Appendix A

TOPIC BASED SCHEMES ASSESSMENT: AoS FOR CONSULTATION DRAFT AIRPORTS NPS

A-4 NOISE

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4 NOISE

4.1 INTRODUCTION

4.1.1 This topic-based assessment considers each airport expansion scheme under the Noise topic. These are London Heathrow Extended Northern Runway (LHR-ENR), London Heathrow Northwest Runway (LHR-NWR) and London Gatwick Second Runway (LGW-2R) (together the shortlisted schemes).

4.1.2 By law, before designating an Airports National Policy Statement (NPS) an Appraisal of Sustainability (AoS) must be carried out. This AoS is a strategic level assessment. It is based on the contents of the draft Airports NPS. The AoS considers alternatives to the Government's preferred scheme as set out in the draft Airports NPS, including the outline masterplans supplied to the Airports Commission (AC) for the three shortlisted schemes. This AoS considers the impacts of expansion without the benefits of the mitigation package put forward by scheme promoters, unless stated otherwise. The Government has outlined that it expects a significant mitigation package to be put in place by the promoter of its preferred scheme to ensure that, wherever possible, significant effects are avoided, reduced or offset.

4.1.3 Further project-level design will be required which will inform an environmental impact assessment (EIA) carried out by the promoter. This would include an assessment, which is likely to include effects identified in the AoS as well as more detailed mitigation developed as detailed design progresses. This will also be developed through consultation with both affected communities and other stakeholders.

4.1.4 This assessment builds on the sustainability assessment undertaken as part of the AC's Appraisal Framework[1], but also responds to the AoS Appraisal Framework. The Framework addresses noise issues that have been identified through scoping (a review of plans, policies and programmes, and also the baseline conditions).

4.1.5 Each expansion scheme is considered against the AoS Appraisal Framework Objectives and Appraisal Questions. The Objective and Question which are addressed within this assessment are as follows:

- **AoS Objective 6:** To minimise and where possible reduce noise impacts on human receptors.
  - **AoS Question 11:** Will it avoid, prevent or reduce the harmful effects due to exposure of people and sensitive buildings to noise?

4.2 POLICY AND LEGISLATION

4.2.1 The policy guidance framework considered relevant to this assessment is summarised below. Their context and applicability is explained as appropriate in the relevant sections of the assessment.

[1] Airports Commission, 2014. *Appraisal Framework*. [online] Accessed 24/12/2015.

Aviation Policy Framework (APF)

4.2.2 The APF[2] sets out central Government policy on air transport, the role of the AC, and Government aims and objectives for a wide range of factors relevant to making plans and decisions on aviation provision, including the effects of noise. The aviation policy objectives are consistent with Government policy on noise.

Noise Policy Statement for England (NPSE)

4.2.3 The NPSE[3] sets out central Government noise policy for England, and the guiding aims and principles to consider in the preparation of wider policies and planning.

National Planning Policy Framework 2012 (NPPF)

4.2.4 The NPPF[4] sets out central Government planning policies and guidance on policy application. Policies relevant to noise make reference to the NPSE.

Planning Practice Guidance (PPG)

4.2.5 The PPG[5] is an internet-based Government-produced resource providing additional context and information for practitioners and policy makers in applying the NPPF.

Transport analysis guidance: WebTAG

4.2.6 The DfT WebTAG[6] resource provides guidance and tools to appraise the potential costs and benefits of transport proposals. TAG Unit A3[7] addresses environmental impacts, including noise, and outlines an approach to analysing the possible health effects associated with a transport option, based on World Health Organisation (WHO) guidance[8] and research reports from Department for Environment, Food and Rural Affairs (Defra)[9] and the Interdepartmental Group on Costs and Benefits (Noise) [IGCB(N)][10].

4.3 BACKGROUND TO THE ASSESSMENT

4.3.1 The assessment is based on the information contained within the following reports:

- → Jacobs, 2014. *5. Noise: Baseline. Prepared for the Airports Commission*[11];
- → Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*[12];

[2] Department for Transport, 2013. *Aviation Policy Framework.* [online] Accessed 21/12/2015.
[3] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*. [online] Accessed 21/12/2015.
[4] Department for Communities and Local Government, 2012. *National Planning Policy Framework*. [online] Accessed 21/12/2015.
[5] Department for Communities and Local Government, 2014. *Planning Practice Guidance*. [online] Accessed 21/12/2015.
[6] Department for Transport, 2014. *Transport analysis guidance: WebTAG.* [online]. Accessed 04/07/2016.
[7] Department for Transport, 2015. *TAG Unit A3: Environmental Impact Appraisal*. [online] Accessed 03/05/2016.
[8] World Health Organisation, 2011. *Burden of disease from environmental noise*. [online]. Accessed 03/05/2016.
[9] Department for Environment, Food and Rural Affairs, 2014. *Environmental noise: valuing impacts on sleep disturbance, annoyance, hypertension, productivity and quiet.* [online]. Accessed 03/05/2016.
[10] Interdepartmental Group on Costs and Benefits (Noise). Noise and health – valuing the human health impacts of environmental noise exposure. [online]. Accessed 03/05/2016.
[11] Jacobs, 2014. *5. Noise: Baseline.* [online] Accessed 21/12/2015.
[12] Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.

- Jacobs, 2014. *5. Noise: National Assessment. Prepared for the Airports Commission*[13];
- Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum. Prepared for the Airports Commission*[14];
- Jacobs, 2014. *5. Noise: Figures. Prepared for the Airports Commission*[15];
- Jacobs, 2015. *5. Noise: Local Assessment Addendum. Prepared for the Airports Commission*[16];
- Civil Aviation Authority (CAA) Environmental Research Consultancy Department (ERCD), 2015. *Noise Modelling for the Airports Commission: Compendium of Results*[17];
- Airports Commission, 2015. *Final Report*[18];
- Airports Commission, 2015. *Business case and sustainability assessment*[19];
- Airports Commission, 2015. *Compendium of Results* (Parts E-02 to E-20 and F-01 to F-02)[20]; and
- Clark,C, 2015. *Aircraft noise effects on health*[21].

4.3.2 It is not the purpose of this appraisal to repeat the detailed assessment conducted by the AC and reported in the documents listed in paragraph 4.3.1. Instead, the appraisal seeks to draw out the key strategic considerations relevant to noise within the context of the Appraisal Framework for this AoS.

4.3.3 Complementary work has been carried out for this AoS topic to augment the AC assessment information:

- the significance criteria for the Noise topic assessment have been developed with reference to current national noise and aviation policies;
- the potential scale of health effects for each scheme have been compared against each 'do minimum'[22] case and across schemes;
- the cumulative effects of ground and airspace noise[23] are considered together alongside the discrete effects of each type of impact; and
- two separate sensitivity tests are presented in Section 4.13, the first examines a potential 'worst case' scenario for noise impacts, and the second testing the effect of

[13] Jacobs, 2014. *5. Noise: National Assessment.* [online] Accessed 21/12/2015.
[14] Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum.* [online] Accessed 21/12/2015.
[15] Jacobs, 2014. *5. Noise: Figures.* [online] Accessed 21/12/2015.
[16] Jacobs, 2015. *5. Noise: Local Assessment Addendum.* [online] Accessed 21/12/2015.
[17] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results.* [online] Accessed 21/12/2015. NB: Unless otherwise stated, the assessment in this Appendix is based on the data as presented in this Compendium.
[18] Airports Commission, 2015. *Final Report*. [online] Accessed 21/12/2015.
[19] Airports Commission, 2015. *Business case and sustainability assessment.* [online] Accessed 21/12/2015.
[20] Airports Commission, 2015. *Compendium of Results, Parts E-02 to E-20 and F-01 to F-02)*. [online] Accessed 21/12/2015.
[21] Clark, C., 2015. *Aircraft noise effects on health.* [online] Accessed 21/12/2015.
[22] The 'do minimum' represents the conditions expected to exist if the scheme did not go ahead.
[23] Here, 'airspace' noise is meant as noise generated by aircraft in flight, takeoff, and landing; 'ground' noise is that generated by aircraft taxiing and ancillary operations (such as fuelling) around the runways.

a lower exposure threshold to maintain consistency with policy proposed in the UK Airspace Policy consultation[24].

4.4 INTERACTION WITH OTHER TOPICS

4.4.1 This assessment focusses on noise effects on human receptors, including (occupied) noise-sensitive buildings (NSBs)[25]. Noise can also have effects on historical sites, tranquillity, non-human biological organisms, and the wider quality of life for communities. These effects are considered in the AoS within the Historic Environment; Landscape; Biodiversity; Quality of Life and Community topics, respectively. In particular, the following interactions are noted within Table 4.1.

Table 4-1: Interactions with other topics

TOPIC	INTERACTION
Community	Noise can have indirect effects on communities, including affecting community and recreational facilities.
Quality of Life	Noise can impact upon annoyance and loss of sleep leading to effects on quality of life.
Biodiversity	Biodiversity can be affected by noise; disturbance of fauna can adversely affect breeding and foraging.
Historic environment	The setting of heritage assets and tranquillity can be affected by aviation and surface access noise.
Landscape	Landscapes and their tranquillity can be affected by noise.

4.5 ASSESSMENT CRITERIA

4.5.1 The general criteria used for assessing the significance of effects are set out in Section 3 of the AoS Report to which this appendix is attached.

4.5.2 The NPSE sets out three key aims[26]:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

4.5.3 The NPSE states[27] that these aims are framed "within the context of Government policy on sustainable development".

4.5.4 The NPSE also establishes the concepts of Observed Effects Levels (OELs) within the field of environmental noise. These are outlined as:

- no Observed Effect Level (NOEL) – the level below which there are no detectable effects of noise on health and quality of life;

[24] Department for Transport (2017) UK Airspace Policy: A framework for balanced decisions on the design and use of airspace.
[25] Schools, hospitals and religious places of worship are considered noise-sensitive buildings for the purposes of this appraisal. NB. Schools are assessed separately to other NSBs in Section 4.9.
[26] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*, p. 4. [online] Accessed 21/12/2015.
[27] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England.* p. 3, [online] Accessed 21/12/2015.

- → lowest Observed Adverse Effects Level (LOAEL) – the level above which adverse effects on health and quality of life can be detected; and
- → significant Observed Adverse Effects Level (SOAEL) – the level above which significant adverse effects on health and quality of life are expected to occur.

4.5.5 In addition, the current PPG[28] on noise provides further relevant qualitative information, including a description of the adverse effects expected from noise impacts increased beyond the SOAE range:

- → Unacceptable Adverse Effect (UAE) – Outcome: Extensive and regular changes in behaviour and / or an inability to mitigate effect of noise leading to psychological stress or physiological effects, eg regular sleep deprivation/ awakening; loss of appetite; significant, medically definable harm, e.g. auditory and non-auditory; Action: Prevent.

4.5.6 The APF[29] sets out central Government policy with respect to air transport in the country. In this framework, indicative impact threshold levels are provided, which also designate levels of action to be taken by airport operators, as shown in Table 4-2.

