



High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

Health

Route-wide commentary on health evidence base (HE-003-000)



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1 Introduction

- 1.1.1 This document provides a commentary on the links between the health determinants (environmental, social and economic factors known to influence health) that are assessed in the health impact assessment (HIA) presented in the High Speed Rail (West Midlands - Crewe) Environmental Statement (ES), and the resulting effects on health and wellbeing, based on a review of available primary¹ and secondary² literature.
- 1.1.2 The purpose of this document is to provide an overview of the scientific consensus on the types of health outcome associated with impacts on health determinants. This evidence base underpins the assessment of the health and wellbeing effects of the Proposed Scheme reported in Volumes 2³, 3⁴ and 5⁵ of the ES.
- 1.1.3 Volume 5: Appendices HE-001-001 to HE-001-005 present the health assessment matrices for each of the community areas (CA).
- 1.1.4 In addition, health profile information for the community areas is set out in Background Information and Data (BID)⁶, (see BID-HE-002-001 to BID-HE-002-005: Community area health profiles).
- 1.1.5 The operational sound, noise and vibration assessment is based on the methodology set out by the Department for Environment, Food & Rural Affairs (Defra)⁷. A summary of this guidance, and the evidence behind it, is included in Volume 5: Appendix SV-001-000.

¹ A primary source is also called an original source and is any source of information that was created at the time under study. Secondary sources are typically based on primary sources

² A secondary source is a source that documents an event, period, or issue in history that was produced after the event, period or issue has happened. These include textbooks and literature reviews

³ See ES Volume 2, Community area reports

⁴ See ES Volume 3, Route-wide effects

⁵ See ES Volume 5, Appendices

⁶ HS2 Ltd (2017), *High Speed Two (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data*, www.gov.uk/hs2.

⁷ Defra (2014), *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-impacts-PB14227.pdf.

2 Scope and methodology

2.1 Scope of the review

2.1.1 This document provides a commentary on the consensus of scientific opinion based on available published evidence and is focused on two key areas:

- a review of available evidence linking changes in health determinants with health outcomes, using mainly secondary sources such as literature reviews; and
- a review of available evidence relating specifically to high speed rail, conventional rail, road or other major infrastructure projects, using both primary and secondary sources.

2.1.2 In order to set clear parameters for the review and to focus on the most up to date evidence, a time limit of 10 years was set for the literature search. Peer reviewed and non-peer reviewed literature from the year 2006 to the present have been searched. A review has been undertaken and a summary of the evidence is provided, with a focus on secondary evidence such as literature reviews that represent a scientific consensus on the available evidence. Examples of primary source articles are also included where these are considered to exemplify the weight of the literature on a particular finding. Based on this review and summary the strength of evidence has then been evaluated.

2.1.3 The review has searched for evidence from the UK and high-income/developed countries internationally (e.g. those in Europe, North America, and Australia, New Zealand, Japan, South Korea and Taiwan). This is because these countries are likely to have the most comparable public and environmental health legislative and regulatory context and have implemented major rail or similar linear projects.

2.2 Literature sources

2.2.1 The review has included online search engines and key databases including:

- Google and Google Scholar;
- Biomed Central;
- JSTOR;
- NICE Evidence Search;
- Pubmed;
- ScienceDirect; and
- Scientific American.

2.3 Search for evidence on health determinants

2.3.1 The topics covered in this review correspond to the health and wellbeing determinants that have been assessed in the health sections of the ES, as set out in

the Scope and Methodology Report (SMR)⁸ and its Addendum⁹. These are listed below.

- 2.3.2 The following health determinants are assessed in Volume 3 (Route-wide effects):
- employment and income;
 - housing; and
 - transport.
- 2.3.3 The health effects of operational sound, noise and vibration are also assessed in Volume 3. This assessment is based on the Department for Transport's (DfT) WebTAG methodology, which is described in Volume 5: Appendix SV-001-000.
- 2.3.4 The following health determinants are assessed in Volume 2 (Community area reports):
- neighbourhood quality (amenity value of the local environment including noise, dust, visual amenity, traffic and safety);
 - access to green space and physical activity;
 - access to local services;
 - education; and
 - social capital.
- 2.3.5 Local and route-wide exposure to air quality impacts have been scoped out of the health assessment, as the level of overall exposure and changes in exposure to airborne pollution and dust are considered to be too low to potentially affect health and wellbeing. Therefore information on links between air quality and health and wellbeing are not included in this review.
- 2.3.6 The available literature on links between the above determinants and health outcomes is, in general, not explicitly related to infrastructure projects. The search terms used in relation to broad determinants of health included 'health' OR 'wellbeing' OR 'well-being' AND:
- education / training / employment / unemployment / jobs / income / regeneration;
 - transport / active transport / active travel / connectivity;
 - housing / residential;
 - social capital / isolation;
 - green space / greenspace / open space / nature;
 - sense of place / built environment;

⁸ *Environmental Impact Assessment Scope and Methodology Report*, Volume 5: Appendix CT-001-001

⁹ *Environmental Impact Assessment Scope and Methodology Report Addendum*, Volume 5: Appendix CT-001-002

- crime / fear of crime / safety / anti-social behaviour;
- physical activity / exercise; and
- local services / local facilities / neighbourhood services / access to services.

2.3.7 The amount of research on links to health outcomes varies between the determinants. However, in total, this amounts to a wealth of primary evidence, a comprehensive review of which is considered to be beyond the scope of this health assessment. Therefore, the review is mainly focused on secondary sources that reflect a scientific consensus on the available evidence. This includes literature reviews and peer-reviewed journal articles on systematic reviews relating to health determinants.

