

# Outer Dowsing Offshore Wind

## Environmental Statement

### Chapter 30 Human Health

#### Volume 3 Appendices

#### Appendix 30.2 Human Health Literature Review

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# Volume 3, Appendix 30.2 Literature Review

## Outer Dowsing Offshore Wind Environmental Statement

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## Acronyms and Abbreviations

Acronym	Expanded name
µm	Micrometre
BMC	BioMed Central
DALYs	Disability-Adjusted Life Years
dB	Decibel
DfT	Department for Transport
ECC	Export Cable Corridor
EEA	European Environment Agency
EEG	Electroencephalography
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
ICB	Integrated Care Board
IHD	Ischemic Heart Disease
LAeq	Equivalent Continuous Sound Pressure Level
Lden	Day Evening Night Average Sound Level
LDN	Day-Night Average Sound Level
Lnight	Night-time Noise Indicator
NHS	National Health Service
NO2	Nitrogen Dioxide
O3	Ozone
OHS	Occupational Health and Safety
PHE	Public Health England
UKHSA	United Kingdom Health Security Agency
WHO	World Health Organisation

## Terminology

Term	Description
<b>Baseline</b>	The status of the environment at the time of assessment without the development in place.
<b>Effect</b>	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the sensitivity of the receptor, in accordance with defined significance criteria.
<b>Environmental Statement (ES)</b>	The suite of documents that detail the processes and results of the EIA.
<b>Export Cable Corridor</b>	The term used to describe the cable that connects the offshore and onshore substations to transmit power from the wind farm to shore.
<b>Impact</b>	An impact on the receiving environment is defined as any change to its baseline condition, either adverse or beneficial





<b>Mitigation</b>	Mitigation measures are commitments made by the Project to reduce and/or eliminate the potential for significant effects to arise as a result of the Project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of potentially significant effects.
<b>Outer Dowsing Offshore Wind (ODOW)</b>	The Project.
<b>Receptor</b>	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of receptors include species (or groups) of animals or plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
<b>The Project</b>	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.



## 30.0 Literature Review

### 30.1 Introduction

1. This appendix provides a summary of key research evidence, drawn from recently published literature reviews, research papers and policy documents that suggest the links between health determinants and potential health outcomes. The information presented in this appendix underpins the assessment of health effects within the Outer Dowsing Offshore Windfarm ('the Project'), Volume 1, Chapter 30: Human Health (document reference 6.1.30).

### 30.2 Noise

#### 30.2.1 Overview of Noise Effects

2. Sound is produced by mechanical disturbance propagated as a wave motion in air or other media. Noise is defined as '*unwanted sound*'<sup>1</sup>; and is considered '*unpleasant, loud, or disruptive to hearing*'<sup>2</sup> According to the World Health Organisation (WHO), '*In some situations, but not always, noise may adversely affect the health and well-being of individuals or populations*'<sup>3</sup>. More recently, WHO has stated that '*Environmental noise is a threat to public health, having negative impacts on human health and well-being*'<sup>4</sup>.
3. It is highlighted by the WHO that certain demographics are more vulnerable to the impacts of excess noise and noise pollution. These include children, the chronically ill and elderly people are more likely to be sensitive to changes in the noise environment. Further to this, those who have low levels of financial security or living in deprivation may be more likely to live in noisier areas or are less likely to have well-insulated and soundproofed homes.<sup>5</sup>

##### 30.2.1.1 Auditory Health Effects

4. Hearing loss and other auditory health effects like tinnitus do not typically occur from typical exposure to environmental noise, it is more commonly associated with occupational

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<sup>1</sup> Seidman & Standing (2010). Noise and Quality of Life. National Institutes of Health.

<sup>2</sup> Glenn (2016) The Nature of Sound. The physics Hypertextbook.

<sup>3</sup> World Health Organisation (1995). Community Noise. Edited by B. Berglund & T. Lindvall

<sup>4</sup> World Health Organisation (2009). Night Noise guidelines for Europe

<sup>5</sup> World Health Organisation (2010) Noise, Available at <https://www.who.int/europe/news-room/factsheets/item/noise> (accessed 09 November 2023)



exposure to much higher noise levels<sup>6</sup>. In the everyday environment, an individual is more likely to respond to sound or noise in a behavioural (such as by reducing the volume of sounds or noise) or psychological (i.e. non-auditory) manner, rather than physiological (such as method to distract individuals from sounds or noise).

### 30.2.1.2 Non-auditory Health Effects

5. There is 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. Non-auditory health effects can also be attributed to other forms of exposure including stress, cardiovascular health and sleeping patterns.<sup>7</sup>
6. Examples of non-auditory health effects which have been linked to environmental noise include annoyance, sleep disturbance and other nighttime effects, cardiovascular and physiological effects, mental health effects, reduced performance, communication and learning effects.<sup>8</sup>
7. 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 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<sup>9</sup> and updated in 2013<sup>10</sup>, reproduced here as Plate 30.1.
8. 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.

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<sup>6</sup> Pueyo *et al.* (2016). Disorders Induced by Direct Occupational Exposure to Noise. National Institutes of Health.

<sup>7</sup> World Health Organisation (2010) Noise, Available at <https://www.who.int/europe/news-room/fact-sheets/item/noise> (accessed 09 November 2023)

<sup>8</sup> World Health Organisation (2010) Noise, Available at <https://www.who.int/europe/news-room/fact-sheets/item/noise> (accessed 09 November 2023)

<sup>9</sup> Babisch W (2002). The noise/stress concept, risk assessment and research needs. *Noise Health* 4(16):1-11

<sup>10</sup> 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



To quote Babisch<sup>11</sup> 'Causality in epidemiology can never be proven. It is a gradual term in which evidence is increasing with an 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'.

