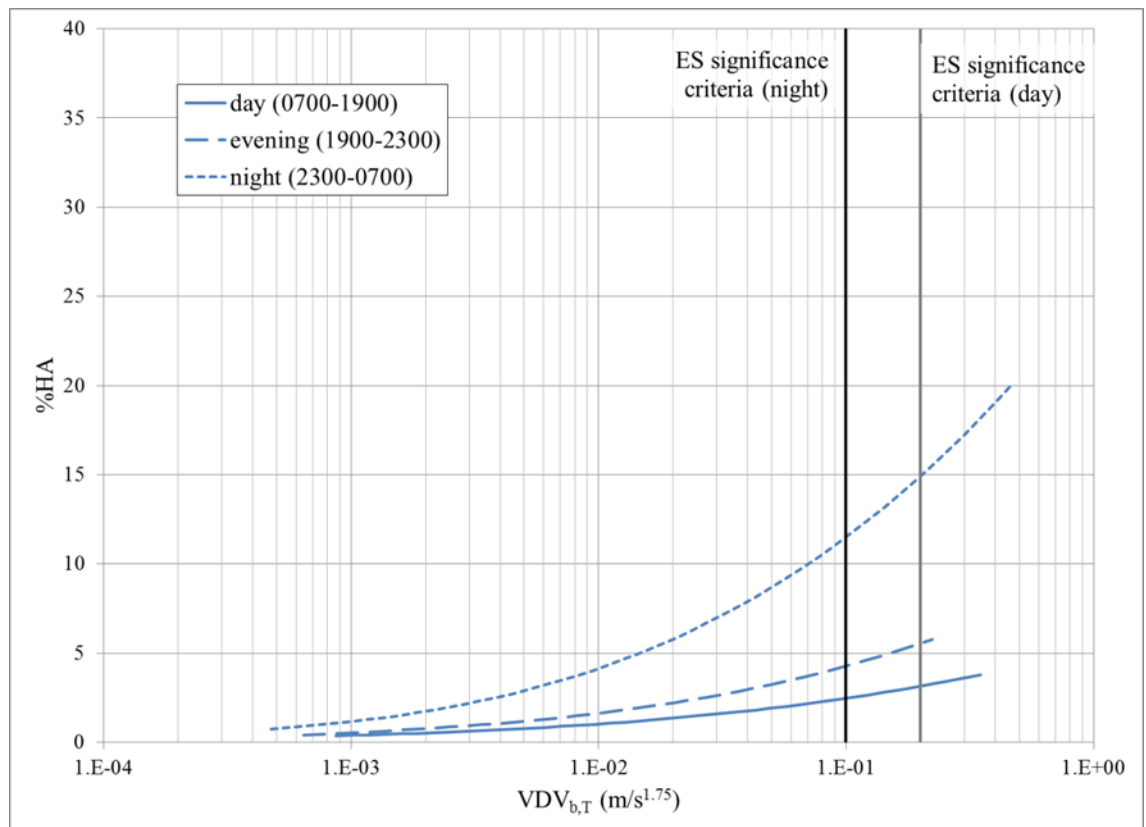
- 4.8.1 The reaction of the human body to vibration can range from annoyance, sleep disturbance, discomfort, interference with activities and it may affect quality of life. Occupants of buildings where there is perceptible vibration may have additional concerns of building damage, safety or a reduction in property value. Levels of vibration at which adverse comment is likely are well below the levels of vibration that may result in even cosmetic damage to buildings.
- 4.8.2 Research reported in 1987 by Woodroof and Griffin⁷¹ investigated annoyance from railway induced vibration in buildings in Scotland. No good correlation was found between objective measures of vibration and reported annoyance. The strongest correlation for annoyance was with the number of train passbys in a 24-hour period. The results suggest that railway induced building vibration did not cause significant annoyance even though about a third of respondents within 100m of the railway could perceive the vibration.
- 4.8.3 A recent study in the UK was undertaken for the Department for Environment, Food & Rural Affairs (Defra) and carried out by a team from Salford University, reporting in 2011⁷². This was a major study, involving almost one thousand face-to-face interviews and over 500 measurements of vibration inside buildings. The study was carried out in the north-west of England and the Midlands area during 2009 and 2010. Exposure-response relationships were developed for human response to railway vibration.

⁷⁰ Based on the assumed train movements during the day and night, the $L_{pAeq, 0700-2300}$ is approximately equal to L_{dn} .

⁷¹ Woodroof, H. and Griffin, M., 1987, A survey of the effect of railway-induced building vibration on the community, ISVR Technical Report 160, University of Southampton.

⁷² University of Salford, 2011, Human response to vibration in residential environments, Reports 1 – 6, Defra.

Figure 8: Percentage highly annoyed by vibration during the day, evening and night



4.8.4 The percentage of respondents expressing a given level of annoyance is higher for night than it is for evening and higher for evening than it is for day. For a vibration level of $0.1\text{ms}^{-1.75}$ ⁷³, the proportion of respondents expressing high annoyance is around 2% during the day, 4% in the evening, and 12% during the night.

4.8.5 There is very little evidence in the existing literature to suggest direct long term physical health effects on people inside buildings are relevant in relation to vibration at the typical levels encountered in the everyday environment⁷⁴.

4.9 Combined effects of noise and vibration

4.9.1 Numerous laboratory and field studies^{75,76,77} have consistently found an interaction between vibration and noise with respect to annoyance to both stimuli. Vibrations may facilitate the perception of noise and make it difficult to ignore and habituate to, which may lead to an increased risk of perceiving the railway noise as more annoying than in situations with no simultaneous vibrations. This synergistic effect is believed to be one of the main factors why

⁷³ Quoted vibration levels in $1\text{ms}^{-1.75}$ refer to the frequency weighted Vibration Dose Value for the respective day and night periods.
⁷⁴ ANC (2012). Measurement and assessment of groundborne noise and vibration, 2nd edition.

⁷⁵ Öhrström, E., 1997, Effects of exposure to railway noise - a comparison between areas with and without vibration, J. Sound & Vibration, 205(4):555-560.

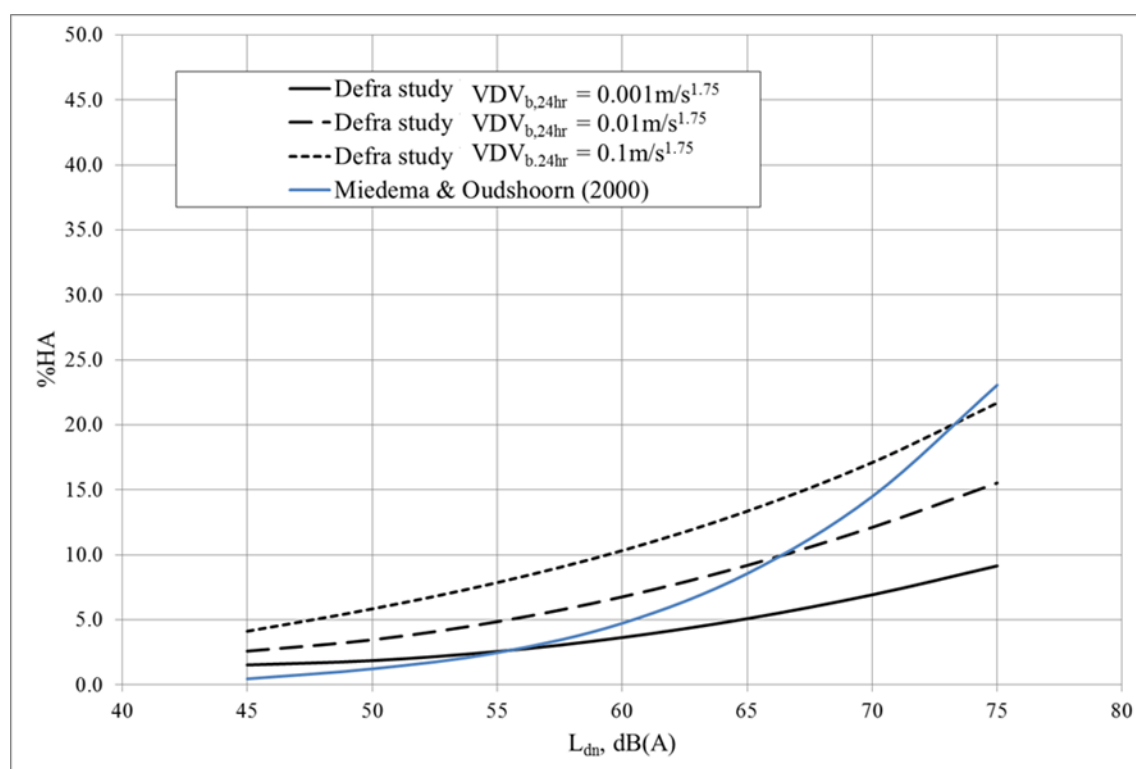
⁷⁶ Gidlöf-Gunnarsson, A., Ögren, M., Jerson, T. and Öhrström, E., 2012, Railway noise annoyance and the importance of number of trains, ground vibration, and building situational factors, Noise Health, 14:190-201.

⁷⁷ Lee, P. and Griffin, M., 2013, Combined effect of noise and vibration produced by high-speed trains on annoyance in buildings, J. Acous. Soc. Am., 133(4):2126-2135.

studies in the Far East report higher level of annoyance than that predicted using the Miedema curve⁷⁸⁷⁹. In the Far East, properties tend to be situated very close to the railway, and groundborne vibrations tend to be exacerbated by the lightweight residential constructions.