Table 4-2: Aviation Policy Framework Threshold Noise Levels

Aviation Policy Framework Threshold Noise Levels	
Threshold noise Level	Policy description
57 dB $L_{Aeq,0700\text{-}2300hrs}$[30]	The approximate onset of significant community annoyance.
63 dB $L_{Aeq,0700\text{-}2300hrs}$	The lowest level at which the Government expects airport operators to offer acoustic insulation to noise-sensitive buildings such as schools and hospitals. Where a residence experiences a 3dB increase in noise that leaves them exposed to levels above this threshold, the Government expects airport operators to offer financial assistance towards acoustic insulation.
69 dB $L_{Aeq,0700\text{-}2300hrs}$	The lowest level at which the Government expects airport operators to offer households assistance with the costs of moving.

4.5.7 It is acknowledged that a range of views exist concerning the most appropriate threshold levels for the onset of effects due to daytime aviation noise[31,32]. It is important to realise that setting any noise threshold value involves simplification of the complexity of human responses to noise in real situations. Moreover, it is not necessarily possible (or desirable) to set a single value that is applied to all types of noise source, or noise impact assessment, and this position is reflected in national policy[33]. This interpretation does not represent an official or endorsed position on the approach to be taken in or adapted to any other assessments or appraisals, which should be considered separately to this AoS and within the set of contexts appropriate to the identified objectives.

[28] Department for Communities and Local Government, 2014. *Planning Practice Guidance*. [online] Accessed 21/12/2015.
[29] Department for Transport, 2013. *Aviation Policy Framework.* [online] Accessed 21/12/2015.
[30] $L_{Aeq,T}$ is the A-weighted equivalent continuous sound pressure level, averaged over time period T.
[31] Airports Commission, 2015. *Consideration of Consultation Responses*, p. 52, paragraphs 2.7.19 – 2.7.22, [online] Accessed 04/07/2016.
[32] Airports Commission, 2014. *Appraisal Framework.* p. 55, paragraph 5.2, [online] Accessed 04/07/2016.
[33] Department for Environment, Food and Rural Affairs, 2010. *Noise Policy Statement for England*, p. 9, paragraph 2.22. [online] Accessed 21/12/2015.

4.5.8 A connection between the description of actions associated with each of the APF thresholds shown in Table 4-2 and the first two aims of the NPSE together with the PPG advice may be drawn:

- → according to the APF, a level of 57 dB $L_{Aeq,0700\text{-}2300hrs}$ marks the approximate onset of significant community annoyance; in the context of current national aviation policy, this level can therefore be taken as within the Observed Adverse Effects (OAE) range;
- → 63 dB $L_{Aeq,0700\text{-}2300hrs}$ is the lowest level at which action must currently be taken by airports to mitigate or avoid the impacts on NSBs via an offer of acoustic insulation. This can therefore be adopted as a SOAEL for the purposes of this assessment; and
- → 69 dB $L_{Aeq,0700\text{-}2300hrs}$ is the lowest level at which action must currently be taken to prevent the impacts (ie an offer of assistance with moving house); therefore this threshold can be adopted as a Unacceptable Adverse Effects Level (UAEL) for the purposes of this assessment.

4.5.9 Identifying a LOAEL for aviation noise is not straightforward, and this is an area of ongoing research and debate. While the APF broadly discusses the need to avoid significant adverse effects on health and quality of life, the impact thresholds provided are not directly linked to specific health effects, with the exception of 57 dB $L_{Aeq,16hr}$ as the approximate onset marker of significant community annoyance[34], according to current UK aviation policy[35]. For the purpose of this AoS, population noise exposure has been assessed against a lower bound set at the >57 dB $L_{Aeq,16hr}$ contour. The assessment of impacts associated with noise-related health effects, as discussed further below, extends down to a threshold of 45 dB L_{den}[36]. The selected threshold levels are not defined here as aviation noise LOAELs, but are adequate to enable this strategic appraisal to be conducted. The Government is currently reviewing several of its aviation noise policies; one of the issues under consideration includes possible schemes for an aviation noise LOAEL. To avoid pre-empting the outcome of the review, current Government policy has been interpreted for the strategic evaluation purposes of this appraisal. A sensitivity test has been conducted to determine the potential effect of varying the lower noise threshold employed in this assessment and is included in Section 4.13.

4.5.10 The AC assessment included consideration of possible health effects due to noise from each scheme, following an approach set out by the CAA, which is based on the IGCB(N) and WHO[37] research underpinning the guidance later published by Defra[38]. The latter also forms part of the WebTAG[39] cost-benefit analysis framework for environmental impacts. The AC approach has been incorporated into this AoS, which addresses annoyance, sleep disturbance, acute myocardial infarction (AMI: heart attack), hypertension-related stroke and hypertension-related dementia.

[34] Annoyance is considered as a health effect under the World Health Organisation definition of health; see World Health Organisation, 2011. *Burden of disease from environmental noise,* p. 4, paragraph 4. [online] Accessed 04/07/2016.
[35] Department for Transport, 2013. *Aviation Policy Framework,* p. 58, paragraph 3.17. [online] Accessed 21/12/2015.
[36] Day-evening-night level: a weighted average of L_{Aeq} over the 24h period.
[37] World Health Organisation, 2011. *Burden of disease from environmental noise.* [online] Accessed 03/05/2016.
[38] Department for Environment, Food and Rural Affairs, 2014. *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet.* [online]. Accessed 04/07/2016.
[39] Department for Transport, 2015. *TAG Unit A3 Environmental Impact Appraisal.* [online]. Accessed 04/07/2016.

4.5.11 The criteria adopted for assessing the scale of health effects have been formed by the exposure-response (or dose-effect) relationships identified by the WHO for annoyance[40], sleep disturbance[41], and AMI[42,43], and by the Health & Safety Laboratory for hypertension-related disorders[44] (commissioned by Defra). The output for this assessment of health effects is in terms of the numbers of 'Disability-Adjusted Life Years' (DALYs; an estimate of the potential healthy life years lost due to premature morbidity or mortality).

4.5.12 An assessment of the potential aviation noise impacts of each scheme on children's cognitive development has been conducted by Queen Mary University of London[45]. There were no specific 'significance' criteria applied, but the assessment examined numbers of schools exposed to daytime average contours down to 54 dB $L_{Aeq,16hr}$. Detailed explanations of noise metrics can be found in the AC reports[46].

4.5.13 The third aim of the NPSE (see paragraph 4.5.2) is intended to bring about improvements in health and quality of life by effective management and control of noise. Beneficial changes in these indicators could be expected to occur where the population exposed to levels exceeding 57 dB $L_{Aeq,16hr}$ and the Adverse Effects Levels (AELs) discussed above is reduced.

4.5.14 On the basis of the framework discussed above, the criteria shown in Table 4-3 have been adopted for the Noise topic assessment. In developing the assessment criteria, a distinction has been made between i) people, ii) schools, and iii) other non-residential NSBs (in this context taken to comprise hospitals and religious places of worship). It is acknowledged that the criteria cannot and do not represent the full complexity of the potential effects of noise that could be experienced at an individual level. In particular, the assessment focuses on the 'L_{eq}' metric, which is an 'equivalent' sound level averaged over specified periods and as such does not directly represent the short-term levels of individual aircraft noise events that may be experienced subjectively. This is because this assessment approach has been developed with a view to providing a platform for a strategic appraisal of the most likely and significant effects associated with each expansion scheme, in view of current Government policy and established exposure-response research. A wider EIA would be required for any scheme taken forwards, including further consideration of potential environmental effects at a more detailed level.

[40] World Health Organisation, 2011. *Burden of disease from environmental noise*, p. 93. [online] Accessed 03/05/2016.
[41] World Health Organisation, 2011. *Burden of disease from environmental noise*, p. 59. [online] Accessed 03/05/2016.
[42] World Health Organisation, 2011. *Burden of disease from environmental noise,* p. 22. [online] Accessed 03/05/2016.
[43] Babisch,W, 2006. *Transportation noise and cardiovascular risk. Review and synthesis of epidemiological studies. Dessau: Umweltbundesamt*. [online] Accessed 03/05/2016.
[44] Harding, A-H., Frost, G., Mason, H., Tan, E., Tsuchiya, A. and Warren, N., 2011. *Quantifying the links between environmental noise related hypertension and health effects. Crown Copyright*. [online] Accessed 03/05/2016.
[45] Clark,C, 2015. *Aircraft noise effects on health.* [online] Accessed 21/12/2015.
[46] Jacobs, 2014. *5. Noise: Local Assessment,* pp. 3-6. [online] Accessed 21/12/2015.

Table 4-3: Noise Topic AoS Assessment Criteria

Classification of Effects in the AoS		
Code	Classification	Description
++	Significant positive effect	Reduction in population DALYs lost Reduction in schools exposed to SOAEL/UAEL
+	Positive effect	Reduced population/NSB exposure to >57 dB contour Reduced population/NSB exposure to SOAEL/UAEL Reduction in schools exposed to daytime noise below SOAEL
-	Negative effect	Increase in numbers of schools/NSBs exposed to daytime noise below SOAEL
--	Significant negative effect	Increase in population DALYs lost Increase in population exposed to >57 dB contour Increase in population exposed to SOAEL/ UAEL Increase in numbers of schools/NSBs exposed to SOAEL/UAEL
+/-, ++/--,	Mixed positive and negative effects	Combinations of the above impacts where there is no dominating factor
?	Uncertain effect	Population exposure or effect uncertain
0	No relationship/neutral effect	No changes in population exposure to effects thresholds or DALYs

Notes to Table 4-3:

1. Throughout the assessment, the terms beneficial/positive and adverse/negative are used interchangeably in relation to effects, with the latter term in each case referring to the conclusions drawn from the assessment, in order to maintain compatibility with the wider AoS.

2. The assessment criteria have been developed to provide a platform for a strategic appraisal of the most likely and significant effects associated with each scheme, in view of current Government policy, which has been interpreted for the specific purposes of this assessment – this does not represent an official or endorsed position on the approach to be taken and criteria for use in any other assessments or appraisals.

4.5.15 It should be noted that schemes are assessed individually against the requirements of the Strategic Environmental Assessment (SEA) Regulations and presented together for comparison. This means that although the nature of effects can vary between schemes, the significance may be the same.

4.6 SUMMARY OF BASELINE AND FUTURE BASELINE

4.6.1 The baseline noise assessment[47] for Gatwick and Heathrow describes how noise exposure is expected to change at the national and local levels in the absence of a scheme, and identifies the underlying reasons for these changes. Aviation noise associated with the 'do minimum' scenarios for the base year (2030), an intermediate year (2040), and end year (2050) were considered, in addition to the 'present-day' noise situations at each airport (considered for 2011/2013)[48].

4.6.2 Numbers of people and non-residential NSBs exposed to the selected noise thresholds have been estimated from modelling described further in Sections 4.7 and 4.8. The study areas have been defined at the local level by consideration of the total areas covered by the modelled contours around each airport[49]. At the national level, the study area includes the modelled contour areas around each of 13 selected UK airports (see Paragraph 4.7.4 below), and considers the enclosed population exposures[50].

4.6.3 It is anticipated that there will be significant changes in the aircraft operated over the period, and by 2050, an increased percentage of the aircraft operating will be new or re-engined aircraft, which would be quieter than current aircraft[51]. It is expected that these developments would lead to smaller overall areas being subject to the current levels of noise in the future do minimum assessment years. Nationally, the improvements in aircraft technology could largely offset noise generated by additional Air Transport Movements (ATMs)[52]. As well as reducing noise at source, further noise benefits by 2050 would be expected from the increased use of quieter operating procedures such as steeper approaches, continuous climb and delayed deployment of landing gear. Improved navigational technology and airspace modernisation could also change how and where aircraft fly, providing increased potential to reduce the impact on communities.