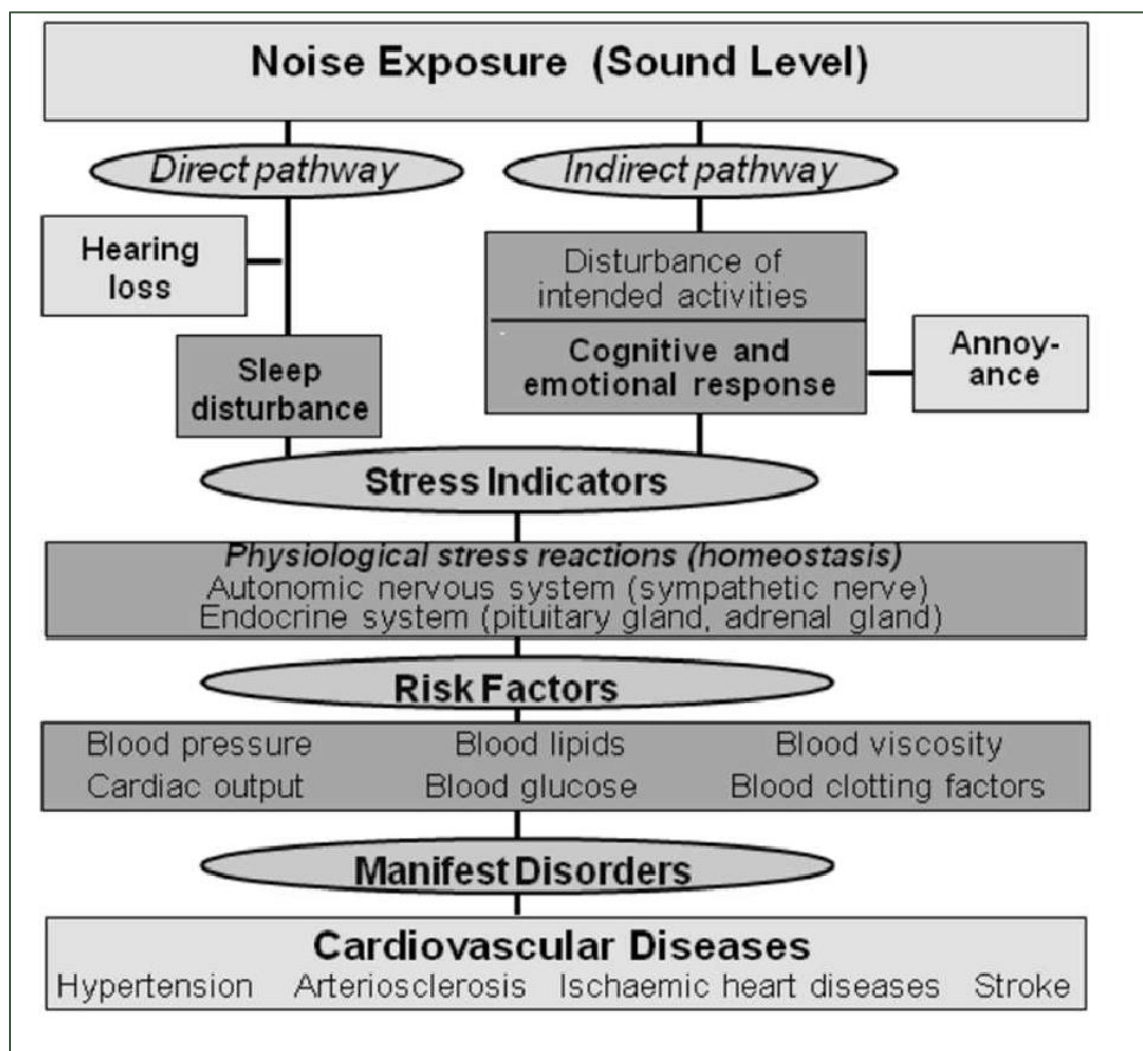


Plate 30.1: Noise effects model <sup>1</sup>

<sup>11</sup> Babisch, W. (2006). Transportation Noise and Cardiovascular Risk - Review and Synthesis of Epidemiological Studies. Federal Environmental Agency, Germany.



9. The Government's Planning Practice Guidance for Noise (22 July 2019)<sup>12</sup> acknowledges that noise can affect people's quality of life and that there is emerging evidence linking noise with direct health effects.

### 30.2.2 Construction Noise Impacts

10. The Noise Policy Statement for England (March 2010)<sup>13</sup> discusses the impact of 'Neighbourhood Noise'. Neighbourhood Noise is described as *'noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites, and noise in the street'*. It is widely understood that noise resulting from construction work can impact both those working on the site and those within the vicinity. The use of heavy tools and machinery, as well as construction processes such as welding, demolition etc. can result in various impacts as summarised in Section 30.2.1 on both short and long-term scales.
11. Noise resulting from the export cable corridor (ECC) (which is a single cable route containing multiple cables) construction is likely to be the key noise-related impact on the onshore aspect of the development. Construction noise, as described by Guan, Hu, Liu & Zhang (2020)<sup>14</sup> is considered to be noise which is characterised by *'sudden, non-permanent, high intensity, concentrated duration, and difficult control, which have a serious impact on [urban] residents'*. While the description refers to urban environments, this definition remains appropriate and applicable to rural environments and residents.
12. Excess construction work (which results in unwanted sounds from infrastructure, transport and building projects that do not control and reduce noise levels) can result in negative impacts on people's health and well-being with a 2022 article from RICS<sup>15</sup> stating that *'every year in Europe, 48,000 new cases of ischaemic heart diseases and 12,000 premature deaths are attributed to exposure to environmental noise'*. A study from 2023<sup>16</sup> concluded the non-auditory effects of construction noise on human health. This study involved 23 participants and utilised differing sources of construction noise including saws,

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<sup>12</sup> Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government, Planning Practice Guidance for Noise (22 July 2019).

<sup>13</sup> Defra, (March 2010) The Noise Policy Statement for England.

<sup>14</sup> Guan, H., Hu, S., Liu, G., & Zhang, L. (2020). The combined effects of temperature and noise on the comfort perceptions of young people with a normal body mass index. *Sustainable Cities and Society*, 54, 1–9, 101993.

<sup>15</sup> RICS, <https://ww3.rics.org/uk/en/modus/built-environment/construction/noisy-neighbours--how-building-sites-are-keeping-quiet.html>

<sup>16</sup> Mostafa Mir (2023) Construction noise effects on human health: evidence from physiological measures





jackhammers, pile drivers, and bulldozers. These noise sources were chosen as previous studies<sup>17</sup> have shown that these items have the highest negative psychological effects. It was concluded that the study *'found significant effects of different types, levels, and exposure durations of construction noise on the physiological responses'* and overall, *'the results of this study showed that exposure construction noise can have negative effects on human health'*.

13. Further to this, a 2011 report by WHO<sup>18</sup> concluded that Western European countries lose approximately 1 – 1.6 million Disability-Adjusted Life Years (DALYs) per annum as a result of exposure to such noise (noting one DALY equals one lost year of healthy life, calculated by summing years of life lost (via premature death) and years lived with disability or a chronic health condition). The study highlighted that unwanted sounds, in this case construction works, can *'provoke stress, poor sleep, and health problems'*. Whilst it has an impact on health, the study did conclude that due to the increasing population, it is expected that more people will be exposed to construction noise in the future.

14. Another study<sup>19</sup> concluded that adverse effects resulting from noise can include both physiological and psychological impacts with the main effects identified as *'annoyance, sleep disturbance, cardiovascular disorders, cognitive impairment and hearing disturbance, stress, anxiety, aggression and irritability, and other mental health disorders'*.

### 30.2.3 Construction Traffic Noise Impacts

15. The most common source of noise pollution in Europe is transport<sup>20</sup>, with road traffic being identified as the key perpetrator. There is a significant amount of research available on the impacts on human health and well-being resulting from increased exposure to road traffic. This includes research from the UK Health Security Agency that suggests in 2018, 130,000

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<sup>17</sup> Lee, S. C., Hong, J. Y., & Jeon, J. Y. (2015). Effects of acoustic characteristics of combined construction noise on annoyance. *Building and Environment*, 92, 657–667.

<sup>18</sup> WHO. (2011). Burden of disease from environmental noise: Quantification of healthy life years lost in Europe. World Health Organization. Regional Office for Europe.

<sup>19</sup> JRHS (2013) Noise Annoyance due to Construction Worksites.

<sup>20</sup> European Environment Agency (2023) Noise. Available at: <https://www.eea.europa.eu/en/topics/in-depth/noise#:~:text=Road%20transport%20is%20the%20most,harmful%20effects%20of%20noise%20pollution>. (Accessed 24<sup>th</sup> January 2024).



healthy life years were lost in the UK due to noise pollution and that 40% of the population was exposed to harmful levels of noise pollution from road traffic.<sup>21</sup>

16. 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 sources and are compounded by other environmental factors, as well as individual factors such as sensitivity, attitude, and pre-existing health conditions. The way individuals respond to noise varies as affirmed in several studies as detailed in section 30.2.2 above.
17. There is a great deal of variation between individual responses to noise, as affirmed in several studies.<sup>22</sup> Typically, there is no threshold of effect, but the effect increases slowly with increasing noise exposure.
18. Construction Traffic is likely to be a key part of excess noise at the outset of this development. This impact may have a further reaching impact radius depending on the route construction vehicles are permitted to take highlighted within the Outline Construction Traffic Management Plan (document reference 8.15) and the Outline Travel Plan (document reference 8.16)<sup>23</sup>

#### 30.2.4 Annoyance

19. 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.<sup>24</sup> Noise annoyance is defined within Ouis<sup>25</sup> 'Annoyance from road traffic noise: a review' as '*displeasure, unwanted, interfering consequences that has adverse effects of exposed people to noise*'. Within this review, construction noise is discussed under the umbrella of '*ambient sound*' relating to everyday sounds within an environment that exists within the background of a person's daily activities. These ambient sounds include traffic and building

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<sup>21</sup> Calvin Jephcote *et al.*, 'Spatial assessment of the attributable burden of disease due to transportation noise in England', *Environment International*, vol. 178 (7 May 2023): <https://www.sciencedirect.com/science/article/pii/S0160412023002398/pdf> (Accessed 24<sup>th</sup> January 2024)

<sup>22</sup> Kahneman, D., Sibony, O. and Sunstein, C.R., 2021. *Noise: a flaw in human judgment*. Hachette UK

<sup>23</sup> Lee, S. C., Hong, J. Y., & Jeon, J. Y. (2015). Effects of Acoustic Characteristics of Combined Construction Noise on Annoyance. *Building and Environment*, 92, 657–667.