2.4 Search for evidence on high speed rail and comparable infrastructure projects

2.4.1 A literature review commissioned by HS2 Ltd¹⁰ in relation to Phase One (London to West Midlands) indicated that there is a lack of research focused on the health and wellbeing effects of high speed rail or other major infrastructure projects. This review has prioritised evidence relating to the health and wellbeing effects of high speed rail projects. In recognition of the scarcity of studies, the scope of this search has been broad, encompassing conventional rail and other linear and non-linear infrastructure projects.

2.4.2 The search has looked for evidence from the UK and other high-income/developed countries (e.g. those in Europe, North America, and Australia, New Zealand, Japan, South Korea and Taiwan). In order to capture all the available evidence, the review has not been limited to secondary sources but has sought information from individual articles, evidence-based editorials, and opinion and perspectives pieces.

2.4.3 The search terms used in relation to infrastructure projects included 'health' OR 'wellbeing' OR 'well-being' AND:

- high speed rail / rail;
- linear infrastructure / infrastructure / large scale infrastructure;
- major project / large scale project / highway project / motorway project; and
- above search terms AND (construction OR operation).

2.5 Evaluating the strength of evidence

2.5.1 The strength of evidence for potential health outcomes associated with health determinants has been evaluated and classified as follows:

- strong: a wide range of peer-reviewed research studies showing similar associations. 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;

¹⁰ HS2 Ltd (2015), *Health impact assessment addendum*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460717/Health_impact_assessment_addendum_-_Euston_station_and_approach_area.pdf.

- moderate: a range of peer-reviewed research studies showing similar associations. The association is widely accepted by the public health community, though there may be debate about the specific causal factors, the mechanism of effect and/or the strength of association; or
- weak: a few peer-reviewed / non-peer reviewed research studies to suggest an association, or studies showing conflicting findings.

2.5.2 It should be noted that weak evidence does not necessarily indicate an absence of association between a health determinant and a health outcome, but shows that there is uncertainty in the assessment of the likely effect.

3 Commentary on evidence for health determinants

3.1 Employment and income

- 3.1.1 There is a large body of evidence linking employment and income levels with health. The World Health Organization (WHO) identifies a list of health determinants¹¹ that combine to affect the health of individuals and communities. Included in this list is: *'income and social status - higher income and social status are linked to better health. The greater the gap between the richest and poorest people, the greater the differences in health'*.
- 3.1.2 The Marmot Review, published in 2010¹², was commissioned by the Department of Health to look into health inequalities in England and focused on correlations between health and wellbeing and the socio-economic status of communities. The report identified six evidence-based policy objectives to reduce health inequalities, one of which was to create fair employment and good work for all. The Review stated that *'being in good employment is protective of health. Conversely, unemployment contributes to poor health'*. This study also identifies links between educational attainment and physical and mental health.
- 3.1.3 Much of the literature on this topic is focused on the increased likelihood of poor health in low income groups. For example, a large-scale study by Wapner in 2015¹³ showed that disadvantaged adolescents reported lower levels of physical activity and higher levels of bodily aches and pains, sleeplessness and emotional difficulties, such as nervousness and irritability, than more advantaged teenagers.
- 3.1.4 A wide range of mechanisms for the health benefits of employment, as well as the negative effects of unemployment, have been suggested. For example, a study by Olesen *et al* in 2013¹⁴ cites numerous references indicating that the health benefits of employment *'are believed to reflect a combination of material (e.g., income and the resulting access to resources) and psychological outcomes, such as social role and status, access to social networks and support, and a sense of purpose/achievement'* and that *'in contrast, excluded individuals experience a set of multiple, and often entrenched, disadvantages including limited social support and networks, inadequate financial resources, and poor employment and health'*. A literature review by Kim *et al* in 2015¹⁵ identified higher incidence of poor self-rated health, mental illness, physical complaints such as coronary heart disease, and higher all-cause mortality in unemployed people compared with those in employment.
- 3.1.5 Based on the criteria set out in Section 2.5 above, the evidence linking income and employment to health and wellbeing is considered to be strong.

¹¹ World Health Organization (2017), *Health Impact Assessment - The determinants of health*, <http://www.who.int/hia/evidence/doh/en/>.

¹² 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

¹³ Wapner, J. (2015), *Money is driving a wedge in teen health*, Scientific American

¹⁴ Olesen, S., Butterworth, P., Leach, L., Kelaher, M. & Pirkis, J. (2013), *Mental health affects future employment- as job loss affects mental health: findings from a longitudinal population study*, BMC Public Health

¹⁵ Kim, T. and Knesbeck, O. (2015), *Is an insecure job better for health than no job at all? A systematic review of studies investigating the health-related risks of both job insecurity and unemployment*, BMC Public Health

3.2 Education

- 3.2.1 There is a large body of evidence linking education, employment and income levels with health. The WHO identifies a list of health determinants¹⁶ that combine to affect the health of individuals and communities. Included in this list is: *'education – low education levels are linked with poor health, more stress and lower self-confidence'*.
- 3.2.2 The majority of evidence linking education with health outcomes looks at educational attainment in the context of broader socio-demographic status. An evidence review by the Joseph Rowntree Foundation¹⁷ states that improved qualifications can lead to better wages and employment, providing greater access to the health benefits associated with good, secure employment. A University of London report by Feinstein *et al* in 2008¹⁸ on the social and personal benefits of learning states that *'people with better qualifications are more likely to have healthy lifestyles, to be fitter and slimmer – and such health advantages can be transferred to the next generation at the earliest age'*. A recent evidence review undertaken in the US¹⁹ states that *'education is critical to social and economic development and has a profound impact on population health'*. However, it goes on to note that *'the factors surrounding the relationship between education and health are the subject of research in different disciplines that are of uneven quality, and closing the many holes in the evidence is a research priority'*.
- 3.2.3 Based on the criteria set out in Section 2.5 above, the evidence linking education to health and wellbeing is considered to be moderate.