- 4.9.2 The Defra-commissioned study on human response to vibration in residential environments gives exposure-response relationships for annoyance caused by noise for a given noise exposure and different levels of vibration exposure. A comparison of these curves with the Miedema curve suggests that the latter takes into account the synergistic effect of low to moderate levels of vibration at high levels of noise exposure. This is not surprising, given that approximately one-third of the data points used in Miedema and Oudshoorn's meta analysis is from Swedish studies at sites with weak or strong railway-induced vibrations.

Figure 9: Percentage of people highly annoyed due to airborne railway noise, for different levels of vibration exposure (from Defra-commissioned study). The blue curve represents the Miedema curve for railway, as discussed in the annoyance section. (Assumption $L_{den} > L_{dn}$)



4.10 Construction noise and vibration

- 4.10.1 Much of the evidence underpinning the discussion of noise and vibration related health effects comes from studies where there has been long-term exposure, during the day, evening and night to the various sources of transport noise. The current models which suggest an association between noise exposure and

78 Oka, S., Murakami, Y., Tetsuya, H. and Yano, T., 2013, Community response to a step change in railway noise and vibration exposures by the opening of a new Shinkansen Line, Proc. Internoise.

79 Yokoshima, S., Matsumoto, Y., Shiraishi, H., Ota, A. and Tamura, A., 2013, Effects of house vibrations on community response to ground transportation noise, Proc. Internoise.

adverse health effects such as hypertension and heart disease operate through longer term stress reaction mechanisms.

- 4.10.2 Potentially high levels of construction noise over a sustained period could impact upon children at school if there was prolonged exposure during the school day. Noise could have an adverse effect on children's learning indoors and on various outdoor learning or rest activities. Experience on other projects such as HS1 and Crossrail has shown that such impacts can be successfully managed.
- 4.10.3 It is important to note that the potential for sleep disturbance will normally only arise in those locations where it is necessary to work at night for engineering, safety or other operational reasons. The amount of surface work at night is likely to represent a small proportion of the overall works. It is recognised that there may be an impact on shift workers or others who have to sleep during the day.
- 4.10.4 The recent Defra-commissioned study⁷² on human response to vibration in residential environments derived exposure-response relationships for annoyance from construction noise and vibration.
- 4.10.5 There is a reasonable level of consensus from other major projects such as HS1 and Crossrail about tolerable levels of construction noise. These clearly depend on the duration of works as well as the level of noise (or vibration) in any particular locality.

5 Air quality

5.1 Overview of air quality effects

5.1.1 Air pollution is made up of a complex mixture of solid, liquid and gaseous compounds. Primary pollutants are those that are generated mainly from human-generated combustion and industrial processes and secondary pollutants are those that are created when primary pollutants react with each other in the atmosphere.⁸⁰

5.1.2 Research findings published since November 2013 are consistent with the findings discussed in this section (Section 5, Sub-sections 5.1-4.8)^{81 82}. There is now expert consensus that NO₂ is likely to have independent effects in its own right and is not just a marker for other types of air pollutants e.g. particulate matter. There is also consensus that reductions in both primary and secondary particulate matter pollution is likely to be beneficial to health.

5.2 Dust

5.2.1 There is no established evidence linking airborne dust such as that from construction sites with adverse health effects. It is generally accepted that particles greater than 10 µm in diameter (PM₁₀) do not penetrate the lungs to cause respiratory health problems. However, dust can cause eye, nose and throat irritation and lead to deposition on cars, windows and property⁸³.

5.3 Road traffic emissions

5.3.1 Evidence on the links between road traffic emissions and health is well established, based on numerous research studies. A WHO report in 2000 suggested that about 36,000–129,000 adult deaths a year are brought forward due to long-term exposure to air pollution generated by traffic in European cities⁸⁴. The main health damaging pollutants released as emissions from road traffic are PM₁₀ and NO₂.

5.4 PM₁₀

5.4.1 PM₁₀, which is an important source of pollution with regard to health impacts, comprises atmospheric particles that are less than 10µm in diameter. Road transport is a major source of PM₁₀, which is emitted from the combustion of vehicle fuels. An important property is the extent to which these particles may be deposited within the lungs, which is dependent on size of particles (smaller particles have a greater chance of reaching the deeper parts of the lungs). There

⁸⁰ World Health Organization, 2006, Air quality guidelines global update 2005.

⁸¹ Public Health England, 2015, Statement on the evidence of the differential health effects of particulate matter according to source or components, Committee on the Medical Effects of Air Pollutants (COMEAP).

⁸² Public Health England, 2015, Statement on the evidence of the differential health effects of nitrogen dioxide on health, Committee on the Medical Effects of Air Pollutants (COMEAP).

⁸³ Mayor of London, 2006, The control of dust and emissions from construction and demolition Best Practice Guidance, Greater London Authority.

⁸⁴ World Health Organization, 2000, Transport, environment and health. WHO Regional Publications, European Series. No.89

is growing evidence that smaller respirable particulate matter may be more relevant to health than larger particles. Recent studies⁸⁴ have found that ultra-fine particles (less than 0.1 µm) have been associated with stronger effects on the lung function and symptoms in asthmatics than either PM₁₀ or PM_{2.5}.

- 5.4.2 Studies have also suggested that particulate pollution of various sizes may exacerbate pre-existing asthma⁸⁵.

5.5 Nitrogen dioxide (NO₂)

- 5.5.1 The effects of road traffic related NO₂ on health are less well understood than the effects of PM₁₀. Numerous epidemiological studies have identified associations between levels of NO₂ and respiratory health⁸⁶, but it may be that in these studies NO₂ is a key marker for traffic-related pollution more generally. NO₂ is a precursor for the formation of ground-level ozone (O₃), which is strongly linked with respiratory disease.

- 5.5.2 A study by Searl (2004)⁸⁷ of various experiments identified minor respiratory changes at concentrations of NO₂ similar to those that would arise at high-pollution events. The results suggest exposure to such an event would have a greater adverse impact on health than a longer term exposure at lower concentrations.

- 5.5.3 Quantifying short- and long-term impacts of NO₂ pollution is problematic due to uncertainties in the concentration-response functions available. It has been estimated that the direct effect of NO₂ on the health of the UK's population could be that between 600 and 6,000 deaths per year may have been brought forward by a matter of days or weeks as a result of the exposure of NO₂ in the ambient air. Likewise it has been estimated that between 1,400 and 14,000 hospital admissions and between 200,000 and 2 million GP consultations for respiratory illnesses may arise as a result of exposure to the ambient NO₂ in the UK each year. Ambient NO₂ is said to contribute to an average of 1-7 extra days of symptoms in asthmatics annually⁸⁷.

5.6 Ozone (O₃)

- 5.6.1 Ground-level O₃ is not released directly into the atmosphere; it is a secondary pollutant that is produced from a reaction with hydrocarbons, road traffic related NO₂ and sunlight. O₃ has the potential to irritate the eyes and air passages which can cause breathing difficulties and can increase susceptibility to infection. Short-term effects of O₃ include changes to lung functions and increased airways inflammation. Longer/higher exposure to ozone can result in more severe alterations in lung function⁸⁶.

85 UK Department of Health, 1998, Quantification of the Effects of Air Pollution on Health in the United Kingdom, Committee of the Medical Effects of Air Pollutants (COMEAP)

86 Health Scotland, MRC Social and Public Health Sciences Unit and Institute of Occupational Medicine, 2007, Health impact assessment of transport initiatives: a guide

87 Searl, A., 2004, A review of the acute and long term impacts of exposure to nitrogen dioxide in the United Kingdom. Institute of Occupational Medicine

5.7 Air pollution links to deprivation

5.7.1 Defra commissioned a study in 2006 to review recent research evidence on links between air quality and social deprivation in the UK⁸⁸. The analysis for England showed that there is a tendency for higher relative mean annual concentrations of NO₂ and particulate matter (PM₁₀) in the most deprived areas of the country. This distribution can largely be explained by the high urban concentrations driven by road transport sources, and the higher proportion of deprived communities in urban areas. If exceedences of national air quality standards are considered, the correlation between poor air quality and deprivation is stronger, showing that when the most polluted areas are considered, the greatest burden is on the most deprived communities, and very little on the least deprived.

5.8 Vulnerable groups

5.8.1 According to the Defra review (2006)⁸⁸, there are a number of factors that affect how susceptible a community is to air pollution effects. These include:

- exposure patterns – for example, indoor/outdoor work, exposure during travel etc. Daily activities/patterns will affect the exposure to air pollution e.g. how we travel to work/school etc;
- individual factors, for example, choice of diet, smoking, level of exercise all impact on overall human health. These lifestyle factors could lead to greater susceptibility to air pollution impacts and may be prevalent in certain socio-economic groups (e.g. links to relationships between diet and income etc.);
- state of health, including physical and mental health, can have a bearing on the level of the immune response which is linked to air pollution exposure. For example, there is evidence to suggest that deprived communities experience poorer health than less deprived communities as outlined in the Independent Inquiry into Inequality in Health report (Acheson 1998)⁸⁸; and
- age of population – the elderly and children would be more susceptible to air pollution impacts.

5.8.2 The review identifies age as a key indicator of susceptibility to air pollution: 'children and elderly groups [are] deemed more susceptible to certain health impacts. An example of this greater susceptibility is the higher rates of asthma observed in children – 1 in 10 (Asthma UK 2004), the symptoms of which can be exacerbated by poor air quality, resulting in additional consultations with physicians [...] On this basis, if a population has a higher proportion of old or young, we could infer that the susceptibility of that population to specific impacts is greater.' The study also notes that 'In England, the most deprived

⁸⁸ Defra, Netcen, Department for Communities and Local Government, National Statistics, 2006, Air quality and social deprivation in the UK: an environmental inequalities analysis - Final Report to Department of Environment, Food and Rural Affairs AEAT/ENV/R/2170, June 2006.

deciles have a greater proportion of children in them relative to other age groups'. This means that 'the inequality already experienced because a deprived community experiences worse air pollution is compounded because that community is likely to be made up of proportionately more children, who in themselves are more susceptible to the negative health impacts associated with air pollution'.