<sup>24</sup> Clark, C., Head, J. and Stansfeld, S.A., 2013. Longitudinal effects of aircraft noise exposure on children's health and cognition: A six-year follow-up of the UK RANCH cohort. *Journal of Environmental Psychology*, 35, pp.1-9..

<sup>25</sup> Ouis D. (2001) Annoyance from road traffic noise: a review. *J Environ Psychol.* 2001;21:101-120.



construction noises. The review highlights that these can be a cause of annoyance and that high exposure to road traffic impacts can result in negative effects.

20. The UK Health Security Agency (UKHSA)<sup>26</sup> has conducted a new study to aid research on this topic. This study concluded that there is a strong connection between noise annoyance and a decrease in life expectancy. The metric DALYs were used within this study, where one DALY was equivalent to one year of good health. It was shown that increased noise annoyance and sleep disturbance contributed to health issues such as strokes, ischemic heart disease and diabetes. The study found that *'40% of all adults in England were exposed to long-term averaged road-traffic noise levels exceeding 50 decibels (dB), but the percentages varied across different areas. Health effects are more likely to be detected if people are exposed to noise levels exceeding 50 dB Lden, which is around the level of noise seen on a quiet street.* The study further concluded that noise exposure from traffic is responsible for significant impacts on human health, which is referred to as 'disease burden', however, these disparities fluctuate in places with more/less noise pollution. The study estimated that 'overall, approximately a hundred thousand DALYs were lost in England in 2018 due to road traffic'.

21. A 2013 study undertaken by Rostam Golmohammadi *et al.*<sup>27</sup>, detailed ways in which excess noise can result in annoyance, such as difficulties in hearing people and interference with daily conservation, concentration, relaxation and sleep disruption amongst other less common symptoms. The results of the study concluded that the main annoyance was from construction works' *'annoying loudness'*, with subjects stating that *'construction works' noise annoyed them and affected different aspects of their lives, including disturbing sleep, making reading difficult, and disturbing concentration and relaxation'*.

### 30.2.5 Mental Illness

22. Environmental noise is not believed to be the direct cause of mental illness, but studies suggest that it can accelerate and intensify the development of latent mental illnesses or

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<sup>26</sup> Calvin Jephcote, Sierra N. Clark, Anna L. Hansell, *et al.* (2023) Spatial assessment of the attributable burden of disease due to transportation noise in England, Environment International, Volume 178.

<sup>27</sup> Rostam Golmohammadi *et al.* (2013) Noise Annoyance due to construction worksites,



disorders<sup>28</sup>. Studies<sup>29</sup> 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. Temporal population studies undertaken over a longer time scale have shown an association between high level and consistent noise exposure and various mental health indicators e.g., an individual (on a scale) rating of well-being, standard psychological symptom profiles, intake of psychotropic drugs and the consumption of tranquillizers and sleeping pills<sup>30</sup>.

23. Recent reviews on noise effects and mental health have concluded that there is no direct association between environmental noise and mental health, in both adults and children.<sup>31</sup> Noise annoyance is consistently found to be an important mediator. Evidence for the 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-being<sup>32</sup>.

### 30.2.6 Sleep Disturbance

24. A WHO report<sup>33</sup> specific to night noise, cites numerous studies that detail the effects of transport noise on sleep. Those studies have shown that noise can affect 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

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<sup>28</sup> Park, J., Chung, S., Lee, J., Sung, J.H., Cho, S.W. and Sim, C.S. (2017) Noise sensitivity, rather than noise level, predicts the non-auditory effects of noise in community samples: a population-based survey. *BMC public health*, 17, pp.1-9.

<sup>29</sup> Jariwala, H.J., Syed, H.S., Pandya, M.J. and Gajera, Y.M., (2017) Noise pollution & human health: a review. *Noise and Air Pollutions: Challenges and Opportunities*, Ahmedabad: LD College of Eng.

<sup>30</sup> World Health Organisation (1995). *Community Noise*. Edited by B. Berglund & T. Lindvall

<sup>31</sup> Clark, C. and Paunovic, K. (2018) WHO environmental noise guidelines for the European region: a systematic review on environmental noise and quality of life, wellbeing and mental health. *International journal of environmental research and public health*, 15(11), p.2400.

<sup>32</sup> Kamp, *et al.* (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 2013*.

<sup>33</sup> World Health Organisation Europe (2009) *Night Noise Guidelines for Europe*.



that people are not conscious of their own bodies when asleep and studies<sup>34,35</sup> have reported inconsistencies between the physiological effects of noise exposure (objective measures) and the subjects' perceived disturbance. At least one study<sup>36</sup> found no statistically significant relation between the subjective assessment of perceived sleep quality and noise data (whole night averages and single event levels). 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.

25. Miedema and Vos<sup>37</sup> have undertaken an updated meta-analysis using data from several studies including Fidell's (2001)<sup>38</sup> twenty-eight datasets from twenty-four field studies of self-reported sleep disturbance from transport noise using the outdoor Lnight noise indicator. The results confirm earlier findings, such as Fidell (2001)<sup>39</sup> that at the same average nighttime 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.

26. 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 electroencephalography (EEG) and polysomnography. Results from studies predominately outline wind projects have negative effects on sleep distance. This includes Micic *et al.* (2018) who concluded that '*Expansion of wind farm facilities nationally and internationally has been associated with community complaints regarding sleep disturbance and adverse health effects.*' 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 EEG.

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<sup>34</sup> U. Moehler & L. Greven (2005), Community response to railway and road traffic noise - a review on German field studies. *Internoise 2005*.

<sup>35</sup> Basner, Müller, E-M. Elmenhorst (2011), Single and combined effects of air, road and rail traffic noise on sleep.

<sup>36</sup> Griefahn, Schuemer-Kohrs, Schuemer, Moehler & Mehnert (2000), Physiological, subjective, and behavioural responses during sleep to noise from road and rail traffic.

<sup>37</sup> Miedema & Vos (2007), Associations between self-reported sleep disturbance and environmental noise, *Behavioural Sleep Medicine* 5(1), pp 1-20

<sup>38</sup> Civil Aviation authority. Aircraft Noise and Annoyance: Recent Findings. Environmental Research and Consultancy Department.

<sup>39</sup> Civil Aviation authority. Aircraft Noise and Annoyance: Recent Findings. Environmental Research and Consultancy Department.





### 30.2.7 Cardiovascular Disease

27. In an article<sup>40</sup> published in 2021, it was stated that *'[traffic] noise at night causes fragmentation and shortening of sleep, elevation of stress hormone levels, and increased oxidative stress in the vasculature and the brain'*. The article then further goes on to state that due to this, increased levels of noise can thereby *'promote vascular dysfunction, inflammation, and hypertension, thereby elevating the risk of cardiovascular disease'*.

### 30.2.8 Cognitive Impairment in School Children

28. A World Health Organisation document on the Burden of Disease<sup>41</sup> states that *'it has been suspected for many years that children's learning and memory are negatively affected by noise'*. Attention span, memory, and reading comprehension have been highlighted by research by Haines (2001) and Evans (1997) as key impacted tasks, reiterating that cognitive activities involving central processing and language are impacted the most<sup>42</sup>.

29. The Burden of Disease document and a separate document by the European Environment Agency (EEA)<sup>43</sup> present a hypothetical exposure-response for cognitive impairment based on these studies. The relationship assumes that 100% of children are cognitively impaired at a very high noise level (95 dB Ldn) and that none are affected at a safe low level (50 dB Ldn). Within this range cognitive impairment is assumed to follow a sigmoidal function, as shown in Plate 30.2. This shows the 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. As seen below, 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.