4.6.4 The AC appraisal considered a range of potential future scenarios to allow for forecasting uncertainty. A detailed description of these scenarios was published in the AC's updated forecasts[53]. The assessment of the potential aviation noise impacts generated by each scheme depends on the assumptions adopted in the prediction scenarios. There are three primary factors considered:

i. Future aviation demand
ii. Carbon policy
iii. Flight path strategies

[47] Jacobs, 2014. *5. Noise: Baseline*. [online] Accessed 21/12/2015.
[48] The impacts of expansion are measured against a future 'do minimum' case in years 2030, 2040 and 2050. The 'present day' noise impacts (2011 for L_{den} and 2013 for L_{Aeq}) are presented as a reference point. The baseline data have not been updated from those used by the Airports Commission. DfT reviewed the Airports Commission's noise assessment and found the evidence contained was sound and robust.
[49] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 10, 75-76 and 207-208. [online] Accessed 21/12/2015.
[50] Jacobs, 2014. *5. Noise: National Assessment*, p. 37, Appendix B. [online] Accessed 21/12/2015.
[51] Jacobs, 2014. *5. Noise: Baseline*, pp. ii-iv, Executive Summary. [online] Accessed 21/12/2015.
[52] Jacobs, 2014. *5. Noise: Baseline*, p. iv, Executive Summary. [online] Accessed 21/12/2015.
[53] Airports Commission, 2015. *Strategic fit: forecasts.* [online] Last accessed 29/07/2016.

4.6.5 When considering future aviation demand, the AC adopted the 'assessment of need' (AoN) scenario as the starting point for its analysis of impacts, testing those results against other scenarios as appropriate. In this scenario, future demand is primarily determined by central projections published by sources such as the Office for Budget Responsibility, Organisation for Economic Coordination and Development (OECD) and International Monetary Fund (IMF) and assumes that there are no changes in airline business models. This is broadly consistent with the central scenario used in the Government's most recent aviation forecasts[54].

4.6.6 The AC also considered two potential carbon policy futures: carbon traded and carbon capped. In order to simplify the presentation of the assessment, the carbon traded scenario is presented where available. Carbon traded data is not available for the national noise assessment and so carbon capped is presented instead. The carbon capped scenarios largely result in lower aviation demand and therefore lower noise impacts. Expanding either Heathrow or Gatwick in whichever carbon future will generally result in increased local noise exposure from increased flights. However, it is very unlikely that expansion would result in increased flights at other airports in the UK, and the predictions indicate expected reductions in ATMs at the other airports considered. Therefore noise exposure around the other airports is also likely to reduce. Given that, with expansion of Heathrow or Gatwick, regional airports are expected to see a decrease in flights compared to the do minimum, consideration of the carbon capped scenario is sufficient, since, in either carbon future, regional airports are likely to experience a decrease in the noise exposure of their local populations. The set of scenario assumptions adopted (aviation demand and future carbon policy) are designated for each noise consideration below. The adopted assessment scenarios are detailed further in Section 4.7.

4.6.7 An alternative forecast was also considered by the AC: the 'low cost is king, carbon traded' scenario[55]. Low cost is king (LCiK) is considered to represent the worst case demand forecasting with respect to potential noise impacts, and a sensitivity test conducted to examine the effect on the assessment outcomes under this scenario is included in Section 4.13.

4.6.8 The assumed flight path designs for LGW-2R[56], LHR-ENR[57], LHR-NWR[58] reflect those selected by the AC in its final assessment[59].

4.6.9 The baseline local population exposures to airspace noise (AoN carbon traded scenario) are summarised in Table 4-4.

Table 4-4: Baseline Local Population Airspace Noise Exposure (AoN Carbon Traded)[60]

Noise Contour ↓	Gatwick Population Noise Exposure				Heathrow Population Noise Exposure			
	Current (2013)	2030	2040	2050	Current (2013)	2030	2040	2050
>57 dB $L_{Aeq,0700-2300hrs}$	3,550	2,700	2,300	2,800	266,100	217,300	220,900	222,200

[54] Department for Transport, 2013. *UK Aviation Forecasts.* [online] Last accessed 29/07/2016.
[55] Jacobs, 2014. *5. Noise: Local Assessment*, Section A.1.1. Appendix A. [online] Accessed 21/12/2015.
[56] Jacobs, 2014. *5. Noise: Local Assessment*, p. 11, Figure 3.2. [online] Accessed 21/12/2015.
[57] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, p. 3, Figure 2.2. [online] Accessed 21/12/2015.
[58] Jacobs, 2014. *5. Noise: Local Assessment*, p. 78, Figure 4.2. [online] Accessed 21/12/2015.
[59] Airports Commission, 2015. *Final Report.* [online] Accessed 21/12/2015.
[60] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables A1, A5-A7, A26, and A30-A32. [online] Accessed 21/12/2015.

Noise Contour ↓	Gatwick Population Noise Exposure				Heathrow Population Noise Exposure			
	Current (2013)	2030	2040	2050	Current (2013)	2030	2040	2050
>63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	350	400	500	500	48,400	34,400	34,600	35,800
>69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	0	200	200	200	2,700	2,100	2,100	2,600
>48 dB $L_{Aeq,2300-0700hrs}$ (night-time)	11,200	13,300	12,200	11,600	421,300	371,000	335,600	388,700

4.6.10 The baseline local schools and other NSB exposures to airspace noise (AoN carbon traded scenario) are summarised in Table 4-5.

Table 4-5: Baseline Local Noise Sensitive Buildings Airspace Noise Exposure (AoN Carbon Traded)[61]

Noise Contour ↓	Gatwick NSB Noise Exposure				Heathrow NSB Noise Exposure			
	Current (2013)	2030	2040	2050	Current (2013)	2030	2040	2050
Schools								
>54 dB $L_{Aeq,0700-2300hrs}$	15	10	8	8	460	304	268	257
>57 dB $L_{Aeq,0700-2300hrs}$	3	3	3	3	167	109	102	101
>60 dB $L_{Aeq,0700-2300hrs}$	2	2	2	2	64	36	33	38
>63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	2	2	2	2	19	11	11	11
>66 dB $L_{Aeq,0700-2300hrs}$	1	0	0	0	7	2	2	1
>69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	0	0	0	0	1	0	0	0
>72 dB $L_{Aeq,0700-2300hrs}$	0	0	0	0	0	0	0	0
Hospitals and places of worship								
>57 dB $L_{Aeq,0700-2300hrs}$	2	2	2	2	122	77	73	75
>63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	2	2	2	2	16	9	9	9

[61] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables B1-B4 and B8-B11. [online] Accessed 21/12/2015.

Noise Contour ↓	Gatwick NSB Noise Exposure				Heathrow NSB Noise Exposure			
	Current (2013)	2030	2040	2050	Current (2013)	2030	2040	2050
>69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	0	0	0	0	1	0	0	0

4.6.11 The baseline local population exposures to ground noise are summarised in Table 4-6.

Table 4-6: Baseline Local Population Ground Noise Exposure[62]

Noise Area Threshold ↓	Gatwick Population Noise Exposure		Heathrow Population Noise Exposure	
	Current (2013)	2030	Current (2013)	2030
≥57 dB $L_{Aeq,0700-2300hrs}$	900	3,150	30,650	30,750

4.6.12 The baseline national population exposures to airspace noise are summarised in Table 4-7 (AoN carbon capped scenario).

Table 4-7: Baseline National Population Airspace Noise Exposure (AoN Carbon Capped)[63]

Noise Contour ↓	Current (2013)	2030	2040	2050
>57 dB $L_{Aeq,0700-2300hrs}$	363,450	340,750	346,400	357,050
>63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	55,100	43,900	44,500	47,850
>69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	3,450	2,450	2,600	3,050
>48 dB $L_{Aeq,2300-0700hrs}$ (night-time)	578,950	449,100	533,650	594,500

4.7 APPROACH TO ASSESSMENT OF NOISE

4.7.1 Construction phase impacts have been assessed on a qualitative basis, considering the scale of the proposed schemes and the proximity to sensitive receptors. Detailed assessment of construction impacts and opportunities for mitigation would be required at the EIA stage for any scheme taken forward.

4.7.2 Impacts at the strategic level have been assessed for the operational phase of each scheme. During operation, potential impacts include airspace and ground noise, of which airspace noise is considered of greater importance due to its wide dispersion and the limitations of available mitigation.

4.7.3 While noise from surface access transportation has the potential to affect areas with changes in noise, any such effects would be localised and limited in spatial extent. It is acknowledged that aviation noise will be the predominant source of potentially significant impacts that entail strategic consideration, and no changes to the overall assessment outcomes are expected due to surface access noise. The potential for cumulative effects of surface access and aviation sources has been given outline consideration within the AoS, and the potential impacts of surface access noise and scope for mitigation should be assessed in further detail at the EIA stage.

[62] Jacobs, 2014. *5. Noise: Baseline,* pp. 29 and 67, Tables 3.6 and 4.6. [online] Accessed 21/12/2015
[63] Jacobs, 2014. *5. Noise: Baseline,* pp. 95, 96, 98 and 100, Tables 6.1, 6.2, 6.4 and 6.6. [online] Accessed 21/12/2015.

4.7.4 The assessment of operational noise impacts is based on the results reported in the source references listed in paragraph 4.3.1. The airspace noise results have been formed from the outputs of the ERCD of the CAA 'ANCON/ANCON2' models, which predict contours at specified level threshold intervals, overlaid on geo-referenced population data to produce estimations of population counts and numbers of NSBs exposed to each designated threshold.

4.7.5 The ground noise impacts have been derived from a separate ground noise prediction model, which outputs an approximation of the total area exposed to a given threshold, centred on the airport[64]. This area has then been used to estimate population noise exposure. The potential cumulative effects of ground and airspace noise on local receptors have also been considered in the assessment below.

4.7.6 The effects of airspace noise are considered at local and national levels separately. The 13 airports[65] included in the national assessment comprise those exceeding 50,000 annual ATMs, which represent the majority of UK air transport provision, as well as those within the London Terminal Manoeuvring Area (LTMA), which would be significantly affected by airport expansion.

4.7.7 The 'AoN carbon traded' aviation scenario has been assessed for each scheme, wherever assessment data are available. This scenario is broadly consistent with the central scenario employed in the latest Government aviation forecasts[66]. The carbon traded scenario is adopted as the focus of this assessment to simplify the presentation of the analysis. Where assessment data are unavailable for this scenario, the 'AoN carbon capped' scenario has been assessed; it is acknowledged that carbon capped scenarios may produce lower estimates of noise impacts in some cases and use of each scenario has been highlighted in the relevant assessment sections. Operational Assumptions underpinning the ground noise assessment are discussed in Section 4.11.

4.7.8 The assessment of health effects is based on the existing monetisation analysis[67], which includes an assumed range of values for the 'disability weighting'[68] for annoyance, sleep disturbance and AMI effects, reflecting the expected uncertainty with regards to population health outcomes. The weighting values used for sleep disturbance are 0.04 (low), 0.07 (mid) and 0.1 (high). The weightings used for annoyance are 0.01 (low), 0.02 (mid) and 0.12 (high). The weighting used for AMI is 0.405.