6 Local environment

6.1 Green space and contact with nature

- 6.1.1 A literature review of peer reviewed papers undertaken by the Forestry Commission⁸⁹ has found evidence that proximity, size and amount of green space available to people in urban environments influences physical and mental health outcomes. The review identifies the key health benefits of green space as:
- 'long- and short-term physical benefits associated with obesity, life expectancy, heart rate and blood pressure;
 - attention and cognitive benefits associated with restoration, mood and self esteem;
 - physical activity benefits associated with the use of greenspace;
 - self-reported benefits in terms of health and life satisfaction; and
 - Community cohesion benefits through social contact fostered by greenspace'.
- 6.1.2 The review suggests various mechanisms for the beneficial effects of green space including 'providing a space that promotes social interaction and inclusion, reducing social annoyances and crime' and 'reducing stress and restoring cognitive function and capacity to function with the demands of life'.
- 6.1.3 A literature review by Greenspace Scotland⁹⁰ also found a positive relationship between green space and general health. Importantly this study also identified that 'the attractiveness or quality of greenspace is an important determination of green space use'.
- 6.1.4 The Greenspace Scotland review also identified links to mental health, stating that 'studies consistently show a relationship between levels of stress and access to urban green spaces' and identified 'activity and exercise, natural daylight, stimulation of the senses and aesthetic experience' as potential factors in reducing stress.
- 6.1.5 Research findings published since November 2013 are consistent with the findings discussed above.⁹¹

89 O'Brien, L., Williams, K., Stewart, A., 2010, Urban health and health inequalities and the role of urban forestry in Britain: a review, The Research Agency of the Forest Commission.

90 Croucher, K., Myers, L., and Bretherton, J., 2007, The links between greenspace and health: a critical literature review, Greenspace Scotland.

91 Wheeler, B.W., Lovell, R., Higgins, S.L., White, M.P., Alcock, A., Osborne, N.J., Husk, K., Sabel, C.E. and Depledge M. H., 2015, Beyond greenspace: an ecological study of population general health and indicators of natural environment type and quality, International Journal of Health Geographics, Volume 14.

6.2 Landscape, townscape and visual issues

- 6.2.1 Research into the effects of the visual and aesthetic environment on wellbeing is mainly focused on the psychological effects of 'natural' versus 'man-made' or urban views. In general, evidence shows a preference for views of natural over man-made scenes. These links are often tied in with other, related issues such as opportunities for exercise and contact with nature.
- 6.2.2 No relevant new research on this topic, published since November 2013, was identified.

6.3 Crime

- 6.3.1 The effects of crime on health include both direct effects, for example through violence, and indirect social and psychological effects arising from fear of crime⁹². A recent Office of National Statistics report on Measuring National Wellbeing⁹³ identified crime as a key factor in determining wellbeing. In the 2008 Place Survey⁹⁴ respondents were asked to identify up to 5 priorities for a good place to live, and 61% identified low levels of crime as a priority.
- 6.3.2 Research by Hirschfield (2003)⁹⁵ showed that victimisation or fear of crime may manifest itself through symptoms such as stress, sleeping difficulties, loss of appetite, loss of confidence and health-harming 'coping' mechanisms such as smoking and alcohol consumption. The research also suggested that neighbourhood problems such as disorder and anti-social behaviour, which are not strictly criminal offences, can have adverse effects on health.
- 6.3.3 A recent study⁹⁶ has identified links between fear of crime and mental and physical health, relating largely to participation in health-promoting physical and social activities. In terms of mental health, the study found that 'participants reporting high levels of fear were 50% more likely to exhibit symptoms of common mental disorder, and more than 90% more likely to exhibit symptoms of depression than were those with the lowest levels'. The study also found that participants who reported the highest levels of fear had 'limitations in physical functioning that were commensurate with that of people nine years apart in age'. The study does not claim a direct causal relationship between fear of crime and health, particularly as poor health may be a driver for fear of crime. However, after adjustments for previous mental and physical health conditions, there remained evidence to suggest that fear of crime was a contributory factor in some adverse health outcomes.

⁹² British Medical Association, 1999. Health and environmental impact assessment: an integrated approach, Earthscan Publications Ltd.

⁹³ Randall, C., Measuring national well-being, where we live, 2012, Office for National Statistics.

⁹⁴ Department for Communities and Local Government, 2008, Place survey.

⁹⁵ Hirschfield, A., 2003. The health impact assessment of crime prevention', Sourced from NHS National Institute for Health and Clinical Evidence.

⁹⁶ Stafford, M., Chandola, T., Marmot, M., 2007, Association between fear of crime and mental health and physical functioning, American Journal of Public Health, 97(11):2076-2081.

- 6.3.4 A comprehensive review (BMC study) undertaken in 2013⁹⁷ set out to synthesize qualitative evidence on fear of crime and the environment. The report notes that 'most research on crime and health hitherto has focused on the direct health impacts suffered by victims of crime. However, the indirect effects of crime and its broader harms on individuals and communities may also have important impacts on wellbeing. Fear of crime is of particular interest here, as it has been shown in several studies to have a modest, but consistently significant, association with health and wellbeing. The report also notes that fear of crime is only weakly correlated with actual crime rates, and highlights other issues such as urban neglect and social cohesion as factors affecting fear of crime.
- 6.3.5 The BMC study examines the consequences of fear of crime, stating that 'relatively few participants see fear as having serious mental health impacts, although several report some degree of psychological stress as a result of fear. A much more widely perceived consequence of fear is to limit people's activities, including social and cultural activities, sometimes leading to social isolation. Participants from across the population report such limitations, but they appear to be more serious for women, older people and people with disabilities. Parents also report placing serious restrictions on children's activities.'
- 6.3.6 Research findings published since November 2013 are consistent with the findings discussed above.⁹⁸ A study in Lambeth identified that perceived neighbourhood disorder as well as experience of crime generated poorer mental health (common mental illness). Neighbourhood disorder is generally considered to have a social component, levels of crime and anti-social behavior that influence feelings of safety and social connectedness, and a physical component, such as graffiti, vandalism, litter and unmaintained buildings, public spaces and infrastructure.⁹⁹

6.4 Vulnerable groups

- 6.4.1 Social inequalities are particularly marked in urban environments, with different population subgroups experiencing impacts to different degrees. A review conducted by Parkes and Kearns, 2004¹⁰⁰ of a number of studies identified that women were more vulnerable to neighbourhood conditions than men, and particularly those women with children, who were not employed outside the home.

97 Lorenc, T., Petticrew, M., Whitehead, M., Neary, D., Clayton, S., Wright, K., Thomson, H., Cummins, S., Sowden, A., Renton, A., 2013, Fear of crime and the environment: systematic review of UK qualitative evidence, BMC Public Health, 13: 496.

98 Lorenc, T., Petticrew, M., Whitehead, M., Neary, D., Clayton, S., Wright, K., Thomson, H., Cummins, S., Sowden, A., Renton, A., 2014, Crime, fear of crime and mental health: synthesis of theory and systematic reviews of interventions and qualitative evidence, Public Health Research, Vol 2(2).

99 Polling, C., Khondoker, M., SELCoH study team, Hatch S.L. and Hotopf, M., 2014, Influence of perceived and actual neighbourhood disorder on common mental illness, Social Psychiatry and Psychiatric Epidemiology, 49:889-901.

100 Parkes, P. & Kearns, A., 2004, The multi-dimensional neighbourhood and health: a cross sectional analysis of the Scottish Household Survey 2001, CNR Paper 19, ESRC Centre for Neighbourhood Research, www.neighbourhoodcentre.org.uk.

- 6.4.2 There are other groups that may be particularly vulnerable to certain impacts; for example children may be disproportionately affected by loss of open space, and older people may be particularly likely to suffer as a result of fear of crime.
- 6.4.3 Research findings published since November 2013 are consistent with the findings discussed above^{101 102}.

¹⁰¹ Dadvand, P., Wright, J., Martinez, D., Basagaña, X., McEachan, R.R.C., Cirach, M., Gidlow C.J., de Hoogh, K., Gražulevičiene, R. and Nieuwenhuijsen, M.J., 2014, Inequality, green spaces, and pregnant women: roles of ethnicity and individual and neighbourhood socioeconomic status, *Environment International*, Vol 71:101-108.

¹⁰² Amoly, E., Dadvand P., Fors, J., López-Vicente M., Basagaña, X., Julvez, J., Alvarez-Pedrerol, M., Nieuwenhuijsen, M.J. and Sunyer, J., 2014, Green and blue spaces and behavioural development in Barcelona schoolchildren: the BREATHE Project, *Environmental Health Perspectives*, Vol 122 (12).