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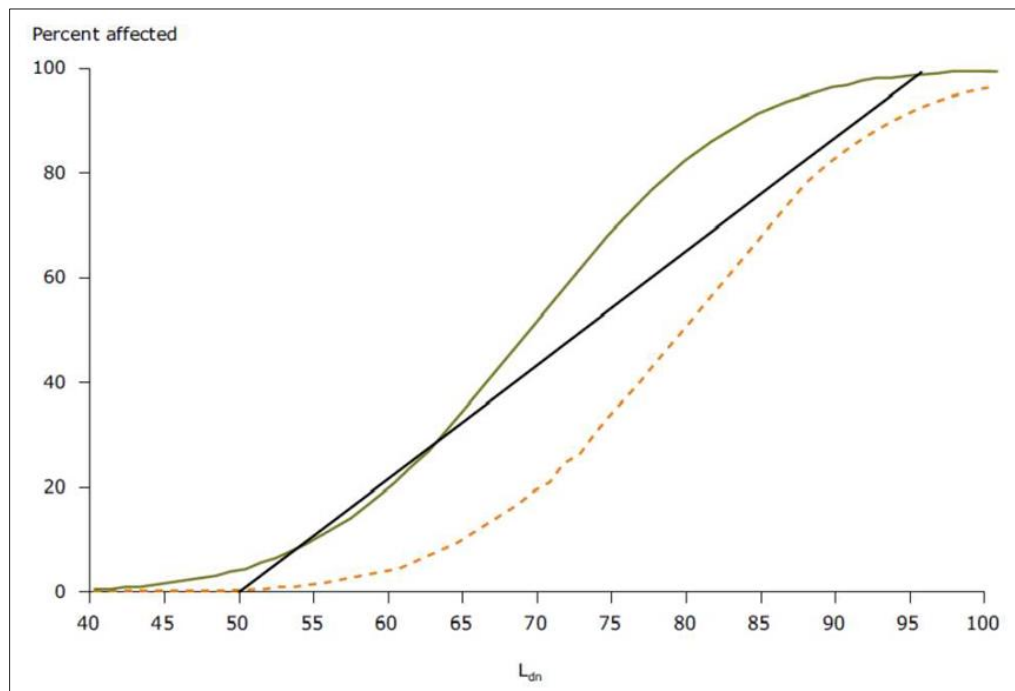
<sup>40</sup> Münzel, T., Sørensen, M. & Daiber, A. (2021), Transportation noise pollution and cardiovascular disease. *Nat Rev Cardiol* **18**, 619–636.

<sup>41</sup> WHO (2011), Burden of disease from environmental noise. Quantification of healthy life years lost in Europe.

<sup>42</sup> Haines MM *et al.* (2001) West London schools study: Aircraft noise at school and child performance and health.

<sup>43</sup> European Environment Agency (2010), Good practice guide on noise exposure and potential health effects. EEA Technical Report No 11/2010.





**Plate 30.2: The hypothetical association between aircraft noise level and cognitive impairment in children**

30. Regarding road traffic noise, Foraster (2022)<sup>44</sup> carried out a study to assess whether school exposure and home exposure were associated with the development of working memory and attention over 12 months in 2,680 children aged 7 to 10 years from 38 schools in Barcelona, Spain. The findings indicated that, in children aged 7 to 10 years in Barcelona, higher exposure to road traffic noise at school relates to poorer development of attention and working memory.
31. Data from the Munich and RANCH studies was reanalysed by Stansfeld *et al.*<sup>45</sup>, who concluded that night 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 the protection of children against the effects of aircraft noise on school performance.

<sup>44</sup> Foraster, M., Esnaola, M., López-Vicente, M., Rivas, I., Álvarez-Pedrerol, M., Persavento, C., Sebastian-Galles, N., Pujol, J., Dadvand, P. and Sunyer, J. (2022) Exposure to road traffic noise and cognitive development in schoolchildren in Barcelona, Spain: A population-based cohort study. *PLoS medicine*, 19(6), p.e1004001.

<sup>45</sup> Stansfeld, *et al.* (2010) Night time aircraft noise exposure and children's cognitive performance. *Noise Health* 24 (49).



### 30.3 Vibration

32. The reaction of the human body to vibration is associated with annoyance, sleep disturbance, discomfort, and interference with activities and it may affect the quality of life. Occupants of buildings where there is perceptible vibration may experience concerns regarding 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.<sup>46</sup>
33. Construction works are likely to result in high levels of vibration, disrupting daily lives and potentially property damage. The Control of Vibration at Work Regulations (2005) state that '*mitigations should be made to prevent or reduce risks from exposure to vibration at work*'. Vibrations in the context of construction sites are likely to be created from various pieces of equipment on-site, such as excavators or drills and other machinery, or incoming rail or road traffic to the site. The Regulations also state that '*construction site vibration can have a tangible negative impact on a number of parties and assets, including the surrounding communities, surrounding buildings, and the workers operating the machines and equipment*'. It is cited within the regulations that increased vibrations as a result of construction work can implicate those from a distance, impacting the quality of life and working efficiency of people in surrounding buildings.<sup>47</sup>
34. A 2022 study<sup>48</sup> from the International Journal of Environmental Research and Public Health deduced that it is not clear if noise or vibration caused more annoyance, however further studies<sup>49</sup>, have concluded that even low-intensity vibrations were 'burdensome' for residents, interfering with living conditions. Another study, undertaken by Sitnik *et al.*<sup>50</sup>, states that the impact of vibrations on human health can result in balance disorders (motion sickness), however, it must be noted that a lot of the studies like Charles *et al.* (2018)<sup>51</sup>

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<sup>46</sup> Beben, D.; Maleska, T.; Bobra, P.; Duda, J.; Anigacz, W. (2022), Influence of Traffic-Induced Vibrations on Humans and Residential Building - A Case Study.

<sup>47</sup> The Control of Vibration at Work Regulations (2005).

<sup>48</sup> Beben, D.; Maleska, T.; Bobra, P.; Duda, J.; Anigacz, W. (2022), Influence of Traffic-Induced Vibrations on Humans and Residential Building—A Case Study.

<sup>49</sup> Pachla, F.; Kowalska-Koczwara, A.; Tatara, (2019) The influence of vibration duration on the structure of irregular RC buildings. Bull. Earthq. Eng. 2019, 17, 3119–3138.

<sup>50</sup> Sitnik, Lech & Magdziak-Tokłowicz, Monika & Wróbel, Radosław & Kardasz, Piotr. (2015). VEHICLE VIBRATION IN HUMAN HEALTH. Journal of KONES. Powertrain and Transport. 20. 411-418. 10.5604/12314005.1137854.

<sup>51</sup> Charles, L., Ma, C., Burchfiel, C. and Dong, R. (2018) Vibration and ergonomic exposures associated with musculoskeletal disorders of the shoulder and neck. Safety and health at work, 9(2), pp.125-132.



and when looking at construction vibration impacts on human health refer to construction workers as opposed to residents surrounding the construction site.

35. Overall, it is concluded that there is little evidence in the existing literature to suggest direct long-term physical health effects on people inside buildings in relation to vibration at the typical levels encountered in the everyday environment<sup>52</sup>.

## 30.4 Air Quality

### 30.4.1 Dust

36. There is research establishing the link between airborne dust from construction and demolition and its impact on human health. Depending on the level of activity, type of activity, and weather conditions the level of dust emissions can vary. There is evidence of major construction sites increasing long-term particulate matter concentrations<sup>53</sup>. Exposure to PM<sub>10</sub> has long been associated with a range of health effects, with an increasing focus on the smallest particles such as PM<sub>2.5</sub> and smaller<sup>54</sup>.

37. The main air quality impacts that may arise during construction activities are:

- dust deposition, resulting in soiling of surfaces;
- visible dust plumes, which are evidence of dust emissions;
- elevated PM<sub>10</sub>, PM<sub>2.5</sub> concentrations from demolition and construction activities; and
- an increase in concentrations of airborne particles and nitrogen dioxide due to exhaust emission from vehicles and equipment used on site (non-road mobile machinery) and vehicles accessing the site.

38. It is highlighted within the Institute of Air Quality Management (IAQM) report from August 2023<sup>55</sup> that the most common impacts are dust soiling and increased ambient PM<sub>10</sub>(including PM<sub>2.5</sub>) concentrations due to dust arising from activities on the site.

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<sup>52</sup> ANC (2012). Measurement & Assessment of Groundborne Noise & Vibration, 2nd edition.

<sup>53</sup> Cheriyan, D. and Choi, J.H. (2020) A review of research on particulate matter pollution in the construction industry. Journal of Cleaner Production, 254, p.120077.

<sup>54</sup> Greater London Authority (October 2019). PM<sub>2.5</sub> in London: Roadmap to meeting World Health Organization guidelines by 2030 October 2019 IAQM Guidance on the assessment of dust from demolition and construction.

<sup>55</sup> IAQM (August 2023). Guidance on the assessment of dust from demolition and construction (version 2.1).