3.3 Housing

- 3.3.1 The WHO states that *'poor housing and indoor environments cause or contribute to many preventable diseases and injuries, such as respiratory, nervous system and cardiovascular diseases and cancer'*²⁰. Most research related to housing is focused on health impacts associated with the internal environment, where there is occurrence of damp, mould, low temperatures, overcrowding, noise and poor conditions. For example, a study across 45 countries found that a total of approximately 83 child deaths from asthma per year were associated with mould in homes and that, across 11 European countries, approximately 38,200 annual excess winter deaths were related to low indoor temperatures²¹.
- 3.3.2 Associations have also been found between housing tenure and physical and mental health. A recent cross-sectional study has shown that people living in social housing experience worse health outcomes than owner-occupiers²². This is attributed to a number of factors: environmental quality is often worse in social housing due to poor design and lower levels of maintenance, and mental wellbeing and self-esteem are

¹⁶ World Health Organization (2017), *Health Impact Assessment- The determinants of health*, <http://www.who.int/hia/evidence/doh/en/>.

¹⁷ Rowntree, J. (2014), *Reducing Poverty in the UK: A collection of evidence reviews*, Joseph Rowntree Foundation

¹⁸ Vorhaus, J., Duckworth, K., Budge, D. and Feinstein, L. (2008), *The Social and personal benefits of learning: A summary of key research findings*, Centre for Research on the Wider Benefits of Learning, Institute of Education, University of London, London

¹⁹ Zimmerman, E., Woolf, S. and Haley, A. (2016), *Understanding the Relationship Between Education and Health: A Review of the Evidence and an Examination of Community Perspectives*, AHRQ

²⁰ World Health Organization (2017), *Housing and health*, <http://www.euro.who.int/en/health-topics/environment-and-health/Housing-and-health>.

²¹ Braubach, M., Jacobs, D. and Ormandy, D. (2011), *Environmental burden of disease associated with inadequate housing*, World Health Organisation Europe Report

²² Ellaway, A., Macdonald, L. and Kearns, A. (2016), *Are housing tenure and car access still associated with health? A cross-sectional study of UK adults over a 13 year period*, British Medical Journal

improved when people feel they live in desirable homes or neighbourhoods. Social housing in the UK is often associated with anti-social behaviour, and lower levels of perceived safety; the Scottish Household Survey²³ found social renters reported antisocial behaviour 2-3 times more often than owner-occupied.

- 3.3.3 According to the 2011/12 Subjective Well-being Annual UK Population Survey dataset²⁴, 80% of those who owned their property reported 'medium' or 'high' levels of life satisfaction, compared with 67.8% of those who rented. Of those in rented accommodation, 0 to 6 out of 10 reported 'low' satisfaction with life, compared with 1 in 5 of those who owned their accommodation outright or with a mortgage.
- 3.3.4 The process of residential relocation is a stressful life event, and involuntary residential relocation may have particular consequences including increased stress and isolation. The majority of evidence in this area is outside the date range for this review. However studies have been found that suggest involuntary residential relocation can have a negative impact on wellbeing, particularly for older people^{25, 26}.
- 3.3.5 Based on the criteria set out in Section 2.5 above, the evidence linking the status and condition of housing to health and wellbeing is considered to be moderate.

3.4 Transport

- 3.4.1 This section focuses on traveller stress and road safety, in line with the assessment of the health effects of transport in Volume 3 (Route-wide effects) of the ES. Transport can also affect health determinants through noise and air emissions, accessibility, social capital, active travel, employment and economic effects, and evidence relating to these health determinants is reviewed elsewhere in this document. It should be noted that, since HS2 Phase 2a (West Midlands - Crewe) does not include any stations, direct transport and connectivity effects arising from the Proposed Scheme are not relevant. Therefore this section focuses on the impacts of the Proposed Scheme on road transport.

Traveller stress

- 3.4.2 Journey ambience is identified as an appraisal criterion in the Government's 2013 Transport Analysis Guidance²⁷ and comprises three factors, one of which is traveller stress. The guidance defines traveller stress as '*the adverse mental and physiological effects experienced by travellers*'. The guidance states that '*the three factors influencing traveller stress are identified as 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 ... The extent of stress will depend on the traveller's driving skill and experience, temperament, knowledge of the route and state of health.*' Influences on frustration are identified as including '*a driver's inability to drive at a*

²³ Ellaway, A., Macdonald, L. and Kearns, A. (2016), *Are housing tenure and car access still associated with health? A cross-sectional study of UK adults over a 13 year period*, British Medical Journal

²⁴ Randall, C. (2012), *Measuring National Well-Being – Where we live*, Office for National Statistics

²⁵ Saito, T., Lee, H. and Kai, I. (2007), *Health and motivation of elderly relocating to a suburban area in Japan*, Archives of Gerontology and Geriatrics.

²⁶ Wu, Y., Prina, A., Barnes, L., Matthews, F. and Brayne, C. (2015), *Relocation at older age: results from the cognitive function and aging study*, Journal of Public Health

²⁷ Department of Transport (2013), *Transport analysis guidance: WebTAG*, <https://www.gov.uk/guidance/transport-analysis-guidance-webtag>.

speed consistent with his or her own wishes relative to the standard of the road (e.g. congestion), or delays on public transport’.