7 Physical activity

7.1 Environmental influences on physical activity

- 7.1.1 A review of available data and literature undertaken for the NHS (2011)¹⁰³ has shown that the environment has an effect on people's participation in physical activity, which in turn affects their health. The report looked at a number of systematic reviews summarising the evidence linking the environment and physical activity to identify those aspects of the environment found to be associated with physical activity. These include:
- access to physical activity facilities;
 - distance to destinations;
 - levels of residential density;
 - type of land use;
 - urban walkability; and
 - perceived safety'.
- 7.1.2 The report also states that 'less-clear associations have been noted for aesthetic features of the environment and parks, and perceived crime'.
- 7.1.3 Research suggests that most sustained exercise is taken during the course of everyday activities such as travelling to work or going to the shops, rather than specifically for health purposes¹⁰⁴. However, safety concerns relating to road traffic can influence choice of mode of transport and levels of physical activity. A fear of traffic is the most common barrier to cycling; a fear that is 'exaggerated in comparison with the likelihood of injury'.
- 7.1.4 Physical activity can be encouraged by improving accessibility to green spaces, ensuring green spaces are of a high quality and attractive¹⁰⁵. The evidence indicates that green space is most valuable as a resource for physical activity when used by high volumes of people, therefore spaces need to be accessible, of sufficient size, and connected to residential areas¹⁰⁶. In addition to accessibility to green space, evidence suggests that access to leisure facilities can determine levels of physical activity and reduce the risks of obesity¹⁰⁷.
- 7.1.5 However, a review of evidence for environmental influences on obesity¹⁰⁸ has suggested that 'the contribution of environmental variables in explaining

103 Cavill, N. and Roberts, K., 2011, Sources of data for investigating the influence of the environment on physical activity and diet. Oxford: National Obesity Observatory.

104 Caldwell, L.L., 2005, Leisure and health: why is leisure therapeutic? British Journal of Guidance and Counselling, 33(1):7-26.

105 Randall, C., 2012, Measuring national well-being – where we live – 2012, Office for National Statistics.

106 At least five a week: evidence on the impact of physical activity and its relationship to health, Department of Health, Physical Activity, Health Improvement and Prevention, April 2004.

107 Greenspace Scotland, 2009, Health impact assessment of greenspace – a guide.

108 Jones, A., Benthall, G., Foster, C., Hillsdon, M. and Panter, J., Obesogenic environments evidence review, Office of Science and Innovation, UK Government.

variation of physical activity or walking is small and less important than socio-demographic variables’.

- 7.1.6 Research findings published since November 2013 are consistent with the findings discussed above.¹⁰⁹

7.2 Physical health effects

- 7.2.1 Evidence demonstrates that ‘an inactive lifestyle has a substantial, negative impact on both individual and public health – specifically, physical inactivity is a primary contributor to a broad range of chronic diseases such as coronary heart disease, stroke, diabetes and some cancers’¹⁰⁶.

- 7.2.2 A recent Department of Health report¹¹⁰ states that ‘regular physical activity can reduce the risk of many chronic conditions including coronary heart disease, stroke, type 2 diabetes, cancer, obesity, mental health problems and musculoskeletal conditions. Even relatively small increases in physical activity are associated with some protection against chronic diseases and an improved quality of life.’

- 7.2.3 It has been shown that ‘physical activity improves health throughout the life course – from childhood through to older age’¹¹¹. The health benefits of physical exercise occur across virtually the full range of diseases, and when this is combined with the prevalence of inactivity among the public, it ‘makes physical activity one of the main contemporary public health issues’.

- 7.2.4 Research findings published since November 2013 are consistent with the findings discussed above¹¹².

7.3 Mental health effects

- 7.3.1 Positive mental health effects associated with exercise have been highlighted in evidence reviews by Cave et al¹¹³, Sport England¹¹⁴ and AEA Technology¹¹⁵. Mental health effects cited include improvements in people with generalised anxiety disorders including phobias, panic attacks, and stress disorders.

- 7.3.2 A Government review¹¹⁶ has also identified positive effects on psychological well-being in people with schizophrenia. The review also states that exercise

109 Calogiuri, G. and Chroni, S., 2014, The impact of the natural environment on the promotion of active living: an integrative systematic review, *BMC Public Health*, 14:873.

110 UK Department of Health, 2011, Start active, stay active: a report on physical activity from the four home countries, Chief Medical Officers Report, Physical Activity, Health Improvement and Protection.

111 Harding, T., 1997, A life worth living: the independence and inclusion of older people, London: Help the Aged, cited in Beaumont, J., 2011, Measuring national well-being: discussion paper on domains and measures, Faculty of Public Health, Office for National Statistics.

112 Gray, C., Gibbons, R., Larouche, R., Beate Hansen Sandseter, E., Bienenstock, A., Brussoni, M., Chabot, G., Herrington, S., Janssen, I., Pickett, W., Power, M., Stanger, N., Sampson, M. and Tremblay, M.S., 2015, What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? a systematic review, *International Journal of Environmental Research and Public Health*, Vol 12(6), 6455-6474.

113 Cave, B, Curtis, S, Aviles, M, and Coutts, A, 2001. ‘Health Impact Assessment for Regeneration Projects. Volume II Selected evidence base’. East London and City Health Action Zone.

114 Sport England. 2007. ‘Active Design. Promoting opportunities for sport and physical activity through good design’. Supported by CABE, DH & DCMS. Sport England.

115 AEA Technology, 2000, Informing transport health impact assessment in London, Commissioned by NHS Executive, London.

116 UK Department of Health, 2004, At least five a week: evidence on the impact of physical activity and its relationship to health’. Chief Medical Officers Report.

can aid in the treatment of clinical depression, sleep problems and low self-esteem, and can contribute towards improved physical perception, and general psychological well-being as well as acting as a buffer to stress. Physical activity can also provide an important opportunity for social interaction, which in itself can aid mental wellbeing.

- 7.3.3 Research findings published since November 2013 are consistent with the findings discussed above¹¹⁷.

7.4 Vulnerable groups

- 7.4.1 Although all groups are shown to benefit from regular exercise, the benefits to children and the elderly are particularly emphasised. The importance of exercise for children is highlighted in terms of benefits in building up bone density, avoidance of weight gain, links to health status in later life, and in establishing habits, which may be more difficult to begin in later life (British Medical Association, 2002 and DH, 2004).¹¹⁸ The benefits for the elderly include retention of mobility, cognitive function and independence.¹¹⁸
- 7.4.2 Research findings published since November 2013 are consistent with the findings discussed above¹¹⁹.

¹¹⁷ Teychenne, M., Costigan, S.A. and Parker, K., 2015, The association between sedentary behavior and risk of anxiety: a systematic review, BMC Public Health, 15:513.

¹¹⁸ UK Department of Health, 2004, Choosing Health Summaries: Diet and Nutrition, Public Health White Paper.

¹¹⁹ Warden, S.J., Mantila Roosa, S.M., Kersh, M.E., Hurd, A.L., Fleisig, G.S., Pandey, M.G. and Fuchs, R.K., 2014, Physical activity when young people lifelong benefits to cortical bone size and strength in men, PNAS, Vol 111 (14):5337-5342.

8 Access to services

8.1 Introduction

8.1.1 According to Quigley et al¹²⁰, the accessibility of local shops, community services and healthcare facilities may be affected by:

- effects on the capacity of existing services;
- physical accessibility (i.e. distances travelled and transport connections);
- social and/or cultural access (i.e. communication issues); and
- separation imposed by a new piece of physical infrastructure.

8.1.2 Research findings published since November 2013 since November 2013 is consistent with the findings discussed above ^{121 122 123 124}.

8.2 Healthcare

8.2.1 According to the 2008 Place Survey, 44% of adults in England reported access to health services as one of the key contributors to how good somewhere was to live¹²⁵. No new place survey has been undertaken since 2008.

8.2.2 According to the DfT, 'over the course of a year over 1.4 million people miss, turn down or simply choose not to seek healthcare because of transport problems'¹²⁶. Capacity to reach healthcare services is affected by the accessibility of transport modes, availability of financial support for those on low incomes and the location of healthcare services¹²⁷. Groups impacted by disability and of certain ages may experience even greater barriers to health and social care services.¹²⁸

8.2.3 It is estimated that around 5% of trips (one million per day) in London are related to accessing healthcare.¹²⁴

8.2.4 No relevant new research on this topic, published since November 2013, was identified.

120 Quigley, R. and Thornley, L., 2011, Literature review on community cohesion and community severance: definitions and indicators for transport planning and monitoring, Report to New Zealand Transport Agency, Quigley and Watts Ltd.

121 Taylor, P., Davies, L., Wells, P., Gilbertson, J. and Tayleur W., 2015, A Review of the Social Impacts of Culture and Sport, Culture and Sport Evidence (CASE) Programme, Department for Culture, Media and Sport (DCMS) in collaboration with the Arts Council England (ACE), English Heritage (EH) and Sport England (SE).

122 Heritage Lottery Fund, 2015, Values and benefits of heritage: a research review.

123 Arts Council England, 2014, The Value of Arts and Culture to people and Society: an evidence review.

124 Mayor of London, 2014, Improving the Health of Londoners: transport action plan, Transport for London.

125 UK Department for Communities and Local Government, 2008, Place survey.

126 Social Exclusion Unit, 2003, Making the Connections: Final Report on Transport and Social Exclusion, ODPM.

127 Randall, C., 2012, Measuring national well-being - where we live – 2012, Office for National Statistics.

128 Hamer, L., 2004, Improving patient access to health services: a national review and case studies of current approaches, Health Development Agency.

8.3 Shops

- 8.3.1 Research has suggested that 'access to local shops, post offices, places of entertainment and community activity all contribute to well-being'¹²⁹.
- 8.3.2 Results from a 2010/11 poll showed that 5% of adults in Great Britain feel 'isolated' as a result of difficulty in accessing local shops and services¹²⁷.
- 8.3.3 No relevant new research or polls on this topic, published since November 2013, were identified.