39. Only particles less than 10 µm are considered to be 'inhalable' to the lung<sup>56</sup>. However, dust can cause eye, nose and throat irritation and lead to deposition on cars, windows, and property<sup>57</sup>.

### 30.4.2 Road Traffic Emissions

40. Evidence on the links between road traffic emissions and health is well established, based on numerous research studies<sup>58</sup>. A WHO report from 2000<sup>59</sup>, 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 cities, with the main health-damaging pollutants released as emissions from road traffic being PM<sub>10</sub> and nitrogen dioxide.

#### PM10

41. PM<sub>10</sub>, which is an important source of pollution with regard to health impacts, comprises atmospheric particles that are less than 10 m in diameter. Road transport is a major source of PM<sub>10</sub>, 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 the size of the particles (smaller particles have a greater chance of reaching the deeper parts of the lungs). There is growing evidence that smaller respirable particulate matter may be more relevant to health than larger particles. Recent studies<sup>60</sup> have found that ultra-fine particles (less than 0.1 µm) have been associated with stronger effects on lung function and symptoms in asthmatics than either PM<sub>10</sub> or PM<sub>2.5</sub>.

42. Studies have also suggested that particulate pollution of various sizes may exacerbate pre-existing asthma<sup>61</sup>.

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<sup>56</sup> Lumb, A.B. and Thomas, C.R. (2020) Nunn's applied respiratory physiology eBook. Elsevier Health Sciences.

<sup>57</sup> Greater London Authority (2006), The Control of Dust and Emissions from Construction and Demolition, Best Practice Guidance.

<sup>58</sup> Zhang, K. and Batterman, S. (2013) Air pollution and health risks due to vehicle traffic. *Science of the total Environment*, 450, pp.307-316.

<sup>59</sup> World Health Organization. (2000) Transport, Environment and Health. WHO Regional Publications, European Series. No.89.

<sup>60</sup> Schraufnagel, D.E. (2020) The health effects of ultrafine particles. *Exp Mol Med* 52, 311–317  
<https://doi.org/10.1038/s12276-020-0403-3>.

<sup>61</sup> DoH Committee of the Medical Effects of Air Pollutants, (1998), Quantification of the Effects of Air Pollution on Health in the United Kingdom.





### 30.4.3 Nitrogen Dioxide (NO<sub>2</sub>)

43. The effects of road traffic-related NO<sub>2</sub> on health are less well understood than the effects of PM<sub>10</sub>. Numerous epidemiological studies have identified associations between levels of NO<sub>2</sub> and respiratory health<sup>62</sup>, but it may be that in these studies NO<sub>2</sub> is a key marker for traffic-related pollution more generally. NO<sub>2</sub> is a precursor for the formation of ground-level ozone, which is strongly linked with respiratory disease.
44. A study by Searl (2004)<sup>63</sup> of various experiments identified minor respiratory changes at concentrations of NO<sub>2</sub> 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 longer-term exposure at lower concentrations.
45. Quantifying short and long-term impacts of NO<sub>2</sub> pollution is problematic due to uncertainties in the concentration-response functions available. It has been estimated that the direct effect of NO<sub>2</sub> on the health of the UK's population could be between 600 and 6000 deaths per year may have been brought forward in a matter of days or weeks as a result of the exposure to NO<sub>2</sub> 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 because of exposure to ambient NO<sub>2</sub> in the UK each year. Ambient NO<sub>2</sub> is said to contribute to an average of 1-7 extra days of symptoms in asthmatics annually<sup>64</sup>

### 30.4.4 Ozone (O<sub>3</sub>)

46. Ground-level ozone (O<sub>3</sub>) is not released directly into the atmosphere; it is a secondary pollutant that is produced from a reaction with hydrocarbons, road traffic-related nitrogen dioxide (NO<sub>2</sub>) and sunlight. Ozone 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 ozone include changes in lung functions and increased airway

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<sup>62</sup> Health Scotland, (2007) MRC Social and Public Health Sciences Unit and Institute of Occupational Medicine. Health Impact Assessment of Transport Initiatives: A Guide. NHS Health Scotland.

<sup>63</sup> 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

<sup>64</sup> Teumzghi F. Mebrahtu, *et al.*, (2023), The effects of exposure to NO<sub>2</sub>, PM<sub>2.5</sub> and PM<sub>10</sub> on health service attendances with respiratory illnesses: A time-series analysis: <https://doi.org/10.1016/j.envpol.2023.122123>



inflammation. Longer/higher exposure to ozone can result in more severe alterations in lung function<sup>65</sup>.

### 30.4.5 Air Pollution Links to Deprivation

47. Defra commissioned a study in 2006 to review recent research evidence on links between air quality and social deprivation in the UK<sup>66</sup>. The analysis for England showed that there is a tendency for higher relative mean annual concentrations of nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>10</sub>) 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 exceedances 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.

48. According to the Defra review (2006)<sup>67</sup> several factors 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 individuals travel to work/school etc;
- Individual factors, for example, choice of diet, smoking, and level of exercise all impact overall human health. These lifestyle factors could lead to greater susceptibility to air pollution impacts and may be prevalent in certain socio-economic groups (such as links to relationships between diet and income);
- 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

<sup>65</sup> Junfeng (Jim) Zhang, *et al.*, (2019), Ozone Pollution: A Major Health Hazard Worldwide.

<sup>66</sup> Defra, (2006), Department for Communities and Local Government, National Statistics. 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.

<sup>67</sup> Defra, (2006), Department for Communities and Local Government, National Statistics. 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.



deprived communities as outlined in the Independent Inquiry into Inequality in Health report (Acheson 1998); and

- Age of population- the elderly and children are susceptible to air pollution impacts.

**49.** The Defra 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 noted that 'In England, the most deprived deciles (decile refers to a subdivision (10 in total) of the UK population, with one being the most deprived) the UK population of 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'.*

## 30.5 Local environment

### 30.5.1 Green Space and Contact with Nature

50. A recent literature review of peer-reviewed papers undertaken by the Forestry Commission<sup>68</sup> has found evidence that proximity, size, and amount of green space available to people in urban environments influence 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 green space;
- Self-reported benefits in terms of health and life satisfaction; and

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<sup>68</sup> 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



- Community cohesion benefits through social contact fostered by green space<sup>69</sup>.
51. 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’*.
52. A literature review by Green Space Scotland<sup>69</sup> also found a positive relationship between green space and general health. Importantly this study identified that *‘the attractiveness or quality of green space is an important determination of green space use’*. The Green Space 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.

### 30.5.2 Landscape, Townscape, and Visual Issues

53. Research into the effects of the visual and aesthetic environment on well-being is mainly focused on the psychological effects of natural versus man-made or urban views<sup>70</sup>. In general, evidence shows a preference for views of natural over man-made scenes: The preference is natural views are commonly related to opportunities for exercise and contact with nature.<sup>71</sup>
54. A 2022 study by Felisberti<sup>72</sup> concluded that participants associated ‘ugly’ landscapes with feelings of fear, death, sadness, and disgust. Previous studies by Kaplan (1995)<sup>73</sup> and Kellert (1993)<sup>74</sup>, have both linked an increase in emotional wellbeing to being within a ‘pleasurable’ environment. On this basis, Felisberti states *‘it is reasonable to assume that extended exposure to visual ugliness in daily environments is likely to impact wellbeing’*

<sup>69</sup> Croucher, K., Myers, L., and Bretherton, J., 2007, The Links Between Greenspace and Health: a Critical Literature Review, Greenspace Scotland.

<sup>70</sup> Felisberti, F. (2022) Experiences of ugliness in nature and urban environments. *Empirical Studies of the Arts*, 40(2), pp.192-208.

<sup>71</sup> 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

<sup>72</sup> Felisberti, F. M. (2022). Experiences of Ugliness in Nature and Urban environments. *Empirical Studies of the Arts*, 40(2), 192-208. <https://doi.org/10.1177/02762374211001798>

<sup>73</sup> Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169–182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2)

<sup>74</sup> Kellert, S. R. (1993). The biological basis for human values of nature. In S. R. Kellert (Ed.) & E. O. Wilson (Eds.), *The Biophilia hypothesis* (pp. 42–69). Island Press.