- 3.4.3 Based on the criteria set out in Section 2.5 above, the evidence linking traveller stress to health and wellbeing is considered to be weak.

Road safety

- 3.4.4 Additional heavy goods vehicles (HGVs) on the road network can influence the risk of serious accidents and fatalities, particularly those involving non-motorised vehicles. According to the DfT figures²⁸ there were 6,037 accidents in 2015 involving at least one HGV, with 8,344 casualties of which 284 were fatal.
- 3.4.5 According to the Government’s Transport Analysis Guidance, 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. DfT figures²⁹ show that there were around 81 fatal or serious accidents involving HGVs per billion HGV vehicle miles in 2015. 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.
- 3.4.6 Based on the criteria set out in Section 2.5 above, the evidence linking road safety to health and wellbeing is considered to be strong.

3.5 Social capital

- 3.5.1 A 2014 Office for National Statistics (ONS) paper, Measuring Social Capital³⁰, provides the following definition of social capital: *‘In general terms, social capital represents social connections and all the benefits they generate. The benefits for people having these social connections can occur either at an individual level (for example, through family support) or at a wider collective level (for example, through volunteering). Social capital is also associated with values such as tolerance, solidarity or trust. These are beneficial to society and are important for people to be able to cooperate.’*
- 3.5.2 The ONS has looked at social capital as part of its Measuring National Well-being (MNW) programme. This programme identifies four aspects of social capital, based on work undertaken by Scrivens *et al* in 2013 for the Organisation for Economic Co-operation and Development (OECD)³¹. These aspects are:
- personal relationships;
 - social network support;
 - civic engagement and trust; and
 - cooperative norms.

²⁸ Department for Transport (2016), *Domestic Road Freight Statistics*, <https://www.gov.uk/government/collections/road-freight-domestic-and-international-statistics>.

²⁹ Department for Transport (2015), Road freight economic, environmental and safety statistics, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/405225/road-freight-economic-environmental-and-safety-statistics-2013.pdf.

³⁰ Siegler, V. and Office for National Statistics (2014), *Measuring Social Capital*, Office for National Statistics

³¹ Scrivens, K. and Smith, C. (2013), *Four interpretations of social capital: an agenda for measurement*, OEDC

- 3.5.3 The 2014 ONS paper includes a review of academic studies on social capital and its effects on health. The evidence suggests that social capital makes a positive contribution to a range of well-being aspects such as personal well-being, health and crime rates, and that these benefits occur at individual, community, regional and national level. In the same paper, the ONS cites evidence to suggest that *'people with a good range and frequency of social contact report higher levels of life satisfaction and happiness, but also better mental health. However, people with poorer health, particularly mental health, have been reported to have significantly smaller social networks. Personal relationships are important for individual well-being, but can also have positive outcomes for firms and organisations, and at a community level'*. The evidence also suggests that *'more socially isolated people are more at risk of risky behaviours such as smoking, drinking, physical inactivity and poor diet'*.
- 3.5.4 An article published in the International Journal for Equity in Health by Uphoff *et al* in 2013³² describes social capital, at an individual level, as focusing on personal resources that emerge from social networks where individuals have good access to information, services and support. The article argues that cultural and socioeconomic aspects can act as a barrier to social capital. For example, some types of social capital may only be beneficial to those who have access to them through sufficient economic capital, such as expensive sports clubs.
- 3.5.5 A study by Nieminen *et al* in 2013 published in BMC Public Health³³ states that *'the value of social capital lies in social networks, norms and trustworthiness that arise from society, communities and households'*. This study identifies associations between health behaviours and social capital: in Sweden lower trust in communities and families led to increased alcohol consumption; in England strong social support networks were associated with increased healthy eating; and in Finland those with higher social participation and networks exhibited healthier behaviours. A study by McPherson *et al* in 2014 published in BMC Psychology³⁴ found that *'social capital can affect the norms and attitudes that influence health behaviours. It can be generated at a family and community level and can influence mental health and behaviour from a young age'*.
- 3.5.6 Based on the criteria set out in Section 2.5 above, the evidence linking social capital to health and wellbeing is considered to be moderate.

3.6 Neighbourhood quality

- 3.6.1 The neighbourhood quality section of the health assessment considers the health effects resulting from the impacts of the construction and operation of the Proposed Scheme on the quality and amenity of the environment in which people live their day to day lives. These include: visual impacts and changes to the character of the local landscape; changes in perceived safety resulting from physical changes such as the re-

³² Uphoff, E., Pickett, K., Cabieses, B., Small, N. and Wright, J. (2013), *A systematic review of the relationships between social capital and socioeconomic inequalities in health: a contribution to understanding the psychosocial pathway of health inequalities*, International Journal for Equity in Health

³³ Nieminen, T., Prattala, R., Martelin, T., Harkanen, T., Hyyppa, M., Alanen, E. and Koskinen, S. (2013), *Social capital, health behaviours and health: a population-based associational study*, BMC Public Health

³⁴ McPherson, K., Kerr, S., McGee, E., Morgan, A., Cheater, F., 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

routing of Public Rights of Way (PRoW) and the presence of construction sites; increased HGV movements; and changes to the noise environment.

- 3.6.2 The scope of this health determinant is broad, since neighbourhood quality is influenced by a range of factors. This evidence review considers links to health and wellbeing associated with aspects of neighbourhood quality that may be impacted by the Proposed Scheme.