8.4 Leisure, faith, culture and recreational facilities

- 8.4.1 Access to leisure and cultural facilities is a determinant of health and wellbeing; according to research 'leisure activities can have a positive effect on people's physical, social, emotional and cognitive health through prevention, coping (adjustment, remediation, diversion), and transcendence'¹³⁰. People participate in cultural activities for a number of reasons including 'enjoyment and entertainment', personal growth and development, and as a 'means of creative expression', 'to learn new skills' or 'to meet new people' and to 'pass on cultural traditions'¹³¹.
- 8.4.2 No relevant new research or polls on this topic, published since November 2013, were identified.

8.5 Vulnerable groups

- 8.5.1 People without private cars are likely to be particularly vulnerable to impacts on access to local shops and facilities, particularly in rural areas. This is more common among people on low incomes and older people.
- 8.5.2 Mobility impaired or visually impaired people will be particularly vulnerable to impacts such as local footpath diversions.
- 8.5.3 People who rely on regular contact with local healthcare services, such as those with disabilities or long term illness, or those with young children, may be more vulnerable to impacts on access to these services.
- 8.5.4 No relevant new research or polls on this topic, published since November 2013, were identified.

¹²⁹ Harding, T., 1997, A life worth living: the independence and inclusion of older people, London: Help the Aged, cited in Randall, C., 2012, Measuring national well-being – where we live, 2012, Office for National Statistics.

¹³⁰ Caldwell, L.L., 2005, Leisure and health: why is leisure therapeutic?, British Journal of Guidance and Counselling, 33(1):7-26

¹³¹ New Zealand Government, 2007, Social report: leisure and recreation, Ministry of Social Development.

9 Transport

9.1 Introduction

- 9.1.1 Evidence on the health effects of transport is mainly focused on the effects of transport related noise, air emissions, access to services, community severance and physical activity. These issues are covered in other sections of this HIA and evidence for these health linkages is presented in the corresponding sections of the evidence base. Evidence related to the linkages between health and changes in road and public transport user experience, changes in the accessibility of stations, and road safety issues during the construction phase are outlined below.

9.2 User experience

- 9.2.1 Journey ambience was identified as an appraisal criterion in the Government's Transport Analysis Guidance in 2013¹³². This document included guidance on traveller stress, stating that: 'Traveller stress is the adverse mental and physiological effects experienced by travellers. Three main factors influence traveller stress: frustration; fear of potential accidents; and route uncertainty. Taken together, these can lead to feelings of discomfort, annoyance, frustration or fear culminating in physical and emotional tension that detracts from the quality and safety of a journey. Extreme cases of traveller stress can contribute towards, or be caused by, 'transport rage'. The extent of stress will depend on the travellers driving skill and experience, temperament, knowledge of the route and state of health.'
- 9.2.2 The guidance identified major influences on frustration as including 'a driver's inability to drive at a speed consistent with his or her own wishes, relative to the standard of the road (e.g. congestion), or delays on public transport'. Route uncertainty (e.g. uncertainty arising from temporary diversions) is also identified as a factor influencing traveller stress.
- 9.2.3 The latest updated Transport Analysis Guidance has replaced the term journey ambience with journey quality.¹³³ Though a detailed definition as stated above is not provided in this updated guidance. The guidance discusses and defines traveller stress in the same way i.e. that the three main factors that influence traveller stress are frustration; fear of potential accidents; and route uncertainty.

¹³² UK Department for Transport, 2003, Transport Analysis Guidance (webTAG), The journey ambience sub-objective, TAG Unit 3.3.13, June 2003, This guidance has now been superseded and archived, <http://webarchive.nationalarchives.gov.uk/20140304105410/http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.3.13.pdf>.

¹³³ UK Department for Transport, 2014, Transport Analysis Guidance (TAG), Social Impact Appraisal, TAG Unit A4.1, Department for Transport, November 2014, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427096/TAG_Unit_A4.1_-_Social_Impact_Appraisal_November2014.pdf.

9.3 Accessibility of stations

- 9.3.1 The Government's Transport Analysis Guidance¹³² stated, in 2013, that 'some public transport users (e.g. the disabled and mothers with young children) may experience frustration in accessing and egressing public transport'.
- 9.3.2 The latest updated Transport Analysis Guidance though it does not make an explicit mention of the above issue does highlight the need to consider traveller stress and frustration and the importance of station quality to the journey quality of rail users¹³³.

9.4 Road safety

- 9.4.1 Additional HGVs on the road network can influence the risk of serious accidents and fatalities, particularly those involving non-motorised vehicles. According to DfT figures¹³⁴ there were 7,103 accidents in 2010 involving at least one HGV, with 9,686 casualties of which 263 were fatal.
- 9.4.2 According to the Government's Transport Analysis Guidance¹³², 'fear of accidents is highest when speed, flow and the HGV content are high'. However, the rate of fatal or serious accidents involving HGVs is reducing significantly due to improved awareness and safety measures. In 2013, the DfT figures stated that 'there were around 83 fatal or serious accidents involving HGVs per billion HGV vehicle miles in 2010. This figure was lower than the rate for all vehicles (120 accidents per billion vehicle miles) and has decreased from 173 per billion HGV vehicle miles in 2000.'
- 9.4.3 The latest DfT figures available in 2015, state that, in 2013, there were 6,092 accidents involving at least one HGV in Great Britain, with 8,448 casualties, of which 258 were fatalities¹³⁵. In addition 'there were around 81 fatal or serious accidents involving HGVs per billion HGV vehicle miles in 2013. This figure was lower than the rate for all vehicles (117 accidents per billion vehicle miles) and has decreased from 139 per billion HGV vehicle miles in 2003.' These statistics show that there has been a continuation of the downward trend in accidents and casualties between 2010 (the figures reports in the main HIA report) and 2013 (the latest figures available for the AP3 HIA addendum report)

¹³⁴ UK Department for Transport, 2011, Road freight statistics, Statistical release, 27 October 2011.

¹³⁵ Department for Transport, 2015, Road freight economic, environmental and safety statistics, Statistical release, 19 February 2015.

10 Social capital

10.1 Introduction

- 10.1.1 The World Bank definition of social capital is '...the institutions, relationships and norms that shape the quality and quantity of a society's social interactions.... Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together'¹³⁶.
- 10.1.2 According to a literature review by Cave et al. (2001)¹³⁷ social capital may:
- protect health by buffering against the effects of life events which may be damaging to health;
 - have physiological effects, through the hormonal system, on the body's response to stress and functioning of the immune system;
 - reduce isolation, which is associated with disease, accidents and suicide;
 - enable people to cope with illness better and have better prognoses when ill; and
 - reduce or protect against mental health problems, such as anxiety and depression.
- 10.1.3 Social networks are also credited with 'creating opportunities for advice and informal care'¹³⁸.
- 10.1.4 The Social Exclusion Unit states that 'participation in social, cultural and leisure activities is very important to people's quality of life and can play a major part in meeting policy goals like improving health, reducing crime and building cohesive communities'.¹³⁹
- 10.1.5 Research findings published since November 2013 is consistent with the findings discussed in this section^{140 141 142}. A report on social capital and resilience for the Housing Diversity Network stated that 'Housing providers can play an important role in providing space and opportunities for people from different backgrounds to mix and form the positive relationships necessary for a community to be cohesive and resilient'¹⁴¹.

¹³⁶ The World Bank, 1999, What is social capital?, PovertyNet.

¹³⁷ Cave, B., Curtis, S., Aviles, M. and Coutts, A., 2001, Health impact assessment for regeneration projects. Volume II selected evidence base, East London and City Health Action Zone, University of London.

¹³⁸ Health Development Agency, 2005, Making the case: improving health through transport, National Health Service.

¹³⁹ Social Exclusion Unit, 2003, Making the connections: final report on transport and social exclusion, Office of the Deputy Prime Minister.

¹⁴⁰ Boniface, S., Scantlebury, R., Watkins, S.J. and Mindell, J.S., 2015, Health implications of transport: evidence of effects of transport on social interactions, Journal of Transport & Health.

¹⁴¹ Centre for Local Economic Strategies, 2014, Community cohesion and resilience – acknowledging the role and contribution of housing providers, Housing Diversity Network.

¹⁴² McPerson, K.E., Kerr, S., McGee, E., Morgan, A., Cheater, F.M., McLean, J. and Egan, J., 2014, The association between social capital and mental health and behavioural problems in children and adolescents: an integrative systematic review, BMC Psychology, 2:7.

10.2 Community consistency

- 10.2.1 Social capital is supported by stable communities where residential turnover is low. According to Government research, 'residential mobility is negatively associated with social capital at the neighbourhood level'¹⁴³. Furthermore, 'sometimes a neighbourhood can be tipped into a low social capital equilibrium by some ... factor, such as urban clearance, disruption by infrastructure, and strong inward migration or social mixing'.
- 10.2.2 Research on construction worker health during the construction phase the 2012 London Olympics found that sexual health related risk factors were low.¹⁴⁴ However, there is some evidence that some workers from outside the UK can have riskier lifestyles than the communities in which they live and work.¹⁴⁵

10.3 Crime

- 10.3.1 Social capital is considered a strong determinant of crime rates in a community, as strong social networks strengthen communities and deter crime and antisocial behaviour¹⁴³. Crime is in turn an important determinant of health and wellbeing¹⁴⁶, so increasing social capital can serve to decrease the adverse health and wellbeing impacts associated with crime.

10.4 Vulnerable groups

- 10.4.1 Some population groups are believed to be at particular risk of social exclusion, including children, minority ethnic groups, disabled people, lone parents, older people, carers, asylum seekers and refugees and ex-offenders.

¹⁴³ Performance and Innovation Unit, 2002, Social capital: a discussion paper, The Cabinet Office.