4.7.9 The monetised quantities are converted to DALY values by dividing by the value of a DALY used in the assessment: £68,851[69]. The output quantities are then stated in DALYs / assessment year, or totals as DALYs / 60-years.

[64] Jacobs, 2014. *5. Noise: Local Assessment,* Section A.1.5, Appendix A. [online] Accessed 21/12/2015.
[65] Aberdeen, Birmingham, Bristol, East Midlands, Edinburgh, Glasgow, Manchester, London City, London Gatwick, London Heathrow, London Luton, London Southend and London Stansted.
[66] Department for Transport, 2013. *UK Aviation Forecasts.* [online] Last accessed 29/07/2016.
[67] Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.
[68] World Health Organisation, 2011. *Burden of disease from environmental noise.* [online] Accessed 03/05/2016.
[69] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* Section D. [online] Accessed 21/12/2015

4.7.10 An important parameter in the assessment of health effects is the choice of lower cutoff threshold for annoyance and sleep disturbance, as discussed in the associated CAA research report[70]. Varying the threshold from 45 dB(A) to 48 dB(A) can have a significant effect on the estimations of health effects in the population[71]. Accordingly, it was proposed by the ERCD that calculations be carried out for both conditions, which was consequently implemented in the AC assessment. The current Defra guidance uses 45 dB as the lower cutoff[72], and this threshold has therefore been adopted for the purposes of this AoS.

4.7.11 Effects on cognitive development in children have been assessed by separate consideration of schools to the other NSB types. To avoid double-counting of impacts, the assessments referring to 'NSBs' in Section 4.9 include data pertaining only to hospitals and religious places of worship.

4.8 MITIGATION INCLUDED IN ASSESSMENT

4.8.1 A range of mitigation measures have been proposed in relation to the schemes. The proposed mitigation measures that do not form part of this assessment are discussed in Section 4.10.

4.8.2 Flight path designs can provide mitigation for noise by minimising exposure, and are inherent in the modelling assumptions adopted in the assessment. The flight paths employed were developed specifically for the noise modelling and as such are indicative and not necessarily the actual routes that would be applied in practice. Precise flight paths can only be defined at a later stage after detailed airspace design work has taken place. This work will need to consider the various options available to ensure a safe and efficient airspace which also mitigates the level of noise disturbance. Once the design work has been completed, the proposal will be subject to extensive consultation as part of the separate airspace decision-making process established by the CAA. The flight path and operational scenarios relating to the schemes are set out in Table 4-8.

Table 4-8: Scheme Scenarios Assessed

SCHEME SCHEMES ASSESSED			
Scheme (AoS notation)	LGW-2R	LHR-ENR	LHR-NWR

[70] Rhodes, D. P., Weston, E. and Jones, K., 2013. *ERCD Report 1209. Proposed methodology for estimating the cost of sleep disturbance from aircraft noise*. [online] Accessed 11/08/2015.
[71] Rhodes, D. P., Weston, E. and Jones, K., 2013. *ERCD Report 1209. Proposed methodology for estimating the cost of sleep disturbance from aircraft noise*, p. 6, paragraph 2.5, [online] Accessed 11/08/2015.
[72] Department for Environment, Food and Rural Affairs, 2014. *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet.* [online]. Accessed 04/07/2016.

SCHEME SCHEMES ASSESSED			
Scenarios, AC or ERCD notation (data availability in parentheses)	AoN carbon traded[73], G-2R-NCT vs G-1R-NCT (available for assessments of: local population and NSB/schools noise exposure and noise-related health effects) AoN, carbon capped[74], LGW-2R-X vs LGW-1R (available for assessment of national population exposure)	Offset Arrivals AoN carbon traded[73], H-HH-O-NCT vs H-2R-NCT (available for assessments of: local population and NSB/schools noise exposure and noise-related health effects) Offset Arrivals, AoN, carbon capped[75], LHR-ENR-O vs LHR-2R (derived for national population exposure)	Minimise Total, AoN carbon traded[73] H-3R-NCT vs H-2R-NCT (available for assessments of: local population and NSB/schools noise exposure and noise-related health effects) Minimise Total, AoN, carbon capped[74], LHR-NWR-T vs LHR-2R (available for assessment of national population exposure)

4.8.3 In all the assessment scenarios, it is assumed that noise will be mitigated to an extent by the future development of quieter aircraft technologies, and the gradual incorporation of newer aircraft into the fleet mixes. Details on the fleet mixes used in the assessment have been published[76,77].

4.8.4 The AC assessment of national effects for the LHR-ENR scheme did not include consideration of the Offset Arrivals scenario noted in Table 4-8. Accordingly, for the AoS assessment at the national level, population exposure figures for the Offset Arrivals scheme have been calculated by comparing the available local assessment figures for the LHR-ENR-O[78] and LHR-ENR[79] scenarios. The differences obtained have then been applied to the national level figures for the LHR-ENR scenario[80] to form the national LHR-ENR-O assessment data. The adjustment calculation process is summarised in Table 4-9. This approach is based on the assumption that an offset arrivals strategy for the LHR-ENR scheme would not alter ATM assumptions for the other airports, when compared with the original ENR scenario modelled.

Table 4-9: Derivation of Adjustments for LHR-ENR National Assessment (AoN Carbon Capped)[81,82]

DO SOMETHING SCENARIO →	LHR-ENR			LHR-ENR-O		
	2030	2040	2050	2030	2040	2050
Local population >57 dB $L_{Aeq,0700-2300hrs}$	297,400	305,700	303,900	257,900	264,700	261,200

[73] Notation from CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results.* [online] Accessed 21/12/2015
[74] Notation from Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.
[75] Jacobs, 2015. *5. Noise: Local Assessment Addendum.* [online] and Jacobs, 2014. 5. Noise: Local Assessment. [online] Accessed 21/12/2015.
[76] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, Appendix A.3. [online] Accessed 21/12/2015.
[77] Jacobs, 2014. *5. Noise: Baseline and Local Assessment Methodology Addendum.* [online] Accessed 21/12/2015.
[78] Jacobs, 2015. *5. Noise: Local Assessment Addendum,* pp. 8-9. [online] Accessed 21/12/2015
[79] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 212-213. [online] Accessed 21/12/2015.
[80] Jacobs, 2014. *5. Noise: National Assessment,* pp. 22-24. [online] Accessed 21/12/2015.
[81] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables A54-A56 and A64-A66 (local data). [online] Accessed 21/12/2015.
[82] Jacobs, 2014. *5. Noise: National Assessment,* Table A4, Appendix A (national data). [online] Accessed 21/12/2015.

DO SOMETHING SCENARIO →	LHR-ENR			LHR-ENR-O		
	2030	2040	2050	2030	2040	2050
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	-39,500	-41,000	-42,700	-	-	-
National population >57 dB $L_{Aeq,0700-2300hrs}$	394,850	409,050	415,450	355,350 (calculated)	368,050 (calculated)	372,750 (calculated)
Local population >63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	63,800	66,900	67,000	63,700	67,500	67,100
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	-100	600	100	-	-	-
National population >63 dB $L_{Aeq,0700-2300hrs}$ (SOAEL)	70,050	74,250	76,450	69,950 (calculated)	74,850 (calculated)	76,550 (calculated)
Local population >69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	3,900	4000	3,900	3,900	4000	3,900
Difference in local populations [ENR-O minus ENR] (= adjustment to be applied to ENR national)	0	0	0	-	-	-
National population >69 dB $L_{Aeq,0700-2300hrs}$ (UAEL)	4,200	4,200	4,400	4,200 (calculated)	4,200 (calculated)	4,400 (calculated)

4.9 ASSESSMENT OF SHORTLISTED SCHEMES

4.9.1 The assessment of the schemes in this section is based on the population and NSB exposure data presented in the succeeding tables, which detail all the source data references.

4.9.2 In this assessment, schools and other NSBs (ie hospitals and religious places of worship) are addressed separately.

4.9.3 It should be noted when viewing the assessment charts that axis scales vary in the graphical presentation in order to show clearly any predicted differences in exposure. Very small relative or zero values have been labelled where necessary to aid visibility.

AoS Objective 6: To minimise and where possible reduce Noise impacts on human receptors

LGW-2R

Construction Phase

4.9.4 During the construction phase, noise and vibration impacts could be generated by on-site vehicles, activities, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LGW-2R would be likely to be negative, and potentially significant, depending on the nature and extent of the works and mitigation. The duration of the construction phase would be several years in length. For the purpose of this AoS, a worst case estimation is that the effects would be Significant Negative (--) for all schemes. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular to areas nearest to the new runway and along construction traffic routes.

Local Effects: Discrete

4.9.5 The local population exposures for the airspace AELs over the assessment periods for LGW-2R are compared with the do minimum in Figure 4-1, Figure 4-2 and Figure 4-3 (AoN carbon traded scenario).

Figure 4-1: LGW-2R Local Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Traded)

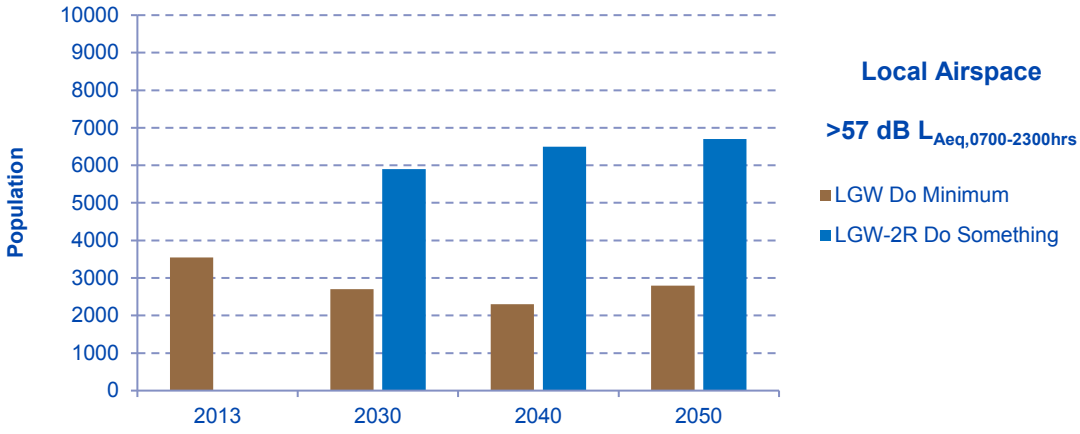


Figure 4-2: LGW-2R Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Traded)