Landscape and visual

- 3.6.3 In 2013, a Position Statement by the Landscape Institute³⁵ looked at evidence linking the quality of places with health and wellbeing across a range of environmental, social and lifestyle determinants. This document cites evidence to suggest that health and wellbeing are influenced positively by factors such as the attractiveness, noise and other pollution, and the perceived safety of the environment. Similarly, a report by Cubbin *et al* in 2008 for the Commission to Build a Healthier America³⁶ identified links between health outcomes and the physical characteristics of neighbourhoods, including issues such as air quality, safety and traffic, alongside a range of social and neighbourhood service characteristics.
- 3.6.4 A literature review by Abraham *et al* in 2010 of over 120 studies³⁷ identified a set of pathways that link landscape and health. The study found that: '*Landscapes have the potential to promote mental well-being through attention restoration, stress reduction, and the evocation of positive emotions; physical well-being through the promotion of physical activity in daily life as well as leisure time and through walkable environments; and social well-being through social integration, social engagement and participation, and through social support and security.*' Another study by Seresinhe *et al* in 2015³⁸ sought to quantify the relationship between environmental aesthetics and human health by comparing geographic data against self-rated health. This found that '*inhabitants of more scenic environments report better health, across urban, suburban and rural areas, even when taking core socioeconomic indicators of deprivation into account, such as income, employment and access to services.*'

Perceived safety and security

- 3.6.5 A literature review by Lorenc *et al* BMC literature review³⁹ looked at 40 studies to review and synthesize qualitative evidence from the UK on fear of crime and the environment. The review found that, while environmental factors may influence fear of crime, including visibility and signs of neglect, factors in the local social environment appear to be more important as drivers of fear of crime.

³⁵ Landscape Institute (2013), *Public Health and Landscape – Creating healthy places*, https://www.landscapeinstitute.org/PDF/Contribute/PublicHealthandLandscape_CreatingHealthyPlaces_FINAL.pdf.

³⁶ Cubbin, C., Pedregon, V., Egarter, S. and Braveman, P. (2008), *Where we live matters for our health: Neighbourhoods and health*, Commission to build a Healthier America

³⁷ Abraham, A., Sommerhalder, K. and Abel, T. (2010), *Landscape and well-being: a scoping study on the health-promoting impact of outdoor environments*, International Journal of Public Health

³⁸ Seresinhe, C., Preis, T. and Moat, H. (2015), *Quantifying the Impact of Scenic Environments on Health*, Scientific Reports

³⁹ Lorenc, T., Petticrew, M., Whitehead, M., Neary, D., Clayton, S., Wright, K., Thomson, H., Cummins, S., Sowden, A. and Renton, A. (2013), *Fear of crime and the environment: systematic review of UK qualitative evidence*, BMC Public Health

- 3.6.6 The Department for Communities and Local Government's 2008 Place Survey⁴⁰ showed that personal safety and low levels of crime are highly valued; 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. A study by Stafford *et al* in 2007 in the American Journal of Public Health⁴¹ found evidence to suggest that fear of crime was a contributory factor in some adverse health outcomes. The study suggested that fear of crime can impact mental health by increasing anxiety and decreasing trust and community participation, and has been linked to reducing people's willingness to participate in physical activity⁴².
- 3.6.7 In 2012, Lorenc *et al*⁴³ highlighted that crime and fear of crime have a substantial impact on health but the pathways are often indirect and mediated by environmental factors. For example, the built environment may affect wellbeing by increasing fear of crime due to poor design or quality.

Noise environment

- 3.6.8 According to the WHO⁴⁴, *'excessive noise seriously harms human health and interferes with people's daily activities at school, at work, at home and during leisure time. It can disturb sleep, cause cardiovascular and psychophysiological effects, reduce performance and provoke annoyance responses and changes in social behaviour'*.
- 3.6.9 A report commissioned by the Noise Association in 2008⁴⁵ gathered qualitative, anecdotal evidence for the effects on people of traffic noise in rural areas. This concluded that: *'Even in lightly populated rural areas disturbance from traffic noise has become problematic, in places severe. Parts of the countryside are subject to levels of traffic noise that are a significant source of unpleasantness for people living, working or taking leisure there.'* It also stated that: *'Although noise levels and acute disturbance are greatest close to roads, in the rural areas studied disturbance was reported from a much wider corridor (1 – 2 miles or more either side of the road) to a degree such that some respondents chose to visit the area less or not at all ... Many reports were received of people avoiding otherwise pleasant countryside areas because traffic noise detracts so much from the experience, even for locations amongst Britain's most scenic places. Of those who choose to visit nevertheless, some find the experience to be noticeably degraded by noise. The most common reactions to encountering traffic noise in otherwise pleasant countryside were expressions of frustration and loss.'*
- 3.6.10 A European Commission publication in 2015⁴⁶ cited evidence that *'living in a quiet area has a positive impact on health. A study assessed quality of life for people living in quiet and noisy locations and found that those who lived in quiet locations – particularly in rural areas – had a better quality of life'*. A literature review by van Kamp and Davies in

⁴⁰ Department for Communities and Local Government, Place Survey (2008),

<http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/documents/statistics/pdf/1326142.pdf>.

⁴¹ Stafford, M., Chandola, T. and Marmot, M. (2007), *Association Between Fear of Crime and Mental Health and Physical Functioning*, American Journal of Public Health

⁴² Jackson, J. and Stafford, M. (2009), *Public health and fear of crime*, British Journal of Criminology Advance

⁴³ Lorenc, T., Clayton, S., Neary, D., Whitehead, M., Petticrew, M., Thomson, H., Cummins, S., Sowden, A. and Renton, A. (2012), *Crime, fear of crime, environment, and mental health and wellbeing: mapping review of theories and causal pathways*, Health Place

⁴⁴ World Health Organization (2017), Noise, <http://www.euro.who.int/en/health-topics/environment-and-health/noise>.