*significantly*'. In Felisberti's study, participants were asked to take photos of 'ugly' environments. In terms of ugliness in the rural setting, it was nearly always connected to 'environmental damage' with 'impenetrable shrubs, stagnated water, decay, and dark and dull colours' being highlighted as key 'ugly' criteria. In urban settings, 'rubbish, destruction, or vandalism' were considered ugly elements. In the context of construction sites, the lack of green space would create a distaste for onlookers. The study further states that people prefer to look at rural landscapes as opposed to urban ones, which is in line with previous studies.

55. Following this train of thought, the above is in line with the general understanding that access to green space improves health and well-being. This a widely acknowledged truth that has come to light in the past decade<sup>75, 76</sup> A report produced in 2020 by Public Health England<sup>77</sup> states in its opening lines that green spaces are *'increasingly being recognised as an important asset for supporting health and wellbeing'*.

### 30.5.3 Crime

56. The effects of crime on health include both direct effects, for example through violence, and indirect social and psychological effects arising from fear of crime<sup>78</sup>. A recent ONS report on Measuring National Wellbeing<sup>79</sup> identified crime as a key factor in determining wellbeing. In the 2008 Place Survey<sup>80</sup> 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.

57. Research by Hirschfield (2003)<sup>81</sup> 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

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<sup>75</sup> Rigolon, A., Browning, M.H., McAnirlin, O. and Yoon, H. (2021) Green space and health equity: a systematic review on the potential of green space to reduce health disparities. *International journal of environmental research and public health*, 18(5), p.2563.

<sup>76</sup> White, M.P., Elliott, L.R., Grellier, J., Economou, T., Bell, S., Bratman, G.N., Cirach, M., Gascon, M., Lima, M.L., Löhmus, M. and Nieuwenhuijsen, M. (2021) Associations between green/blue spaces and mental health across 18 countries. *Scientific reports*, 11(1), p.8903.

<sup>77</sup> Public Health England, (2020), *Improving Access to Green Space a New Review for 2020*.

<sup>78</sup> British Medical Association (1999). *'Health and Environmental Impact Assessment: an Integrated Approach'*. Earthscan Publications Ltd.

<sup>79</sup> Randall, C., (2012) *Measuring National Well-being, Where we Live*, Office for National Statistics.

<sup>80</sup> Department for Communities and Local Government, 2008, *Place survey*.

<sup>81</sup> Hirschfield, A. (2003). *'The Health Impact Assessment of Crime Prevention'*. Sourced from NHS National Institute for Health and Clinical Evidence.



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.

58. A recent study<sup>82</sup> 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 9 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.

59. A comprehensive review undertaken in 2013 by BMC Public Health<sup>83</sup> set out to synthesize qualitative evidence on fear of crime and the environment. The report notes that most research on crime and health, 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 well-being. 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<sup>84, 85</sup>. 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.

60. 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*

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<sup>82</sup> Stafford, M., Chandola, T., Marmot, M., (2007) Association Between Fear of Crime and Mental Health and Physical Functioning, American Journal of Public Health.

<sup>83</sup> Lorenc, T., *et al.* (2013), A. Fear of Crime and the Environment: Systematic Review of UK Qualitative Evidence, BMC Public Health.

<sup>84</sup> Alfaro-Beracochea, L., Puente, A., Da Costa, S., Ruvalcaba, N. and Páez, D. (2018) Effects of fear of crime on subjective well-being: A meta-analytic review. European Journal of Psychology Applied to Legal Context, 10(2), pp.89-96.

<sup>85</sup> Chataway, M. and Bourke, A. (2020) Fear of crime, disorder, and quality of life. Geographies of Behavioural Health, Crime, and Disorder: The Intersection of Social Problems and Place, pp.137-163.





*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.*

### **30.5.4 Vulnerable Groups**

61. Social inequalities are particularly marked in urban environments, with different population subgroups experiencing impacts to different degrees. A review conducted by Parkes and Kearns, 2004<sup>86</sup> of a number of studies identified that women were more vulnerable to neighbourhood conditions than men, particularly those women with children, who were not employed outside the home.

62. 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.

## **30.6 Employment and Economy**

### **30.6.1 Employment**

63. 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.

64. The Marmot Review (2010)<sup>87</sup>, which was commissioned by the Department of Health to look into health inequalities in England, looks at the differences in health and well-being 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.*

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<sup>86</sup> 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](http://www.neighbourhoodcentre.org.uk).

<sup>87</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.



65. The London Health Commission's report *Health in London: Review of the London Health Strategy High-Level Indicators (2005)*<sup>88</sup> 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.*
66. Employment is related to social and psychological well-being; a study commissioned by the Department of Work and Pensions<sup>89</sup> 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'*.
67. As acknowledged in a National Health Service (NHS) evidence review on the causal relationship between worklessness and health<sup>90</sup>, the relationship is complex and *'confounded by other variables such as educational attainment, the environment, and economic circumstances'*.

### 30.6.2 Income

68. Income is a key factor through which employment status affects health and well-being. In Waddell's (2011) study it was 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'*.<sup>91</sup>

### 30.6.3 Job Security and Job Relocation

69. 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*

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<sup>88</sup> Greater London Authority, (2005), *Health in London: Review of the London Health Strategy High Level Indicators*, London Health Commission.

<sup>89</sup> Waddell, G., Burton, A. K., (2007), *Is Work Good for your Health and Well-being?*

<sup>90</sup> Mclean. C., *et al.*, (2005), *Worklessness and health 'what do we know about the causal relationship?'* Evidence review, NHS Health Development Agency.

<sup>91</sup> Waddell, G., Burton, A. K., (2007), *Is Work Good for your Health and Well-being?*



*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.<sup>92</sup>*

70. Involuntary or prompted job relocation, as well as causing financial concerns, can impact people's home and family lives. Research<sup>93</sup> 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...'*<sup>94</sup>

#### **30.6.4 Training and Skills**

71. The Marmot Review<sup>95</sup> highlights the links between inequalities in educational outcomes and physical and mental health and identifies *'Reducing the social 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.

#### **30.6.5 Vulnerable Groups**

72. The Marmot Review also highlights that unemployment leads to adverse circumstances such as increased deprivation and isolation, which in turn can increase vulnerability to a wide variety of health effects. Certain groups such as older people and disabled people

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<sup>92</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.

<sup>93</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.

<sup>94</sup> 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>.

<sup>95</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.



may be more vulnerable to job losses, as these people may face greater difficulty in finding alternative employment<sup>96</sup>.

73. In addition, temporary workers are more likely to experience poor self-reported health, erosion of Occupational Health and Safety (OHS) procedures and strategies, psychological ill health associated with job insecurity, higher rates of job dissatisfaction, less access to training and worse working conditions<sup>97</sup>

## 30.7 Housing

### 30.7.1 Housing Quality

74. Housing quality affects both physical and mental health. WHO research<sup>98</sup> 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'.

### 30.7.2 Security of Ownership, Value, and Saleability

75. Housing security provides financial and social stability. A WHO study conducted in 2018 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<sup>99</sup>.

### 30.7.3 Involuntary and Prompted Relocation

76. Involuntary or prompted relocation of people from their homes has been shown to play a determinative role in health outcomes<sup>100, 101</sup>. Disturbance to people's living and social

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<sup>96</sup> Kartseva, M. and Kuznetsova, P. (2020) The economic consequences of the coronavirus pandemic: which groups will suffer more in terms of loss of employment and income?.

<sup>97</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.

<sup>98</sup> Thomson, H. and Petticrew, M., (2005), Is Housing Improvement a Potential Health Improvement Strategy, World Health Organisation Europe.

<sup>99</sup> World Health Organisation (2018) Housing Impacts Health: New WHO Guidelines on Housing and Health.

<sup>100</sup> Miltenburg, E.M., van de Werfhorst, H.G., Musterd, S. and Tieskens, K. (2018) Consequences of forced residential relocation: Early impacts of urban renewal strategies on forced relocatees' housing opportunities and socioeconomic outcomes. *Housing Policy Debate*, 28(4), pp.609-634.

<sup>101</sup> Holder, J.M. and Jolley, D., 2012. Forced relocation between nursing homes: residents' health outcomes and potential moderators. *Reviews in Clinical Gerontology*, 22(4), pp.301-319.



environment and routine may precipitate stress and health deterioration in relocated individuals<sup>102</sup>.