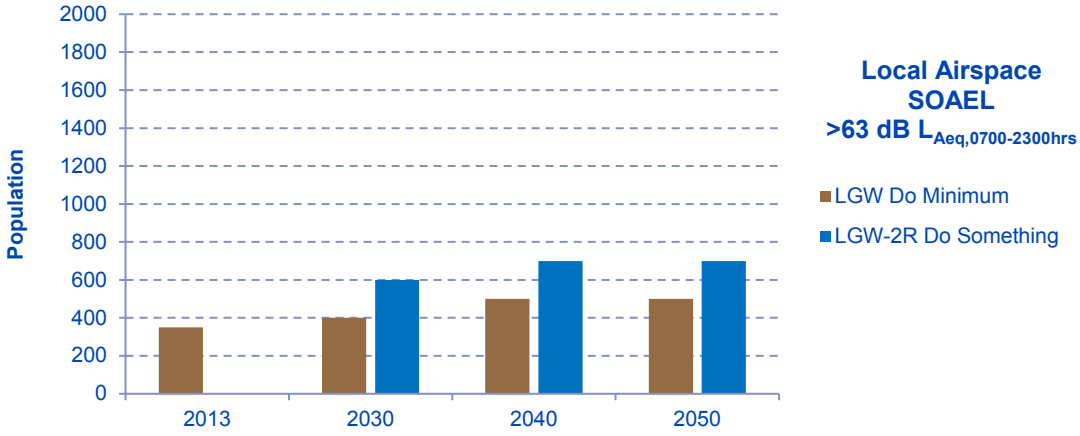
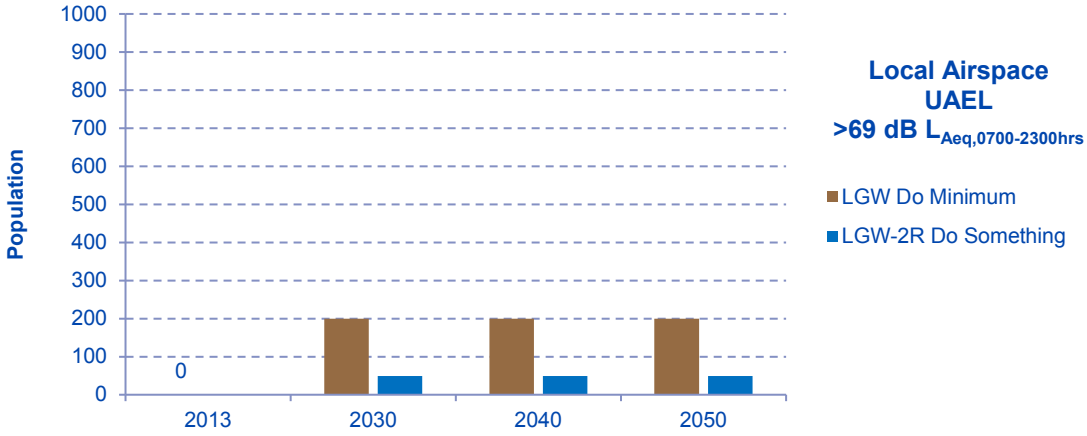


Figure 4-3: LGW-2R Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Traded)[83]



4.9.6 The local population assessment indicates that the LGW-2R scheme would result in increases in exposure to the >57 dB $L_{Aeq,16hr}$ contour and the SOAEL compared with the do minimum (Figure 4-1 and Figure 4-2). The population exposure to the UAEL is expected to be reduced compared with the do minimum over the assessment terms considered (Figure 4-3); this is partly due to reductions in the size of the contour over populated areas, but also because some properties would be within the expanded geographical boundary of the airport and therefore no longer exist in the do something scenario[84].

4.9.7 In view of the criteria set out in Table 4-3, the effects of changes in airspace noise exposure on the local population for the LGW-2R scheme (under the AoN carbon traded scenario) are considered to be predominantly Significant Negative.

[83] As shown in the corresponding assessment table, the population for the LGW-2R UAEL exposure is predicted as a range of possible values (<50); here, the worst-case value of 49 has been assumed.
[84] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 19-22. [online] Accessed 21/12/2015.

4.9.8 The local NSB exposures (including hospitals and religious places of worship; schools are considered separately below) to the airspace AELs over the assessment periods for LGW-2R are compared with the do minimum in Figure 4-4 and Figure 4-5 (AoN carbon traded scenario).

Figure 4-4: LGW-2R Local Airspace >57 dB Daytime Average Noise NSB Exposure (AoN, Carbon Traded)

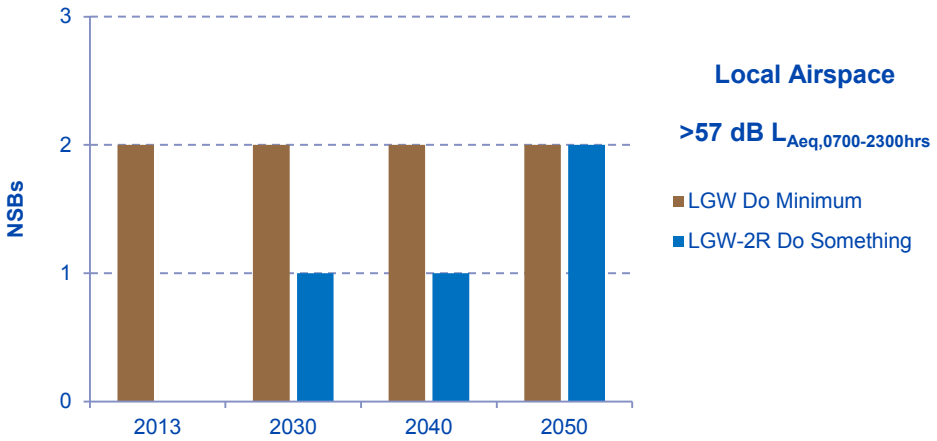
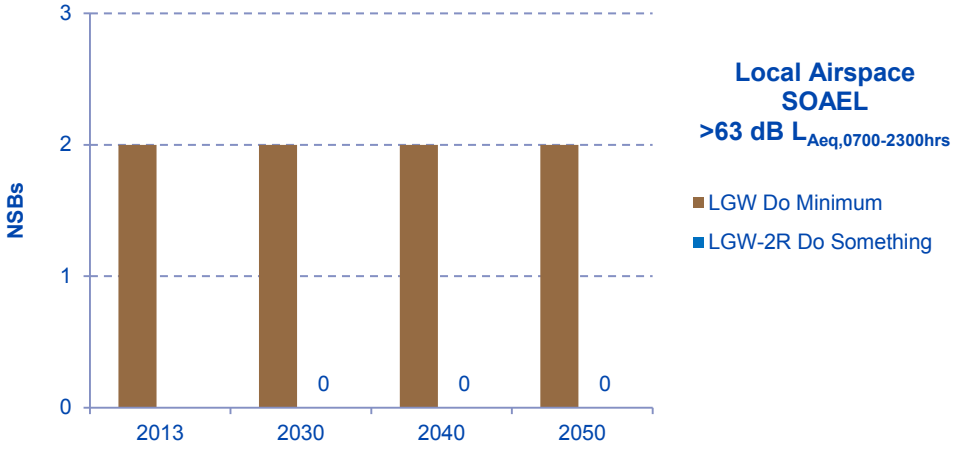


Figure 4-5: LGW-2R Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (AoN, Carbon Traded)

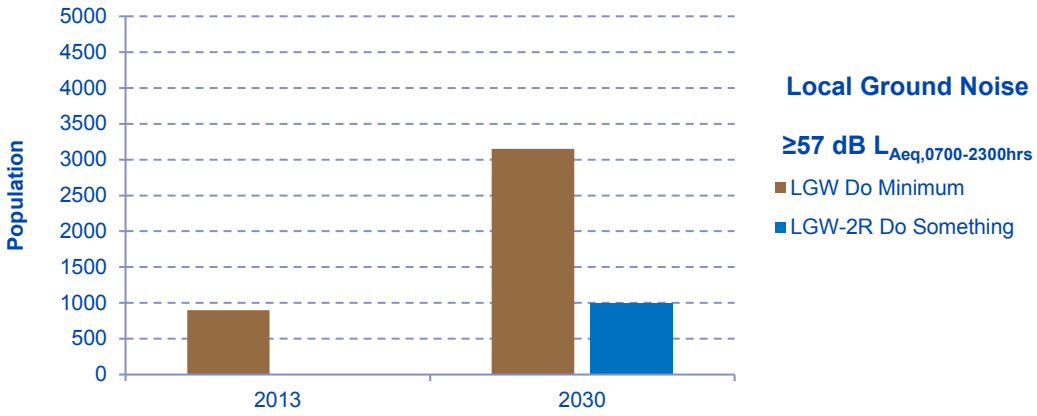


4.9.9 The local NSB exposure to the >57 dB $L_{Aeq,16hr}$ contour for LGW-2R is expected to be reduced in the 2030 and 2040 assessment years (Figure 4-4), but may increase by 2050. The numbers of NSBs exposed to the SOAEL are expected to be lower over the assessment terms compared with the do minimum (Figure 4-5), while the number exposed to the UAEL is unchanged at zero (not shown).

4.9.10 In view of the criteria set out in Table 4-3, the local effects of changes in airspace noise exposure on NSBs for the LGW-2R scheme are considered to be Positive

4.9.11 The local population exposure to the ground noise >57 dB $L_{Aeq,16hr}$ contour is compared with the do minimum in Figure 4-6.

Figure 4-6: LGW-2R Local Ground >57 dB Daytime Average Noise Population Exposure

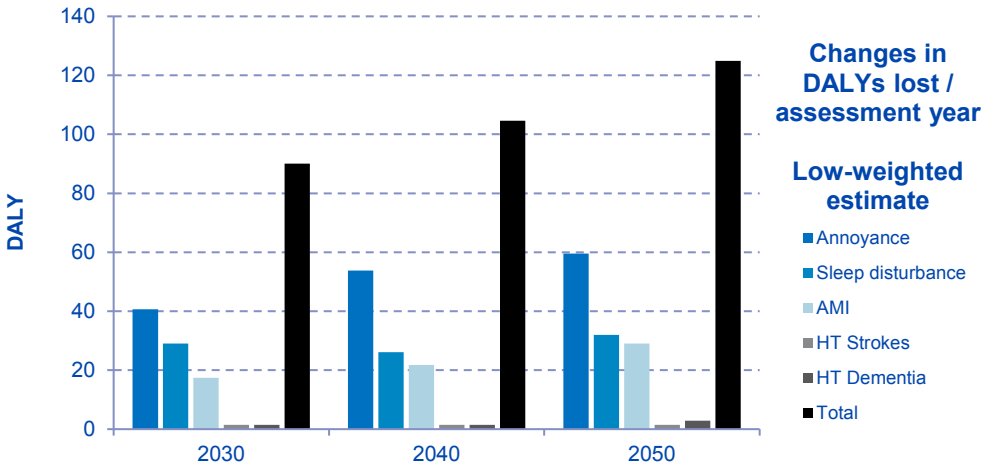


4.9.12 The ground noise assessment for LGW-2R indicates that the total local population exposure to the >57 dB $L_{Aeq,16hr}$ contour in 2030 is expected to remain very similar to the baseline current situation, and reduced compared with the do minimum in the 2030 assessment year. This is due to the relocation of some sources of ground noise, which would offset an increase in aircraft activity. In the do minimum case, exposure to ground noise is expected to rise due to increases in airport activity; in the do something case increases in activity are expected to be outweighed by reductions in taxiing, enabled by the new terminal and aprons between the runways[85].

4.9.13 In view of the criteria set out in Table 4-3, the effects of changes in ground noise exposure on the local population for the LGW-2R scheme are considered to be Positive, since a smaller population would be adversely affected compared with the do minimum.

4.9.14 The predicted scale of noise-related health effects, in terms of DALYs lost for low, mid and high-weighted estimations for LGW-2R (compared with the do minimum), is shown in Figure 4-7, Figure 4-8 and Figure 4-9 (AoN carbon traded scenario).

Figure 4-7: LGW-2R Low-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN Carbon Traded)



[85] Jacobs, 2014. *5. Noise: Local Assessment*, p. 69, paragraphs 1-2. [online] Accessed 21/12/2015.