⁴⁵ UK Noise Association, Traffic Noise in Rural Areas, 2008, http://www.ukna.org.uk/uploads/4/1/4/5/41458009/rural_traffic_noise.pdf.

⁴⁶ European Commission, Science for Environment Policy, Thematic issues: Noise impacts on health (2015), <http://ec.europa.eu/environment/integration/research/newsalert/pdf/47si.pdf>.

2013⁴⁷, cited in the aforementioned European Commission publication, looked at 62 papers published from April 2006 to April 2011, which included the impact of environmental noise on the health of vulnerable people, including primary school children, young adolescents, preschool children, the elderly, and children with autism, asthma and attention deficit hyperactivity disorder. This found that, while vulnerable groups of people may be more at risk from exposure to environmental noise than healthy adults, there is comparatively little research focusing on the adverse health effects of noise on vulnerable people.

Traffic

- 3.6.11 In addition to noise, the presence of HGVs may affect perceptions of neighbourhood quality, particularly in relation to road safety. No evidence has been found linking concerns about road safety with perceived wellbeing or neighbourhood quality, but there is evidence from a study conducted by the DfT in 2011⁴⁸ that perceived risks can affect people's behaviours and the way they use their local environment.
- 3.6.12 Neighbourhood quality is a broad topic, incorporating a range of factors that contribute to the overall quality of the local living environment. The strength of evidence linking these factors to health and wellbeing range from strong to moderate. Based on the criteria set out in Section 2.5 above, the evidence linking overall neighbourhood quality to health and wellbeing is considered to be moderate.

3.7 Access to green space

- 3.7.1 Numerous studies have found links between health and wellbeing and access to green space. A comprehensive review by O'Brien *et al* in 2010 for the Forestry Commission⁴⁹ of papers examining the health effects of green space found evidence to support the view that access to open space and natural environments have health benefits, particularly through increased physical activity.
- 3.7.2 The aforementioned literature review by the Forestry Commission found that the proximity, size and amount of green space available to people in urban environments influenced physical and mental health outcomes. The review identified 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.'*

⁴⁷ van Kamp, I. and Davies, H. (2013), *Noise and health in vulnerable groups: A review*, Noise and Health

⁴⁸ Department for Transport (2011), *Strategic Framework for Road Safety*, <https://www.gov.uk/government/publications/strategic-framework-for-road-safety>.

⁴⁹ O'Brien, L., Williams, K. and 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

- 3.7.3 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'*.
- 3.7.4 A literature review by Croucher *et al* in 2007 for Greenspace Scotland⁵⁰ found a positive relationship between green space and general health, and also identified that *'the attractiveness or quality of greenspace is an important determination of green space use'*. The 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.
- 3.7.5 Often the poorest people experience poor quality outdoor environments and suffer disproportionately from a lack of equitable access to natural environments and green spaces. Research conducted by Maas *et al* in 2006⁵¹ has suggested that there is a positive association between the proportion of green space in a residential area and the perceived general health of residents, and that this relationship is strongest for lower socio-economic groups.
- 3.7.6 Based on the criteria set out in Section 2.5 above, the evidence linking access to green space to health and wellbeing is considered to be moderate.

3.8 Physical activity

- 3.8.1 There is a large body of evidence linking physical activity with improved physical and mental health. The WHO⁵² defines physical activity as *'any bodily movement produced by skeletal muscles that requires energy expenditure'* and states that *'physical activity has significant health benefits and contributes to prevent non-communicable diseases'*. These benefits are identified as reduced risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression and the risk of falls, improved bone and functional health, and weight control. The WHO also states that *'beyond exercise, any other physical activity that is done during leisure time, for transport to get to and from places, or as part of a person's work, has a health benefit. Further, both moderate- and vigorous-intensity physical activity improve health.'*
- 3.8.2 The health benefits of physical activity are summarised in a 2011 Department of Health Report⁵³, which 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'*. The report also states that *'even relatively small increases in physical activity are associated with some protection against chronic diseases and an improved quality of life.'*

⁵⁰ Croucher, K., Myers, L., and Bretherton, J. (2007), *The links between greenspace and health: a critical literature review*, Greenspace Scotland

⁵¹ Maas, J., Verheij, R., Groenewegen, P., de Vries, S. and Spreeuwenberg, P. (2006), *Green space, urbanity and health: how strong is the relation?* Journal of epidemiology and community health

⁵² World Health Organization, Physical activity (2017), <http://www.who.int/mediacentre/factsheets/fs385/en/>.

⁵³ Department of Health (2011), *Start Active, Stay Active: A report on physical activity from the four home countries*, Chief Medical Officers, <https://www.gov.uk/government/publications/start-active-stay-active-a-report-on-physical-activity-from-the-four-home-countries-chief-medical-officers>.

- 3.8.3 A 2013 literature review focused on the health benefits of active travel by Saunders *et al*⁵⁴ determined that, although there is no clear evidence in the effectiveness of active travel in reducing obesity, there has been a rise in the prevalence of obesity which has occurred in parallel with a decline in active travel in the past 30-40 years. Data from a report by the National Obesity Observatory in 2011⁵⁵ suggests a number of factors impact active travel including access to fitness facilities, distance to destinations, land use, urban walkability scores, safety, availability of equipment and the provision of footpaths. A further set of studies by Vernon in 2014⁵⁶ suggest that road safety interventions can also help to encourage physical activity by creating a safer physical road environment and reducing the level of danger posed to vulnerable road users.
- 3.8.4 The aforementioned study by Vernon *et al* also looked at the current level of integration of road safety and public health activities. This states that '*road safety has a much wider impact on health than just preventing injuries. This is because some forms of travel (i.e., walking and cycling), and the provision for them, bring more health benefits for individuals and society than others. However, the way that people travel is influenced by concerns about actual or perceived safety; effective intervention to reduce road danger can encourage more people to travel by these active, health-promoting modes.*'
- 3.8.5 Based on the criteria set out in Section 2.5 above, the evidence linking physical activity to health and wellbeing is considered to be strong.