77. Moving house involves significant disruption, uncertainty and changes to social networks and familiar environments and routines. Thomson *et al.*, 2003<sup>103</sup> 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 opportunity to negotiate with the housing authority regarding control around the move'.

78. 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 stress<sup>104</sup>. In the extreme, relocation has been implicated in increased mortality in highly vulnerable persons, such as the institutionalised elderly<sup>105</sup>.

79. 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.

#### **30.7.4 Vulnerable Groups**

80. Ekstrom (1994) suggests that 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 of relocation. For those living in social housing, the impact of moving house, which is considered to be

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<sup>102</sup> 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.

<sup>103</sup> Thomson, H., *et al.* (2003), *Health Impact Assessment of Housing Improvements: Incorporating Research Evidence*.

<sup>104</sup> Weaver, R.H., Roberto, K.A. and Brossoie, N. (2020) A scoping review: Characteristics and outcomes of residents who experience involuntary relocation. *The Gerontologist*, 60(1), pp.e20-e37.

<sup>105</sup> 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>



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.

## 30.8 Physical activity

### 30.8.1 Environmental Influences of Physical Activity

81. A review of available data and literature undertaken by Cavill and Roberts (2011)<sup>106</sup> who did a study for the NHS 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.

82. The report also states that less clear associations have been noted for aesthetic features of the environment and parks, and perceived crime'.

83. 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 purposes<sup>107</sup>. However, safety concerns relating to road traffic can influence the choice of mode of transport and levels of physical activity. The fear of traffic is the most common barrier to cycling; a fear that is 'exaggerated in comparison with the likelihood of injury'.

84. Physical activity can be encouraged by improving accessibility to green spaces, ensuring green spaces are of a high quality and attractive<sup>108</sup>. The evidence indicates that green

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<sup>106</sup> 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.

<sup>107</sup> Caldwell, L.L., (2005), Leisure and Health: Why is Leisure Therapeutic?

<sup>108</sup> Randall, C., (2012), Measuring National Well-being - Where we Live – 2012, Office for National Statistics.





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 areas<sup>109</sup>. 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 obesity<sup>110</sup>.

85. However, a review of the evidence for environmental influences on obesity<sup>111</sup> has suggested that *'the contribution of environmental variables in explaining the variation of physical activity or walking is small and less important than socio-demographic variables'*.

### 30.8.2 Physical Health Effects

86. 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'*.<sup>112, 113</sup> . A recent Department of Health report<sup>114</sup> 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.'*

87. It has been shown that *'physical activity improves health throughout the life course- from childhood through to older age'*<sup>115</sup>. The health benefits of physical exercise occur across virtually the full range of diseases, and when this is combined with the prevalence of

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<sup>109</sup> Department of Health, (2004). At Least Five a Week: Evidence on the Impact of Physical Activity and its Relationship to Health.

<sup>110</sup> Greenspace Scotland, (2009), Health Impact Assessment of Greenspace - A Guide.

<sup>111</sup> Jones, A, *et al.* (2019), Obesogenic Environments Evidence Review, Office of Science and Innovation.

<sup>112</sup> Kruk, J. (2014) Health and economic costs of physical inactivity. *Asian Pacific Journal of Cancer Prevention*, 15(18), pp.7499-7503.

<sup>113</sup> Knight, J.A. (2012) Physical inactivity: associated diseases and disorders. *Annals of Clinical & Laboratory Science*, 42(3), pp.320-337.

<sup>114</sup> Department of Health, (2011), Start Active, Stay Active: A Report on Physical Activity from the Four Home Countries' Chief Medical Officers.

<sup>115</sup> 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.



inactivity among the public, it '*makes physical activity one of the main contemporary public health issues*'.<sup>116</sup>

### 30.8.3 Mental Health Effects

88. Positive mental health effects associated with exercise have been highlighted in evidence reviews by Cave *et al.*<sup>117</sup>, Sport England<sup>118</sup>, and AEA Technology<sup>119</sup>. Mental health effects cited include improvements in people with generalised anxiety disorders including phobias, panic attacks, and stress disorders.

89. A Government review<sup>120</sup> has also identified that exercise can have positive effects on psychological well-being in people with schizophrenia. The review also states that exercise can aid in the treatment of clinical depression, sleep problems and low self-esteem, 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 well-being.

### 30.8.4 Vulnerable Groups

90. Although all groups are shown to benefit from regular exercise, the benefits to children and the elderly are particularly emphasised<sup>121,122</sup>. 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 and DH, 2004<sup>93</sup>). The benefits for the elderly include retention of mobility, cognitive function, and independence<sup>123</sup>.

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<sup>116</sup> Public Health England, (2020), Improving Access to Green Space a New Review for 2020.

<sup>117</sup> Cave, B, *et al.* (2001), 'Health Impact Assessment for Regeneration Projects. Volume II Selected evidence base']. East London and City Health Action Zone.

<sup>118</sup> Sport England, (2007). 'Active Design. Promoting Opportunities for Sport and Physical Activity Through Good Design'. Supported by CABE, DH & DCMS. Sport England.

<sup>119</sup> AEA Technology, (2000), 'Informing Transport Health Impact Assessment in London'. Commissioned by NHS Executive, London.

<sup>120</sup> Department of Health (DH), (2004), Chief Medical Officers Report- 'At least Five A Week: Evidence on the impact of Physical Activity and its Relationship to Health'.

<sup>121</sup> Francis, P (2014). "Physical activities in elderly: benefits and barriers."

<sup>122</sup> Archer, T. (2014) Health benefits of physical exercise for children and adolescents. *Journal of Novel Physiotherapies*, 4(2), p.203.

<sup>123</sup> Department of Health, (2004), 'Choosing Health Summaries: Diet and Nutrition'. Public Health White Paper.



## 30.9 Access to Services

91. According to Quigley *et al.*<sup>124</sup>, 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 and transport connections);
- Social and/or cultural access (i.e., communication issues); and
- Separation imposed by a new piece of physical infrastructure.

### 30.9.1 Healthcare

92. 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 live<sup>125</sup>.

93. According to the Department for Transport, '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'<sup>126</sup>. The 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 services<sup>127</sup>. Groups impacted by disability and of certain ages may experience even greater barriers to health and social care services<sup>128</sup>.

### 30.9.2 Shops

94. Research (Harding, 1997) has suggested that 'access to local shops, post offices, places of entertainment and community activity all contribute to well-being'. The research suggests that adults in Great Britain feel 'isolated' as a result of difficulty in accessing local shops and services<sup>129</sup>.

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<sup>124</sup> 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.

<sup>125</sup> Department for Communities and Local Government, (2008), Place Survey, UK Government.

<sup>126</sup> Social Exclusion Unit, (2003), Making the Connections: Final Report on Transport and Social Exclusion.

<sup>127</sup> Randall, C., (2012), Measuring National Well-being - Where we Live - 2012, Office for National Statistics.

<sup>128</sup> Hamer, L., (2004), Improving Patient Access to Health Services: A National Review and Case Studies of Current Approaches, Health Development Agency.

<sup>129</sup> 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.



### 30.9.3 Leisure, Faith, Culture, and Recreational Facilities

95. 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*'<sup>130</sup>. 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'<sup>131</sup>

### 30.9.4 Vulnerable Groups

96. 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.

97. Mobility-impaired or visually impaired people will be particularly vulnerable to impacts such as local footpath diversions.

98. 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.

## 30.10 Transport

99. 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.

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<sup>130</sup> Caldwell, L.L., (2005), Leisure and health: Why is Leisure Therapeutic?

<sup>131</sup> New Zealand Government, 2007, Social Report: Leisure and Recreation, Ministry of Social Development, New Zealand Government.



### 30.10.1 User Experience

100. Journey ambience is identified as an appraisal criterion in the Government's Transport Analysis Guidance<sup>132</sup>. This document includes 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 traveller's driving skill and experience, temperament, knowledge of the route and state of health.*'

101. The Guidance identifies 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.

### 30.10.2 Accessibility of Stations

102. The Government's Transport Analysis Guidance<sup>133</sup> states that 'some public transport users (e.g., the disabled and mothers with young children) may experience frustration in accessing and egressing public transport'.

### 30.10.3 Road Safety

103. Additional HGVs on the road network can influence the risk of serious accidents and fatalities, particularly those involving non-motorised vehicles. According to Department for Transport (DfT) figures<sup>134</sup> there were 7,103 accidents in 2010 involving at least one HGV, with 9,686 casualties of which 263 were fatal.