Figure 4-8: LGW-2R Mid-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN Carbon Traded)

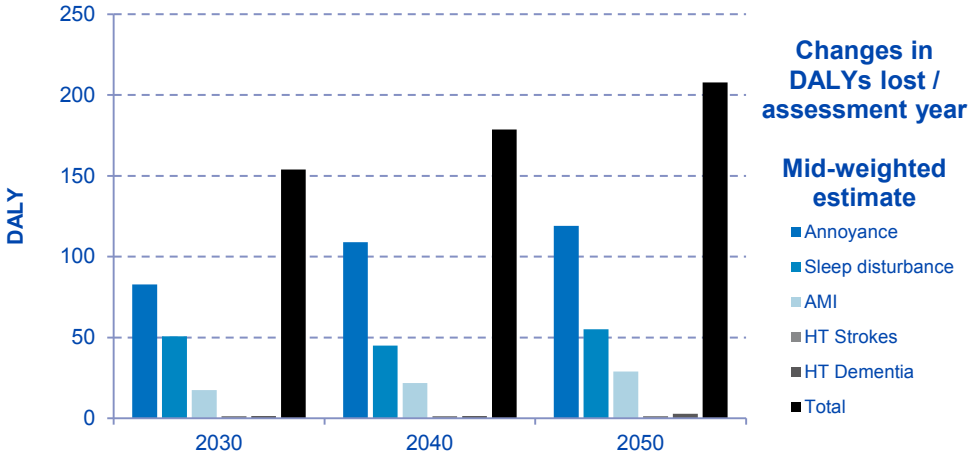
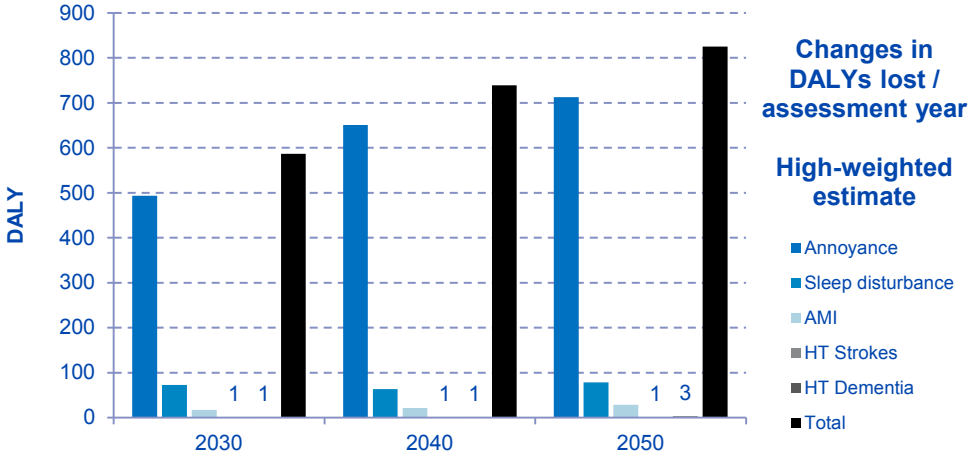


Figure 4-9: LGW-2R High-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN, Carbon Traded)

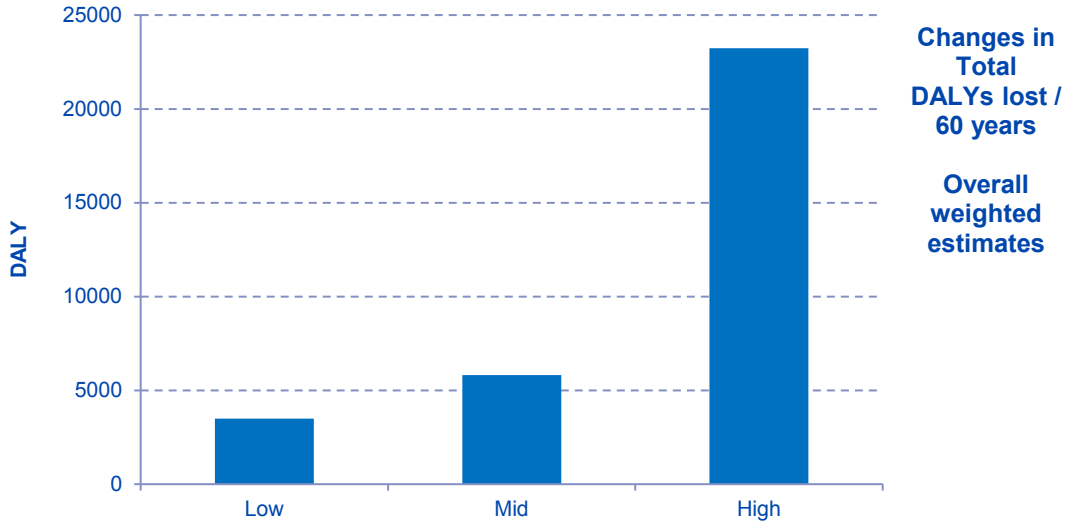


4.9.15 The health effects assessment illustrated across Figure 4-7, Figure 4-8 and Figure 4-9 indicates:

- All assessed health effects are expected to result in additional DALYs lost compared with the do minimum;
- Annoyance, sleep disturbance and AMI effects dominate total estimated differences in DALYs lost for all disability weightings;
- Annoyance increasingly dominates the differences in total estimated DALYs lost as the disability weightings are increased; and
- DALYs lost due to annoyance are expected to increase over the assessment period for all weightings.

4.9.16 Over a 60-year appraisal period, the estimations of total DALYs lost due to noise in the LGW-2R do something case (compared with the do minimum) are shown for all weightings in Figure 4-10 (AoN carbon traded scenario).

Figure 4-10: LGW-2R All Weighted Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (AoN Carbon Traded)



4.9.17 Under the AoN carbon traded scenario, the effects of the LGW-2R scheme for the health outcomes assessed are considered to be Significant Negative, since it is expected that DALYs lost due to noise exposure would be increased by the do something compared with the do minimum.

4.9.18 The LGW-2R scheme is expected to result in increases in exposure of schools to the >54 dB $L_{Aeq,16hr}$ daytime average noise level contour (8 in 2030, 12 in 2040, 13 in 2050) and some increases for exposure >57 dB $L_{Aeq,16hr}$ (2 in 2050). Reductions in exposure are, however, expected for exposure >60 dB $L_{Aeq,16hr}$ (1 in each assessment year) and >63 dB $L_{Aeq,16hr}$ (2 in 2030 and 2040, 1 in 2050). These results can be interpreted as having mixed Significant Positive/Negative effects (++/-) for children's cognitive development.

Local Effects: Cumulative

4.9.19 The combination of airspace and ground noise could lead to cumulative negative effects for some areas. For example:

- For receptors exposed to airspace noise levels of at least 62 dB $L_{Aeq,16hr}$, the addition of ground noise of 57 dB $L_{Aeq,16hr}$ or more could push those areas above the SOAEL; and
- For receptors exposed to airspace noise at levels of 68 dB $L_{Aeq,16hr}$, ground noise would need to be at least 63 dB $L_{Aeq,16hr}$ to push these areas above the UAEL.

4.9.20 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.21 For some areas, reductions in exposure to ground noise may to some extent be counteracted by increases in airspace noise; conversely some areas (particularly in close proximity to the north of the existing runway) may experience some reductions in both ground and airspace noise.

4.9.22 In view of the criteria set out in Table 4-3, the local cumulative effects of the LGW-2R scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).

National Effects

4.9.23 The national population exposures for the airspace thresholds over the assessment periods for LGW-2R are compared with the UK do minimum in Figure 4-11, Figure 4-12 and Figure 4-13 (AoN carbon capped scenario).

Figure 4-11: LGW-2R National Airspace >57 dB Daytime Average Noise Population Exposure (AoN Carbon Capped) [NB. Non-zero axis]

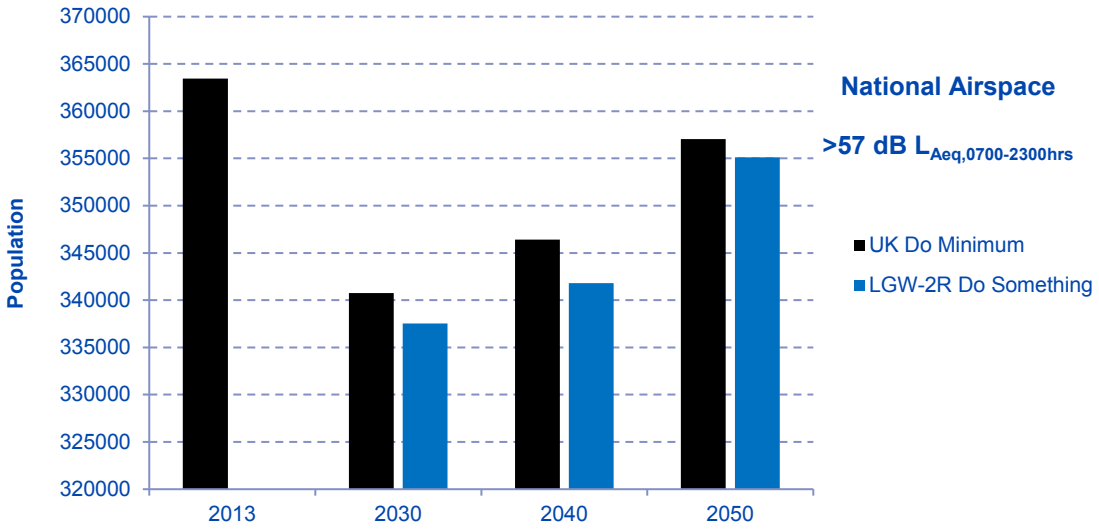


Figure 4-12: LGW-2R National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN Carbon Capped)