3.9 Access to local services

- 3.9.1 Access to services and community facilities can affect health and wellbeing directly, through access to treatment and care, or access to fresh food retailers, and indirectly through issues such as access to social networks. The London Health Urban Development Unit⁵⁷ identified access to public services and social infrastructure as a key determinant of health and wellbeing.
- 3.9.2 A study by Iwasaki in 2010⁵⁸ suggests that access to social infrastructure including leisure and cultural facilities has been shown to play a key role in the recovery of people with mental illness and have an overall positive impact on health and wellbeing. A report by the New Zealand Government in 2007⁵⁹ identifies a number of reasons for participation in cultural and leisure activities including personal growth and development, to learn new skills for enjoyment and for entertainment, all of which can benefit health and wellbeing.
- 3.9.3 A survey by Randall in 2008 for the ONS⁶⁰ found that 5% of adults felt isolated due to difficulties accessing local shops and services, and 22% of adults knew someone who

⁵⁴ Saunders, L., Green, J., Petticrew, M., Steinback, R. and Roberts, H. (2013), *What are the health benefits of active travel? A systematic review of trials and cohort studies*, PLoS ONE

⁵⁵ NHS, National Obesity Observatory (2011), *Data sources: environmental influences on physical activity and diet*, https://khub.net/c/document_library/get_file?uuid=68b8960e-4145-4ed2-b9f8-1ce767f1d2ff&groupId=31798783.

⁵⁶ Vernon, D. (2014), *Road Safety and Public Health*, Royal Society for the Prevention of Accidents (RoSPA)

⁵⁷ NHS, Healthy Urban Development Unit (2013), *HUDU Planning for Health- Rapid Health Impact Assessment Tool*, <http://www.healthyurbandevelopment.nhs.uk/wp-content/uploads/2013/12/HUDU-Rapid-HIA-Tool-Jan-2013-Final.pdf>.

⁵⁸ Iwasaki, Y. Coyle, C. and Shank, J. (2010), *Leisure as a context for active living, recovery, health and life quality for persons with mental illness in a global context*, Health promotion international

⁵⁹ Ministry of Social Development, New Zealand Government (2007), *Social Report: Leisure and Recreation*, <http://socialreport.msd.govt.nz/2007/index.html>.

⁶⁰ Randall, C. (2012), *Measure national well-being: Where we live 2012*, Office for National Statistics Report

felt this way. Overall, the survey highlighted that alongside crime and cleanliness, the most important factors that made a place suitable to live was access to services, particularly health services.

3.9.4 A 2011 literature review by Quigley *et al*⁶¹ focusing on transport and community severance found that, 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.'*

3.9.5 A study by Hamer in 2004⁶² suggested that groups impacted by disability and older people may experience greater barriers to health and social care services.

3.9.6 Based on the criteria set out in Section 2.5 above, the evidence linking access to services to health and wellbeing is considered to be moderate.

⁶¹ 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

⁶² Hamer, L. (2004), *Improving patient access to health services: a national review and case studies of current approaches*, Health Development Agency

4 Commentary on evidence for health effects of infrastructure projects

4.1.1 HS2 Ltd undertook a literature review in 2015⁶³ as part of the Health Impact Assessment (HIA) for HS2 Phase One (London to West Midlands) to look for data on the health consequences of large-scale infrastructure projects. This review did not identify any articles focused specifically on health effects from long-term exposure to a major project's construction or operational impacts, suggesting that little or no research has been undertaken in this area. The 2015 review by HS2 Ltd identified five articles looking at the effects of projects on specific health determinants, as follows.

- Reported health effects associated with construction air emissions from the redevelopment of the King's Cross area in London:** The London Borough of Camden set up an extensive particulate monitoring programme to determine if there were any health impacts on local residents from emissions from the demolition and construction work. An unpublished HIA cited in Haynes et al in 2007⁶⁴ identified that some residents reported experiencing health problems associated with King's Cross phase 1 construction impacts, including difficulty breathing, rashes and irritation to the eyes and nose. It is not clear how long these symptoms lasted and what mitigation measures were undertaken in order to ensure that these symptoms were alleviated and did not recur. This finding reinforces a point made in the aforementioned HS2 Ltd HIA that dust and other air pollutants can at times have health effects even with good mitigation in place.
- Relative annoyance from construction and operational noise:** A large, Defra-funded study 'NANR209: Human response to vibration in residential environments'⁶⁵ assessed how residents became used to vibration and noise experienced when living next to a standard railway line (i.e. during the operation phase). However, during the construction phase, though some respondents mentioned getting used to the vibration and noise, it was considered unacceptable by the majority of respondents. There is general evidence that human beings can adapt to certain types of noise. The above research suggests that construction noise, possibly because it can involve noisier and less predictable activities such as piling, is likely to be more annoying and unacceptable to local residents than long term operational railway noise.
- Impacts of temporary events on cyclists' safety:** A review by Teschke et al in 2012⁶⁶ of route infrastructure and the risk of injury to cyclists published in the

⁶³ HS2 Ltd (2015), Health impact assessment addendum, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460717/Health_impact_assessment_addendum_-_Euston_station_and_approach_area.pdf.