¹⁴⁴ Shanmugaratnam, S., Horne, P., and Coyne, K.M., 2012, Olympic outreach: testing for sexually transmitted infections in construction workers, *International Journal of STD & AIDS*, 23:659-660.

¹⁴⁵ Burns, F.M., Evans, A.R., Mercer, C.H., Parutis, V., Gerry, C.J., Mole, R.C.M., French, R.S., Imrie, J., Hart, G.J., 2011, Sexual and HIV risk behavior in Central and Eastern European migrants in London, *Sexually Transmitted Infections*, 87:318-324.

¹⁴⁶ Greater London Authority, 2005, Review of the London Health Strategy high level indicators, London Health Commission.

11 Vulnerable groups

11.1 Introduction

- 11.1.1 The Government's Transport Analysis Guidance in 2013¹³² stated that 'the impact of transport is more fundamental to health for certain sectors of society than others. Vulnerable groups include children, the elderly, disabled, women, those suffering from long-term illnesses, and the financially disadvantaged, who are less likely to have access to a private vehicle and suffer from any lack of public transport. Those in lower socio-economic class are also shown to experience a disproportionately greater numbers of road casualties.'
- 11.1.2 The latest updated Transport Analysis Guidance also highlights the importance of considering the needs of different social, potentially vulnerable, groups transport needs and priorities¹⁴⁷.

11.2 Overview of vulnerable groups

- 11.2.1 Vulnerable groups comprise those sections of the population that for certain reasons may be disproportionately affected (either positively or negatively) by the Proposed Scheme. Specific sensitivities have been identified within the evidence base presented above. The section below provides an overview and summary of key vulnerable groups discussed in the previous section of this appendix. Further discussion of vulnerable groups and potential health inequalities is provided within the relevant assessment sections of the HIA.

11.3 Older people

- 11.3.1 Older people comprise an important and growing group in society with multiple sensitivities to the negative health impacts of development projects. The elderly are a vulnerable group because they are generally physically less able to cope with impacts on air quality, noise and other environmental factors than young and middle aged adults.
- 11.3.2 Older people are also more likely to face difficulties in accessing health and social services as well as local services such as supermarkets, due to issues such as physical mobility, lower income, greater reliance on public transport, and fear of crime and antisocial behaviour. Older people are therefore likely to be disproportionately affected by impacts such as disruption to public transport services, footpath diversions, and permanent or temporary loss of local facilities. They are also likely to find it more difficult to adapt to changes.
- 11.3.3 These issues may lead to behavioural changes with adverse health consequences, such as a decrease in social interaction, reduced levels of exercise, deterioration in diet and a lower use of health and social care facilities.

¹⁴⁷ Department for Transport, Transport Analysis Guidance (TAG), 2014, Distributional Impact Appraisal, TAG Unit A4.2, Department for Transport, January 2014, Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427097/webtag-tag-unit-a4-2-distributional-impact-appraisal.pdf.

11.4 Children and adolescents

- 11.4.1 Children and adolescents are a vulnerable group because they are physically more sensitive than young and middle aged adults to air pollution, noise, odour and other environmental factors.
- 11.4.2 Children are also more likely to be involved in road traffic accidents. The barriers to physical activity created by heavy traffic are especially restrictive for children.
- 11.4.3 Children from low income families and/or living in deprived areas are particularly sensitive to health and wellbeing impacts associated with social, economic and environmental changes.

11.5 Disabled people and long-term illness sufferers

- 11.5.1 Long-term illness sufferers are likely to be more sensitive to environmental changes, and in particular are likely to suffer from the detrimental effects of increased noise and air emissions.
- 11.5.2 People with impaired mobility or sight may be more vulnerable to the disruptive effects of construction, such as footpath diversions and increased traffic flows, as well as the permanent or temporary loss of local facilities necessitating additional travel.
- 11.5.3 Both groups are likely to be more dependent on health and social care services, and therefore more susceptible to disruption in access to these services.

11.6 Low income/lower socio-economic groups

- 11.6.1 People living on low incomes and/or living in deprived communities generally live in cheaper but poorer quality neighbourhoods both in terms of higher levels of environmental pollution, air, noise and visual impacts; as well as poorer availability of and access to services and amenities and poorer quality housing.
- 11.6.2 Low income groups and those living in deprived areas are shown to experience a disproportionately greater numbers of road casualties. Traffic volumes and the proportion of vehicles exceeding speed limits are also generally higher in less affluent areas.
- 11.6.3 For those living in social housing, the impact of moving house, which is considered to be a stressful, health damaging life event, can be compounded by a lack of opportunity to negotiate with the housing authority regarding control of the move.
- 11.6.4 Low income groups are more dependent on public transport and therefore more likely to be affected by restricted access to services and facilities and/or community severance when services are interrupted or delayed. This can affect people's ability to access health and social care services, and basic facilities.

- 11.6.5 These communities also tend to have a higher incidence of health damaging behaviours such as smoking and poor diet. All of these result in lower levels of baseline health and wellbeing and reduced resilience.

11.7 Minority ethnic groups

- 11.7.1 There are few instances where particular ethnic groups are more physically susceptible to health impacts. However, links between areas of high deprivation and high levels of ethnic diversity mean that minority ethnic groups are more likely to have elevated vulnerability associated with social and economic disadvantages.
- 11.7.2 Other factors such as language and lifestyle may also influence the way in which different ethnic groups are affected by impacts on health determinants.
- 11.7.3 Non-English speakers may face barriers to accessing information about the works or expressing their concerns.

Appendix 4 Existing baseline

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1 Introduction

1.1.1 Information has been gathered from a variety of published sources in order to provide a profile of the existing communities living around Euston station, including socio-economic, demographic and health characteristics. This information has provided a baseline against which the potential health effects of the AP3 revised scheme have been assessed.

1.1.2 Where no updated data is available or the updated data is similar to that presented in the main HIA, this is stated. For convenience information presented in the main HIA that is still relevant has been included.

1.2 Community profiles

1.2.1 The community profile has used detailed information available from publicly accessible sources. The granularity of data varies between different data sets used, ranging from regional level data to small localised areas (lower super output areas (LSOAs)). LSOAs are small geographical areas with populations of between 1000 and 1500, which are used to report small area statistics in England and Wales.

1.2.2 Where reasonably practicable, as part of the community health profiling, available information on existing vulnerable groups has been collated. This has focused on:

- communities that are vulnerable due to existing deprivation; and
- groups of people who may be particularly susceptible due to characteristics such as age or disability.

1.3 Environmental and socio-economic baseline

1.3.1 Baseline data on the following health determinants has also been gathered from a range of publicly accessible sources:

- employment and economy;
- housing;
- social capital;
- noise;
- local environment;
- physical activity;
- access to services and health care; and
- transport.

- 1.3.2 Relevant baseline data from the ES has also been reviewed, including information on:
- existing community facilities;
 - the existing noise environment; and
 - local environmental features (including green and open spaces and landscape characteristics).

2 Euston

2.1 Community profile

Demographic profile

Population trends

- 2.1.1 There are no signs that the trend in population growth in Camden is slowing. The population of Camden has grown rapidly over the 10 year period from 2003–2013, by approximately 12.4%, just less than the London average of 13.8%.¹ The 2014 mid-year population estimates for Camden put the current population at 234,846.² Camden's resident population is forecast to grow by 11.7% (26,300).³
- 2.1.2 In terms of age structure, Camden has a relatively young population, with a higher proportion of residents within the 15–29 and 30–44 age groups than the London or national average. However, those wards in closest proximity to the route, Regent's Park and St Pancras and Somers Town, are more aligned with the average age structure for London (albeit with significantly higher proportions of the 15–29 age group)⁴.

Indices of multiple deprivation

- 2.1.3 The English indices of multiple deprivation⁵ measures relative levels of deprivation at LSOA level, and is made up of seven 'domains' of deprivation (income; employment; health; education, skills and training; barriers to housing and services; crime; and living environment).
- 2.1.4 The area around Euston station shows a mixed pattern of deprivation, which is typical of inner London. The Regent's Park Estate and Somers Town, immediately west and east of Euston station respectively, have relatively high levels of deprivation, falling within the 20% most deprived LSOAs in England. The area around Harrington Street to the west of the station approach lines and within the Regent's Park Estate is the most deprived area in the locality, falling just within the top 10% most deprived LSOAs in England. This area falls directly within the AP3 revised scheme footprint and a number of properties here are proposed to be demolished.
- 2.1.5 The areas surrounding the Regent's Park Estate and Somers Town such as Camden to the north, Regent's Park to the far west, and Holborn to the south, have much lower levels of deprivation.

¹ <http://www.ons.gov.uk/ons/guide-method/compendiums/compendium-of-uk-statistics/population-and-migration/find-out-more/index.html> and <http://data.london.gov.uk/dataset/office-national-statistics-ons-population-estimates-borough/resource/c8457adc-cebd-4f77-97e7-02571c791b79>.

² ONS (2014) Mid – Year Population Estimates.

³ London Borough of Camden (2013), Research & Intelligence Briefing.

⁴ ONS (2011) Age structure.

⁵ Department for Communities and Local Government (2010). Indices of Deprivation.

Ethnicity

- 2.1.6 ONS data ⁶ indicates that 30% of Camden's overall population is estimated to be from a minority ethnic background, which is the same as the average across London and considerably higher than the figure of 14% for England as a whole.
- 2.1.7 The largest ethnic minority group in Camden is 'Asian or Asian British' (16.1%) with Bangladeshis making up 5.7% and Indians 2.8% of total population. A significant Asian community is centred on Drummond Street, to the west of Euston station. This LSOA also has a significant Chinese population at 8.7%, compared with a London average of 1.5%.
- 2.1.8 A large Bangladeshi community also exists, around Harrington Street, where most of the demolition of social housing will take place. In this location, Bangladeshis account for 28.1% of the population. There is also a fairly high proportion of 'Black/African/Caribbean/Black British: African' people in this LSOA, at 9.1 %, compared with 7% for London as a whole.