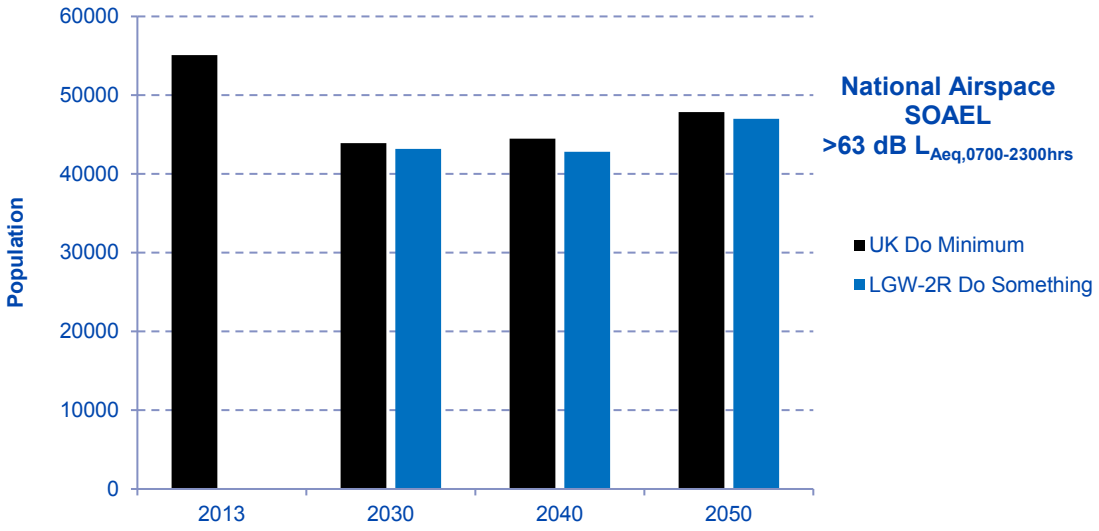
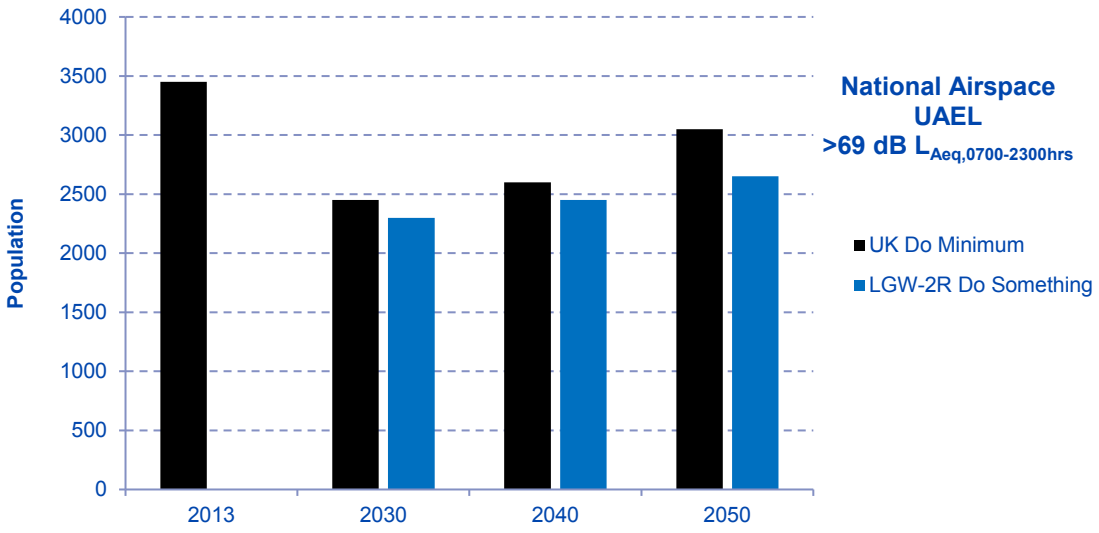


Figure 4-13: LGW-2R National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN Carbon Capped)



4.9.24 The national assessment indicates that the LGW-2R scheme would result in reduced total population exposure to airspace noise above the thresholds over the full assessment period, compared with the do minimum. This is mainly due to a decrease in exposure at a number of other airports which more than offsets increases at Gatwick airport[86]. In consideration of the criteria set out in Table 4-3, the national effects of the LGW-2R scheme (under the AoN carbon capped scenario) are considered to be Positive.

LGW-2R Individual Assessment Outcome

4.9.25 In terms of local population noise exposure, and the potential for adverse health impacts affecting the local population, the LGW-2R scheme has the potential for Significant Negative effects. Both these elements have been assessed under the AoN Carbon Traded scenario assumptions.

4.9.26 The assessment of the LGW-2R scheme has also identified the potential for some Positive effects, with regards to noise exposure of local schools and other NSBs and noise exposure of the population from a national perspective. However, the number of schools expected to have reduced exposure to noise is considerably smaller than the number likely to see increases in noise. The national exposure values have been assessed under the AoN carbon capped scenario assumptions, due to the unavailability of modelling data. It is possible that under a set of carbon trading assumptions, the results for this element would be less positive than has been assessed here, although it is acknowledged that an expected outcome cannot be directly extrapolated.

4.9.27 On the basis of the above considerations, the LGW-2R scheme is considered to have predominant Significant Negative (--) overall effects. This outcome is justified by emphasising the negative impacts on people in the local area in consideration of the AoS Noise topic Objective 'To minimise and where possible reduce noise impacts on human receptors'. However, it is acknowledged that the potential for some Positive effects from LGW-2R has also been identified, in particular due to a reduction in the exposure at a small number of schools (although larger numbers of schools could have increased exposure). This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

[86] Jacobs, 2014. *5. Noise: National Assessment*, pp. 12, 14. [online] Accessed 21/12/2015.

LHR-ENR

Construction Phase

4.9.28 During the construction phase, noise (and potentially, vibration) impacts could be generated by on-site vehicles, activities, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LHR-ENR would be likely to be Significant Negative, depending on the nature and extent of the works and mitigation proposals. The duration of the construction phase would be several years in length. For the purpose of this AoS, a worst case estimation is that these effects would be Significant Negative. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular upon areas nearest to the extended northern runway and along construction traffic routes.

Local Effects: Discrete

4.9.29 The local population exposures for the airspace thresholds over the assessment periods for LHR-ENR are compared with the do minimum in Figure 4-14, Figure 4-15 and Figure 4-16 (AoN carbon traded scenario).

Figure 4-14: LHR-ENR Local Airspace >57 dB Daytime Average Noise Population Exposure (AoN Carbon Traded)

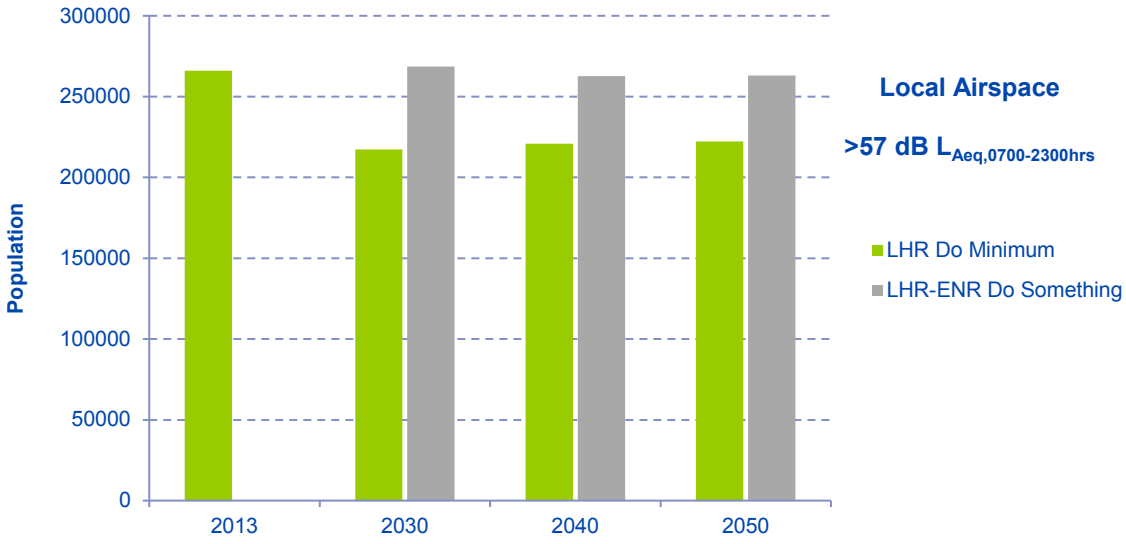


Figure 4-15: LHR-ENR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (AoN Carbon Traded)

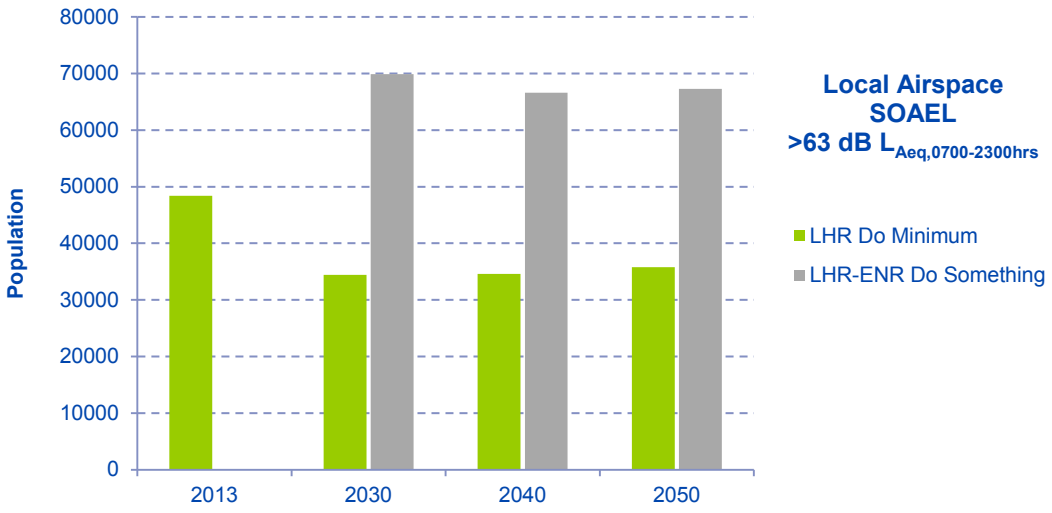
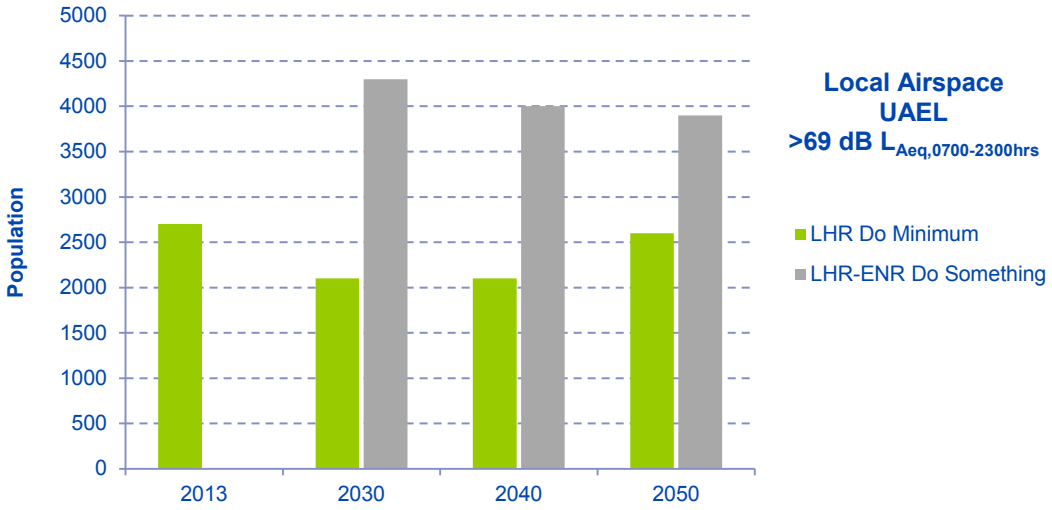


Figure 4-16: LHR-ENR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (AoN Carbon Traded)



4.9.30 The local population assessment indicates that the LHR-ENR scheme would result in increases in exposure to all thresholds over the full assessment period, compared with the do minimum.

4.9.31 In view of the criteria set out in Table 4-3, the effects of changes in airspace noise exposure on the local population for the LHR-ENR scheme (under the AoN carbon traded scenario) are considered to be Significant Negative.

4.9.32 The local NSB exposures (comprising hospitals and religious places of worship; schools are addressed separately below) for the airspace thresholds over the assessment periods for LHR-ENR are compared with the do minimum in Figure 4-17, Figure 4-18 and Figure 4-19 (AoN carbon traded scenario).