⁶⁴ Haynes, R. and Savage, A. (2006), *Assessment of the Health Impacts of Particulates from the Redevelopment of Kings Cross*, Unpublished

⁶⁵ Waddington, D., Moorhouse, A., Steele, A., Woodcock, J., Condie, J., Peris, E., Sica, G., and Koziel, Z. (2011), *Human Response to Vibration in Residential Environments*, NANR

⁶⁶ Teschke, K., Harris, M., Reynolds, C., Winters, M., Babul, S., Chipman, M., Cusimano, M., Brubacher, J., Hunte, G., Friedman, S., Monro, M., Shen, H., Vernich, L. and Cripton, P. (2012), *Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study*, American Journal of Public Health

American Journal of Public Health found evidence suggesting that temporary events such as construction activities are associated with an increased risk of injury for cyclists. The review suggested that when construction sites impact transportation corridors for cyclists, safe detours need to be provided for them.

- **Effects of dialogue on public perception of risk:** A qualitative study by Marincioni et al published in *Environmental Management* in 2009⁶⁷ looked at residents living near the construction of the Lyon-Turin segment of the new European high-speed rail network at the beginning of the 1990s. The findings of the study were that that public acceptance of risk was influenced by the characteristics of hazards perceived by the residents and by the communicative approach used by the project's stakeholders. The implementation of measures to take 'greater care to inform and consult' improved the quality of the public debate and better addressed community concerns. The other key finding was that the lack of effective early dialogue between the project proponents and government on one side and communities on the other contributed to the formation of local residents' viewpoints on the environmental and health risks. Once formed, these views persisted even when new information was presented.

4.1.2 A number of additional articles have been found during this review, focusing on changes in health determinants associated with the construction and operation of high speed rail. The relevant findings of these studies are summarised below.

4.1.3 A study by Cole *et al* in 2017⁶⁸ looking at the impact of the Los Angeles-San Francisco high speed line on health identified the following potential positive and negative impacts on health determinants associated with the scheme:

- an influx of transportation and infrastructure-related jobs during the construction phase;
- noise and traffic-safety concerns around the high-speed rail station;
- tendency to route the trains through areas that place a disproportionate share of these burdens on low-income populations during construction and operation;
- providing communities with an additional transportation option, likely to be less expensive than owning and operating an automobile;
- expansion of the pool of available employment;
- additional walking time compared with travelling by car, associated with getting to and from the station; and
- a reduction in vehicle miles travelled, which is associated with traffic risks, air pollution and greenhouse gas emissions.

⁶⁷ Marincioni, F. and Appiotti, F. (2009), *The Lyon-Turin High-Speed Rail: The Public Debate and Perception of Environmental Risk in Susa Valley, Italy*, *Environmental Management*

⁶⁸ Cole, B. and Jerrett, M. (2017), *On the Right Track*, UCLA Fielding School of Public Health

- 4.1.4 An article by De Rus *et al* in 2007⁶⁹, published in the Journal of Transport Geography, looked at the minimum levels of demand required from which investment in high speed rail could be considered profitable from a social perspective. This found that the majority of benefits derive from additional rail capacity and alleviating road and airport congestion, rather than through journey time savings, and that these benefits are dependent on the number and composition of users. A further article by Ryder in 2012⁷⁰ noted that high speed rail can stimulate economic development through increasing tourism and attracting new industries. In terms of property values, a study by Anderson in 2010⁷¹ published in the Journal of Transport Geography found that close proximity to high speed rail lines was associated with significant negative effects on property values during operation, whereas access to high speed rail gave rise to a minor increase in the value of properties close to stations.
- 4.1.5 An article by Levinson in 2012⁷², published in the Journal of Transport Geography, looks at the accessibility impacts of high speed rail in America. This stated that *'evidence from the research shows that lines have two major impacts. There are positive accessibility benefits in metro areas served by stations, but there are negative nuisance effects along the lines themselves. High speed lines are unlikely to have local accessibility benefits separate from connecting local transit lines because there is little advantage for most people or businesses to locate near a line used infrequently (unlike public transit). However, they may have more widespread metropolitan level effects. They will retain, and perhaps worse, have much higher nuisance effects than local transit.'*
- 4.1.6 The article goes on to state that *'high speed lines are unlikely to have local accessibility benefits separate from connecting local transit lines because there is little advantage for most people or businesses to locate near a line used infrequently (unlike public transit). However, they may have more widespread metropolitan level effects.'* This view is reflected in the article by published by Jiao *et al* in 2017⁷³ in the Journal of Transport Geography which states that many businesses are unlikely to relocate near a line which does not stop often and acts as a source of nuisance.
- 4.1.7 The evidence identified in this search has been mainly focused on impacts on health determinants resulting from the construction and operation of high speed rail and major infrastructure projects, rather than links to health and wellbeing outcomes specifically. Based on the criteria set out in Section 2.5 above, the evidence linking the construction and operation of high speed rail and other infrastructure projects with health and wellbeing is considered to be weak.

⁶⁹ De Rus, G. and Nombela, G. (2007), *Is investment in High Speed Rail socially profitable?*, Journal of Transport Economics and Policy

⁷⁰ Ryder, A. (2012), *High Speed Rail*, Journal of Transport Geography

⁷¹ Andersson, D. (2010), *Does high-speed rail accessibility influence residential property prices? Hedonic estimates from southern Taiwan*, Journal of Transport Geography

⁷² Levinson, D. (2012), *Accessibility Impacts of High Speed Rail*, Journal of Transportation Geography

⁷³ Jiao, J., Wang, J. and Jin, F. (2017), *Impacts of high-speed rail lines on the city network in China*, Journal of Transport Geography

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