Social grade

- 2.1.9 In 2011 there was a significant percentage (23.9%) of the population in Regent's Park ward within the lowest social grade 'DE' (Semi-skilled and unskilled manual occupations, unemployed and lowest grade occupations).
- 2.1.10 On the east side of Euston station, in the ward of St Pancras and Somers Town, there is an even higher percentage of residents within the lowest social grades 'DE' at 33.1% which is significantly higher than the Camden, London and national averages of 17.7%, 22.4% and 25.5% respectively. ⁷

Health profile

Indices of Deprivation (IoD) health deprivation and disability

- 2.1.11 The IoD for health deprivation and disability measures health deprivation based on years of potential life lost, illness and disability, acute morbidity and mood and anxiety disorders⁸. Those LSOAs closest to Euston station and the proposed works all fall within the 20% most deprived on the IoD domain for health. The area around Park Village East to the north west of Euston station and close to the Park Street tunnels falls within the 10% most deprived on the IoD for health deprivation and disability.

Rates and incidence of disease

- 2.1.12 In terms of the rates and incidence of disease, statistics from Public Health England (PHE) show that Camden has a higher rate of heart disease and stroke, at 133.6 per 100,000 population compared with a London average of 118.6 and an England average of 114.5.

⁶ ONS (2011) Ethnic Group, 2011.

⁷ <http://www.nomisweb.co.uk/query/construct/summary.asp?reset=yes&mode=construct&dataset=566&version=0&anal=1&initset=>

⁸ Department for Communities and Local Government, Indices of Deprivation (2010): IOD for Health deprivation and disability.

- 2.1.13 Rates for cancer and respiratory disease in Camden are on or around the London and national averages⁹.

Obesity

- 2.1.14 Obesity levels amongst children in Camden are just above the London and similar to the England average, but obesity levels amongst adults are significantly lower than both the London and England averages.¹⁰

Mental health

- 2.1.15 According to the PHE community mental health profile (based on Clinical Commissioning Group data), the residents of Camden generally experience good mental health, with below England average levels of new diagnosis and unresolved depression amongst adults, low levels of emergency admissions for self-harm and low mortality rates for suicide and undetermined injury.¹¹ However, the percentage of residents with depression and anxiety, mental health problems and long-term mental health problem are higher.

Life expectancy

- 2.1.16 Life expectancy provides an indicator of the general health of a population and the differences in health between different populations and socio-demographic groups. PHE (2015) indicates that average life expectancy at birth (2011–2013) in England for males is 79.4 and for females, 83.1¹². In Camden, life expectancy for both males and females is higher than the English average, at 81.1 for males and 86.0 for females.

Vulnerable groups

- 2.1.17 The following groups have been identified as being particularly vulnerable to health impacts within the Euston area.

Ethnic minority groups

- 2.1.18 Many of the capital's ethnic minority communities suffer elevated levels of poverty, violence, unemployment and ill health¹³. Most of the city's ethnic minority groups are likely to experience unemployment rates at twice the national average, with direct impacts upon wealth and socio-economic class. There is a strong link between poverty and well-being. Those in high-risk groups for poverty are also more likely to suffer health problems.

Lower social grades

- 2.1.19 Differences in social grade are linked to health inequalities. As outlined above, the area immediately around Euston station contains a high proportion of people within the lowest social grades, with high numbers of residents being either on state benefit

⁹ Public Health England (2015), Camden Health Profile 2015.

¹⁰ Public Health England (2015), Camden Health Profile 2015.

¹¹ PHE (2014) Camden Community Mental Health Profiles 2014.

¹² PHE (2015) Camden Health Profile 2015.

¹³ <https://www.london.gov.uk/sites/default/files/ELCFA%20FINAL%20.pdf>.

or unemployed lowest grade workers. The majority of those in the lowest social grades are living within social housing on the Regent's Park and Somers Town estates.

Children

- 2.1.20 The Maria Fidelis secondary school is located on two sites either side of Euston station. The Lower School site is close to the works boundary on North Gower Street.
- 2.1.21 Other education facilities in the area include: Netley Primary School; Christ Church Church of England (CE) Primary School on Redhill Street and the Regent's Park Children's Centre. Further west, Francis Holland Schools is located on Ivor Place, off the A41 Park Road.

2.2 Employment and economy

- 2.2.1 In Camden, levels of employment amongst both men and women are just below the national average. Youth unemployment in Camden is relatively low; employment levels for those in the youngest age group (16–24) are significantly below the England and London averages¹⁴ due to the high student population.
- 2.2.2 Levels of employment in the area surrounding Euston station are relatively high compared with the England average, although there are a number of areas of low employment¹⁵. The area around Harrington Street on the Regent's Park Estate ranks within the 5% most deprived LSOAs for income, and 20% most deprived for employment. Additionally, most of the LSOAs in the Somers Town area fall within the 10% most deprived for employment.
- 2.2.3 The proportion of people classified as working in the construction industry in Camden is relatively low, at 2.9% compared with the London average of 6.6%. This figure rises to 3–5%¹⁶ in the areas of Somers Town and the southern part of the Regent's Park Estate. In the Harrington Street area, which is most directly affected by the works, the proportion of construction workers is around 1%.

2.3 Housing

- 2.3.1 The area to the immediate west of Euston station around Cobourg Street, Euston Street, Drummond Street and Melton Street is generally characterised by three-storey terraced properties of a range of ages. Starcross Street is generally characterised by four-storey flats
- 2.3.2 Somers Town to the east of Euston station is characterised by medium rise blocks of local authority housing, progressing to high rise blocks on the Ampthill Square Estate.
- 2.3.3 The Regent's Park district to the west of Euston station has a large quantity of social housing, primarily in and around the 1950s Regent's Park Estate. The estate is of relatively low density for a social housing estate, with a number of buildings, ranging from 3–8 storeys in height, located around squares, gardens and other open spaces.

¹⁴ ONS (2011), Annual Population Survey. As a proportion of working age population (16–64) by age and gender.

¹⁵ Department for Communities and Local Government, Indices of Deprivation (2010).

¹⁶ ONS (2011) Industry, 2011.

- 2.3.4 To the north west of Euston station, a mix of low rise housing including new detached houses to the north and five storey flats to the south, are located on Park Village East.
- 2.3.5 In terms of the IOD domain 'barriers to housing and services'¹⁷, the area on the eastern edge of the approach lines to Euston station and the area around Harrington Street on the Regent's Park Estate, both fall just within the 20% most deprived. All other areas on the Regent's Park Estate and Somers Town fall outside the 20% most deprived. However, in terms of the sub-domain 'wider barriers', which looks at only the housing element (including household overcrowding, homelessness and housing affordability) areas within the Regent's Park Estate generally fall within the 5-15% most deprived; areas on the Amptill Estate fall within the 10% most deprived; and LSOAs within Somers Town fall within the 5-10% most deprived, indicating that there are significant issues in terms of access to high quality housing in and around the area of Euston station.
- 2.3.6 Camden has a significant proportion of local authority owned housing (23,630 properties) as well as housing association owned property (11,389 properties). This equates to approximately 36% of all housing in Camden being social housing. This is significantly more than the 25% in the adjacent borough of Westminster, but significantly less than the 43% in the adjacent borough of Islington¹⁸.
- 2.3.7 Housing waiting lists indicate that in Camden in 2014 there were 22,409 households on the waiting list (excluding households looking for transfers). This represented 23% of all households in the borough. This was significantly more than in the neighbouring borough of Westminster where 7.3% of all households were on the housing waiting list; and more than the adjacent borough of Islington where 12.7% of all households were on the waiting list¹⁹. This indicates that demand for social housing within the borough outweighs availability.
- 2.3.8 LBC undertook a housing needs survey²⁰ of households potentially affected by HS2.
- 2.3.9 The housing needs survey reports that there are:
- 121 children living within the safeguarded area and 222 children living adjacent to the safeguarded area;
 - 8% of tenants will need disability alterations if rehoused;
 - four tenants will be interested in sheltered accommodation; and
 - other requirements that will be met by providing homes to a Lifetime Homes Standard.

¹⁷ Department for Communities and Local Government, Indices of Deprivation (2010).

¹⁸ GOV.uk. Table 100 Dwelling stock: Number of Dwellings by Tenure and district: England; 2011.

<http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/stockincludingvacants/livetable/>

¹⁹ Table 600 Rents, lettings and tenancies: numbers of households on local authorities' housing waiting lists, by district: England 1997-2011.

<http://www.communities.gov.uk/housing/housingresearch/housingstatistics/housingstatisticsby/stockincludingvacants/livetable/>.

²⁰ London Borough of Camden (2013) Housing Needs Survey for properties affected by the High Speed Two (HS2) plans in Camden.