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<sup>132</sup> Transport Analysis Guidance (TAG), (2003), The Journey Ambience Sub-Objective, TAG Unit 3.3.13, Department for Transport.

<sup>133</sup> Transport Analysis Guidance (TAG), (2003), The Journey Ambience Sub-Objective, TAG Unit 3.3.13, Department for Transport.

<sup>134</sup> Department for Transport, (2011), Road Freight Statistics, Statistical Release,



**104.** According to the Government's Transport Analysis Guidance<sup>135</sup> '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, 2012). The DfT figures state 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.

### 30.11 Social Capital

105. The World Bank's 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'*<sup>136</sup>.

106. According to a literature review by Cave *et al.* (2001),<sup>137</sup> 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 the 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.

107. Social networks are also credited with 'creating opportunities for advice and informal care'<sup>138</sup>

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<sup>135</sup> Transport Analysis Guidance (TAG), (2003), The Journey Ambience Sub-Objective, TAG Unit 3.3.13, Department for Transport.

<sup>136</sup> The World Bank, (1999), What is Social Capital? PovertyNet.

<sup>137</sup> Cave, B., *et al.*, (2001), Health Impact Assessment for Regeneration Projects. Volume II Selected Evidence base, East London and City Health Action Zone, University of London.

<sup>138</sup> Health Development Agency, (2005), Making the Case: Improving Health Through Transport, National Health Service.





108. The Social Exclusion Unit<sup>139</sup> 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."*

### **30.11.1 Community Consistency**

109. 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'<sup>140</sup>. 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'*.

### **30.11.2 Crime**

110. Social capital is considered a strong determinant of crime rates in a community, as strong social networks strengthen communities and deter crime and antisocial behaviour<sup>141, 142</sup>. Crime is in turn an important determinant of health and wellbeing<sup>143</sup>, so increasing social capital can serve to decrease the adverse health and wellbeing impacts associated with crime.

### **30.11.3 Vulnerable Groups**

**111.** Some population groups are believed to be at particular risk of social exclusion, including minority ethnic groups, disabled people, lone parents, older people, carers, asylum seekers refugees and ex-offenders.<sup>144</sup>

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<sup>139</sup> Unit, S.E. and Britain, G. (2001) Preventing social exclusion. London: Cabinet Office.

<sup>140</sup> Performance and Innovation Unit, (2002), Social Capital, A Discussion Paper, The Cabinet Office.

<sup>141</sup> Johnson, D.T., Headey, B. and Jensen, B (2006) Communities, social capital and public policy: literature review. FaHCSIA Research Paper, (26).

<sup>142</sup> Behera, J.K. (2021) Role of social capital in disaster risk management: A theoretical review. Int. J. Manag.(IJM), 12, pp.221-233.

<sup>143</sup> Greater London Authority, 2005, Review of the London Health Strategy High Level Indicators, London Health Commission

<sup>144</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.



## 30.12 Vulnerable Groups

112. According to the Government's Transport Analysis Guidance<sup>145</sup> *'the impact of transport is more fundamental to health for certain sectors of society than others. Vulnerable groups include children, the elderly, the 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 number of road casualties.'*

### 30.12.1 Overview of Vulnerable Groups

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

### 30.12.2 Older People

114. The Marmot Review (2010) highlights that 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.<sup>146</sup>

115. The Review also suggests that 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,

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<sup>145</sup> Transport Analysis Guidance (TAG), The Journey Ambience Sub-Objective, TAG Unit 3.3.13, Department for Transport, June 2003.

<sup>146</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.



footpath diversions, and permanent or temporary loss of local facilities. They are also likely to find it more difficult to adapt to changes<sup>147</sup>.

116. 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.<sup>148</sup>

### 30.12.3 Children and Adolescents

117. 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<sup>149</sup>

118. Children are also more likely to be involved in road traffic accidents<sup>150</sup>. The barriers to physical activity created by heavy traffic are especially restrictive for children<sup>151</sup>.

119. Children from low-income families and/or living in deprived areas are particularly sensitive to health and well-being impacts associated with social, economic, and environmental changes<sup>152</sup>.

### 30.12.4 Disabled People and Long-Term Illness Sufferers

120. 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<sup>153</sup>

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<sup>147</sup> Marsden, G. and Docherty, I. (2021) Mega-disruptions and policy change: Lessons from the mobility sector in response to the Covid-19 pandemic in the UK. *Transport Policy*, 110, pp.86-97.

<sup>148</sup> 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.

<sup>149</sup> Bhutta, Z.A., Bhavnani, S., Betancourt, T.S., Tomlinson, M. and Patel, V. (2023) Adverse childhood experiences and lifelong health. *Nature Medicine*, 29(7), pp.1639-1648.

<sup>150</sup> Novikov, A., Shevtsova, A. and Vasilieva, V. (2020) Development of approach to reduce number of accidents caused by drivers. *Transportation research procedia*, 50, pp.491-498.

<sup>151</sup> Devarajan, R., Prabhakaran, D. and Goenka, S., 2020. Built environment for physical activity—An urban barometer, surveillance, and monitoring. *Obesity Reviews*, 21(1), p 12938.

<sup>152</sup> Visser, K., Bolt, G., Finkenauer, C., Jonker, M., Weinberg, D. and Stevens, G.W. (2021) Neighbourhood deprivation effects on young people's mental health and well-being: A systematic review of the literature. *Social Science & Medicine*, 270, p.113542.

<sup>153</sup> Cianconi, P., Betrò, S. and Janiri, L. (2020) The impact of climate change on mental health: a systematic descriptive review. *Frontiers in psychiatry*, 11, p.74.



121. 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.
122. 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.<sup>154</sup>

### 30.12.5 Low-Income/Lower Socio-Economic Groups

123. The Marmot Review (2010)<sup>155</sup> advises that 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.
124. The Marmot Review (2010) also highlights that low-income groups and those living in deprived areas are shown to experience disproportionately greater numbers of road casualties. Traffic volumes and the proportion of vehicles exceeding speed limits are also generally higher in less affluent areas<sup>156</sup>.
125. 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<sup>157</sup>. 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.<sup>158</sup>

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<sup>154</sup> 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.

<sup>155</sup> Marmot, M., *et al.*, (2010), Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England Post-2010, The Marmot Review.

<sup>156</sup> Aldred, R., Verlinghieri, E., Sharkey, M., Itova, I. and Goodman, A., 2021. Equity in new active travel infrastructure: A spatial analysis of London's new Low Traffic Neighbourhoods. *Journal of Transport Geography*, 96, p.103194.

<sup>157</sup> Pykett, J., Chrisinger, B., Kyriakou, K., Osborne, T., Resch, B., Stathi, A., Toth, E. and Whittaker, A.C., 2020. Developing a Citizen Social Science approach to understand urban stress and promote wellbeing in urban communities. *Palgrave Communications*, 6(1), pp.1-11.

<sup>158</sup> Cave, B., *et al.* (2001), 'Health Impact Assessment for Regeneration Projects. Volume II Selected evidence base']. East London and City Health Action Zone.



126. These communities also tend to have a higher incidence of health-damaging behaviours such as smoking and poor diet<sup>159</sup>. All of these result in lower levels of baseline health and well-being and reduced resilience<sup>160</sup>.

### **30.12.6 Ethnic Minority Groups**

127. Randall (2012)<sup>161</sup> has researched health inequalities in ethnic minority groups and highlighted that 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.

128. Other factors such as language and lifestyle may also influence the way in which different ethnic groups are affected by impacts on health determinants.

129. Non-English speakers may face barriers to accessing information about the works or expressing their concerns.

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<sup>159</sup> Marteau, T.M., Rutter, H. and Marmot, M. (2021) Changing behaviour: an essential component of tackling health inequalities. *Bmj*, 372.

<sup>160</sup> Kumareswaran, K. and Jayasinghe, G.Y. (2023) Climate resilience and sustainable cities. In *Green Infrastructure and Urban Climate Resilience: An Introduction* (pp. 39-97). Cham: Springer International Publishing.

<sup>161</sup> Randall, C., (2012) *Measuring National Well-being - Where we Live – 2012*, Office for National Statistics.



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