2.4 Air quality

- 2.4.1 The Euston area lies in the south east of the LBC, although the City of Westminster (WCC) is also close to the boundary of the study area. Therefore, information has also been taken from relevant sources within WCC.
- 2.4.2 Monitoring in the vicinity indicates that many parts of the Euston area currently experience long-term and short-term average concentrations²¹ of NO₂ that exceed air quality standards, especially in close proximity to major roads. Monitoring and mapping data indicate that air quality standards for daily mean PM₁₀ have also been exceeded in recent years. Annual average PM₁₀ and PM_{2.5} concentrations currently meet the standards. Background map and monitoring data are presented in Volume 5: SES2 and AP3 ES Appendix AQ-001-001.
- 2.4.3 Whole borough Air Quality Management Areas have been designated by LBC and the WCC, as a result of NO₂ and PM₁₀ concentrations being in excess of the air quality standards for the annual and daily average respectively.
- 2.4.4 There are many receptors in the study area given its urban nature and the proximity of many residential properties and commercial premises to construction sites and roads where traffic flows will change (see Map AQ-01-001, Map AQ-02-001-01, Map AQ-02-001-02 and Map AQ-02-001-03, Volume 5 SES2 and AP3 Air Quality Map Book).

2.5 Noise

- 2.5.1 The existing baseline sound environment for this area is typical of urban central London.
- 2.5.2 Sound levels are high in close proximity to busy multi-lane roads, such as Euston Road, where daytime sound levels are typically around 75 dB²². However, due to the screening provided by buildings and other structures, sound levels can be much lower (typically 55 to 60dB) on side roads away from the major thoroughfares.
- 2.5.3 To the north of Euston station, sounds from existing trains (including 'wheel squeal'), traffic on Hampstead Road and other local roads contribute to the prevailing sound environment. Here, daytime sound levels are typically 65 to 70dB.
- 2.5.4 To the east of the station, sound from traffic on the A4200 Eversholt Street, a relatively busy road, dominates the sound environment and daytime sound levels are typically around 70dB. Side roads away from the station have lower sound levels, due to the screening effect of buildings and other obstacles between these locations and the main road traffic sound sources, resulting in daytime sound levels of typically 55 to 60dB.
- 2.5.5 Located to the south of the station is the A501 Euston Road, which is a very busy cross-London route. Local to this road, traffic movements, including many buses and HGV, generate sound levels during the day of around 75dB. Further to the south,

²¹ Long-term concentrations are usually described by the annual average concentration. Short-term concentrations refer to those which are measured as daily or hourly averages and for which air quality standards refer to peak concentrations.

²² Quoted dB values at residential areas refer to the free-field 16 hour daytime (07:00 to 23:00) equivalent continuous sound pressure level, L_{pAeq,16hr}.

smaller side roads can be screened from the busy main roads typically experiencing sound levels around 65dB. Local traffic still dominates the sound environment.

- 2.5.6 To the west of the station, at St James’s Gardens and adjacent areas, sound levels are relatively low for an urban environment. Daytime levels are typically around 55dB, due to the screening of the main road traffic sound by buildings and other obstacles. The playground of Maria Fidelis (Lower) School borders St James’s Gardens and also experiences existing sound levels which are relatively low for such an urban location.
- 2.5.7 Night-time sound levels²³ across the area are 2 to 4dB lower than the daytime level where it is dominated by road traffic on busy main roads and 5 to 8dB lower in locations further away from these roads.

2.6 Local environment

Local character

- 2.6.1 The immediate area around Euston station is currently characterised by the large scale of the station building and the depots and warehouses along Cardington Street and Barnby Street, and the high-rise offices to the front of the station.
- 2.6.2 Somers Town to the east of Euston station is characterised by medium- and high-rise blocks of local authority housing, as well as Camden High Street and the Georgian terraces at Mornington Crescent to the north.
- 2.6.3 The Regent’s Park district, to the west of Euston station is characterised by a relatively low density for a social housing estate, with a number of buildings, ranging from 3–8 storeys in height, located around a variety of squares, gardens and other open spaces.

Green spaces

- 2.6.4 Key areas of greenspace likely to be affected by the proposed works include:
- St James’s Gardens to the west of Euston station;
 - Euston Gardens to the immediate south of Euston station;
 - Eskdale Play Area on the Regent's Park Estate, located to the west of Stanhope Street; and
 - Hampstead open space on the west side of Hampstead Road – including a children’s playground.
- 2.6.5 Other areas of open space in close proximity to the works include:
- Cumberland Market, Munster Square, Clarence Gardens, Hope Gardens on the Regents Park Estate; and
 - Tolmers Square between North Gower Street and the Hampstead Road.

²³ Night-time sound levels refer to the free-field 8 hour night-time (23:00 to 07:00) equivalent continuous sound pressure level, $L_{pAeq,8hr}$.

2.7 Physical activity

- 2.7.1 Within Camden, levels of physical activity amongst adults (i.e. those achieving at least 150min physical activity per week) is above the London and England average²⁴. Previous data had shown that levels were just below the London and England average.
- 2.7.2 No updated data was available for child physical activity.²⁵ The 2013 Child health profile indicated that Amongst children, levels of physical activity (percentage of school children who participate in at least 3 hours of high quality PE and school sport within and beyond the curriculum) are just above the London and England average²⁶.
- 2.7.3 Existing opportunities for exercise within the works area include:
- a multi-use games area, including a basketball/five-a-side football court in the eastern corner of St James's Garden Open Space;
 - Eskdale Play Area on Stanhope Street in the north of the Regent's Park Estate;
 - Hampstead Road Open Space on the west side of Hampstead Road – including children's playground; and
 - a children's playground on Lancing Street to the north of Wellesley House.

2.8 Access to services

- 2.8.1 Services available in the local area include:
- a range of food and retail outlets within Euston station and a number of food and drink establishments on the plaza to the south of the main station building;
 - a range of convenience stores, specialist ethnic food shops, pubs and restaurants on Drummond Street to the immediate west of the existing Euston station;
 - numerous shops, restaurants and public houses;
 - small parade of shops and restaurants on Hampstead Road;
 - small parade of shops on Stanhope Street on the Regent's Park Estate; and
 - shops and services along Parkway, just to the east of the route, including a cinema, bank and several public houses.
- 2.8.2 There is also an educational establishment in the local area, which is the Maria Fidelis School on North Gower Street.

²⁴ PHE (2015), Camden Health Profile 2015.

²⁵ PHE (2015), Camden Child Health Profile 2015.

IOD geographical barriers sub-domain (barriers to housing and services)

- 2.8.3 No LSOAs in the Euston area fall within the 5%-20% most deprived in terms of the geographical barrier sub-domain within the barriers to 'housing and services' IOD. Two LSOAs (that cover the station and the roads to the west around Euston Street, Cobourg Street and Drummond Street and the west side of Euston station) fall within the 5% least deprived, the Ampthill Estate area north of Euston station falls within the 10% least deprived and the east side of Euston station falls within the 20% least deprived²⁷.

2.9 Traveller stress

Road networks

- 2.9.1 Key road routes crossing the proposed works and likely to be directly affected by them include:
- A501 Euston Road which runs along the front of Euston station;
 - A400 Hampstead Road which crosses the railway just north of Euston station;
 - Granby Terrace which crosses the railway just north of the Hampstead Road Crossing;
 - Mornington Street;
 - A4201 Parkway; and
 - A4200 Eversholt Street.

Public transport networks

- 2.9.2 Euston station is a major transport interchange and a terminus for intercity and local trains. The station is served by two London Underground (LU) lines. These are the Victoria and the Northern Line (both Charing Cross and Bank branches). Euston Square underground station, which is served by the Circle, Hammersmith & City and Metropolitan Lines, is about 300m from Euston station, west along Euston Road. There is a bus station served by 12 bus routes at the front of the station and a taxi rank under the station.

2.10 Social capital

- 2.10.1 'Social capital' comprises connections between individuals within and between communities, and the inclination that arises through these networks for individuals to feel valued, to feel a sense of belonging, to have companionship and to tangibly support each other.

²⁷ Department for Communities and Local Government (2010): LSOA level sub-domain scores for the Barriers to Housing and Services domain from the Indices of Deprivation.

Community facilities

- 2.10.2 The key community facilities in the area directly affected by the proposed works are The Old Tenants Hall on Harrington Street in the Regent's Park Estate and the Bree Louise public house on Euston Street.
- 2.10.3 Other community facilities are located within 500m of the proposed works but they are not affected by the proposed works.

Social capital

- 2.10.4 A 2012 residents' survey found in relation to social capital that 91% of residents were fairly or very satisfied with their local area as a place to live (an increase on the 2008 survey described below); 81% felt that they fairly or very strongly belonged to their local area; 79% tended to agree or definitely agreed that they were proud of the local area; 70% felt that they tended to agree or definitely agreed that they have a choice about whether they lived in the local area or not; and 82% felt that they tended to agree or agreed that that the local area was a place where people of different backgrounds get on well together (and increase on the 2008 survey described below).²⁸
- 2.10.5 A 2008 survey of social capital in Camden looked at trust and reciprocity; perception of and identification with neighbourhood; control and self-efficacy, participation, social engagement and commitment, social interaction, social networks and social support; and cohesion, respect and diversity.
- 2.10.6 The survey identified that there appears to be a strong sense of social cohesion amongst residents, with the majority of residents (56%) agreeing that their neighbourhood is a place where people from different cultures and religions get on well together. Nearly nine in ten (87%) of residents are satisfied with their neighbourhood as a place to live, which is higher than the national average of 78%. Furthermore, residents generally agree that they feel part of the local neighbourhood (74%).
- 2.10.7 However, there appears to be a slight degree of contradiction in perceptions, as the survey results indicate that there has been a decline of six percentage points since 2005 in terms of the proportion of residents who agree their neighbourhood has a good sense of community (from 73% to 67%). Similarly, more residents in 2008 now believe that most people are trying to move out of their area (20% in 2008 compared to 14% in 2005), and that nobody cares about the neighbourhood (19% compared to 17%).

²⁸ London Borough of Camden (2012), Headline Results from Residents' Survey 2012.

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