Figure 4-17: LHR-ENR Local Airspace >57 dB Daytime Average Noise NSB Exposure (AoN Carbon Traded)

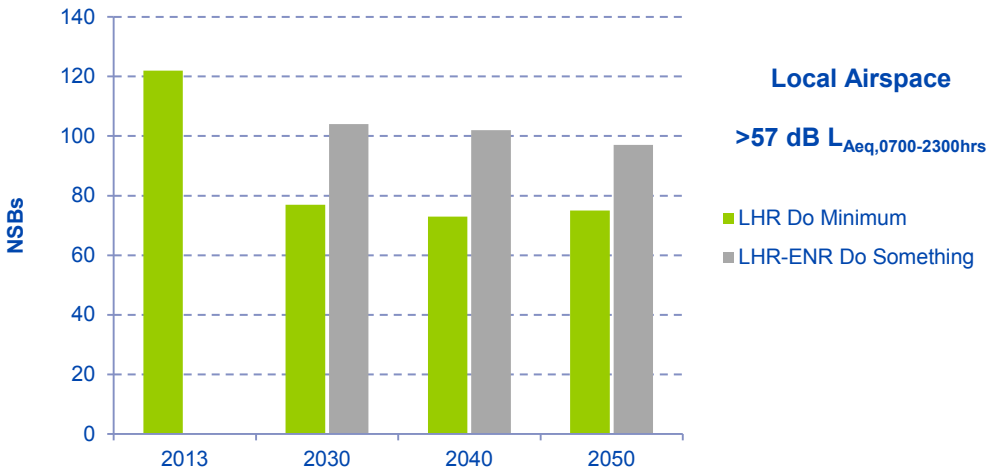


Figure 4-18: LHR-ENR Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (AoN Carbon Traded)

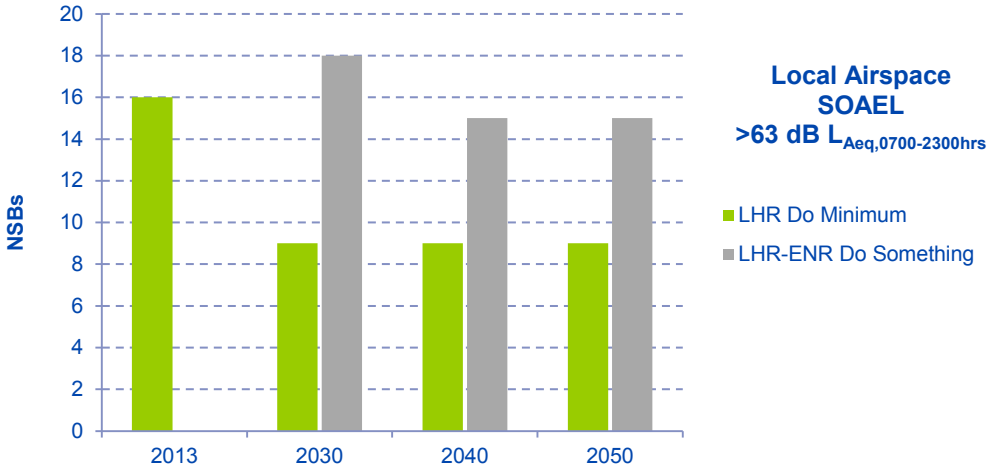
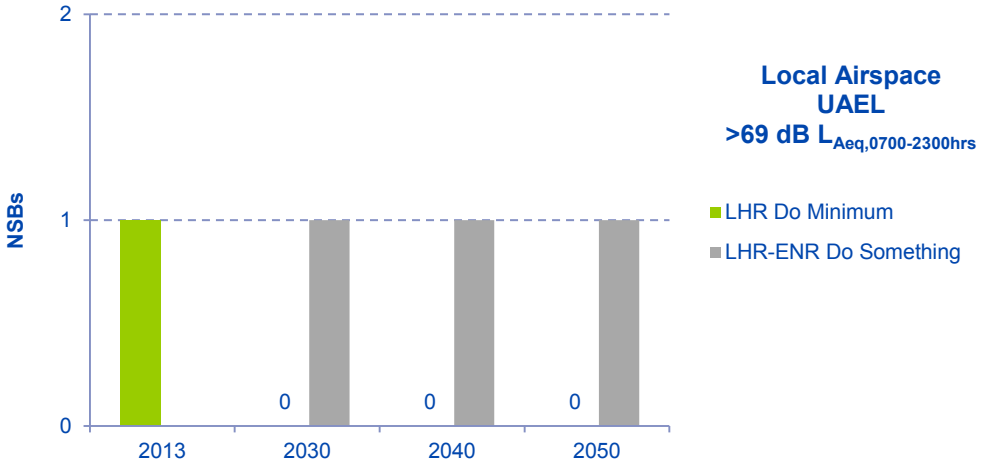


Figure 4-19: LHR-ENR Local Airspace >69 dB Daytime Average Noise UAEL NSB Exposure (AoN Carbon Traded)

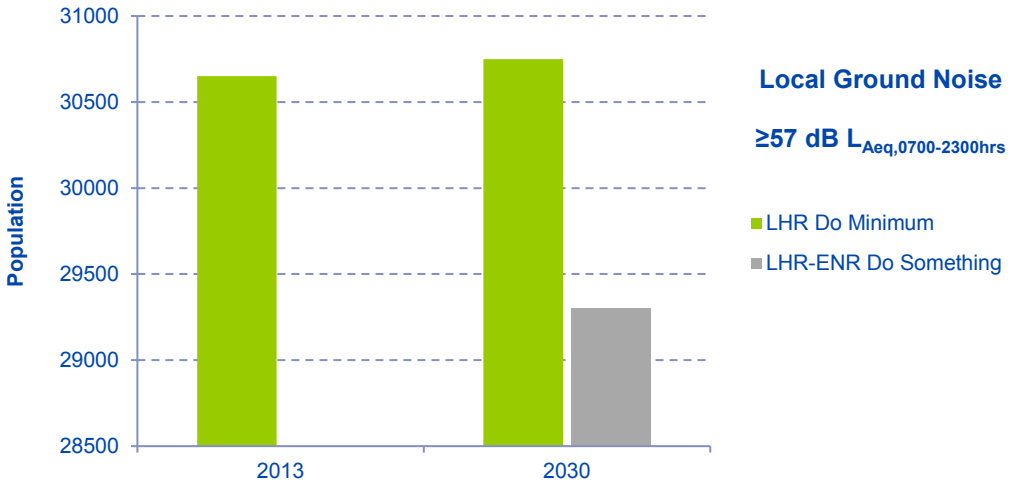


4.9.33 The local NSB assessment indicates that the LHR-ENR scheme would result in increases in exposure to all AELs over the full assessment period, compared with the do minimum.

4.9.34 In view of the criteria set out in Table 4-3, the effects of changes in airspace noise exposure on local NSBs for the LHR-ENR scheme are considered to be Significant Negative.

4.9.35 The local population exposure to ground noise >57 dB $L_{Aeq,16hr}$ is compared with the do minimum in Figure 4-20.

Figure 4-20: LHR-ENR Local Ground >57 dB Daytime Average Noise Population Exposure (NB. Non-zero axis)



4.9.36 The ground noise assessment for LHR-ENR indicates that the local population exposure to the >57 dB $L_{Aeq,16hr}$ threshold is expected to reduce compared with the do minimum in the 2030 assessment year. This is due to the relocation of some sources or receptors of ground noise in the assessment year[87]. In view of the criteria set out in Table 4-3, the effects of changes in ground noise exposure on the local population for the LHR-ENR scheme are considered to be Positive, since a reduction in exposure to the >57 dB $L_{Aeq,16hr}$ threshold is expected compared with the do minimum.

4.9.37 The predicted scale of noise-related health effects, in terms of DALYs lost for low, mid and high-weighted estimations for LHR-ENR (compared with the do minimum), is shown in Figure 4-21, Figure 4-22 and Figure 4-23 (AoN carbon traded scenario).

[87] Jacobs, 2014. *5. Noise: Local Assessment*, p. 271, paragraph 3. [online] Accessed 21/12/2015.

Figure 4-21: LHR-ENR Low-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN Carbon Traded)

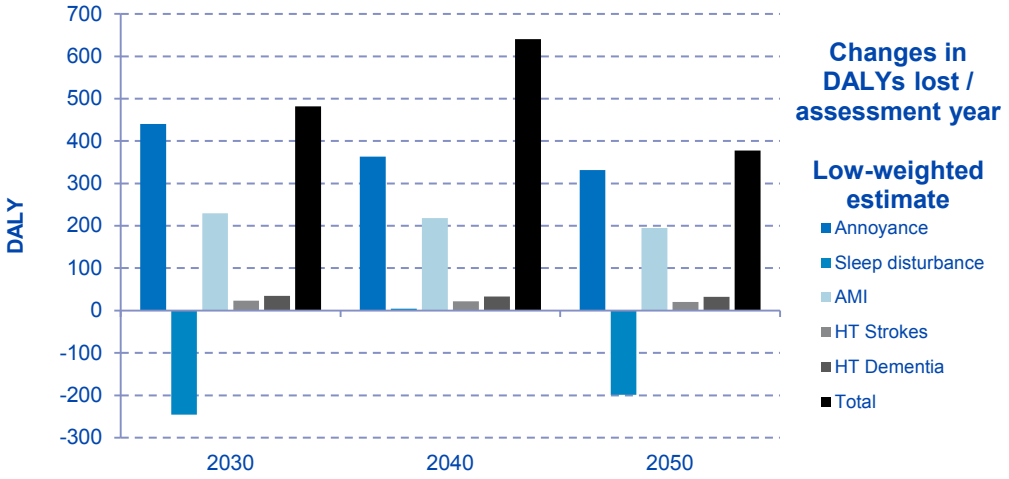


Figure 4-22: LHR-ENR Mid-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN Carbon Traded)

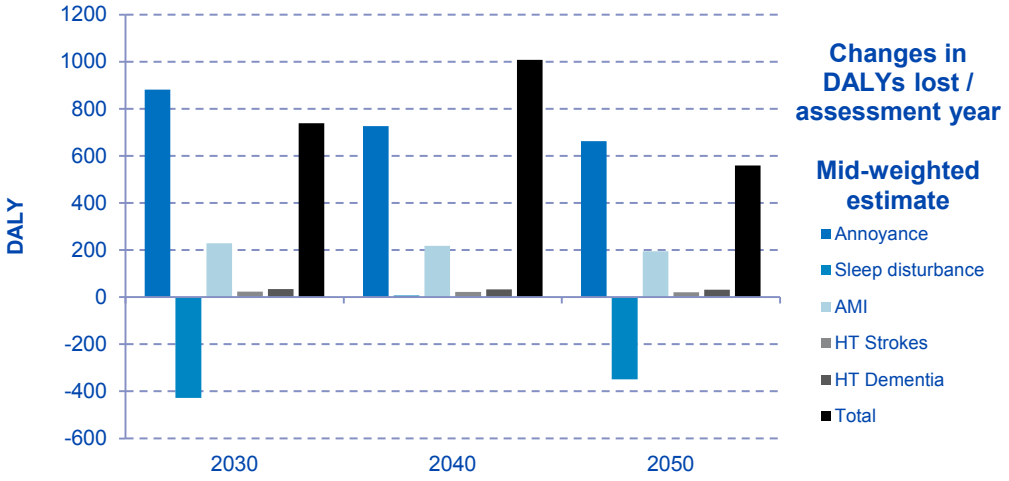
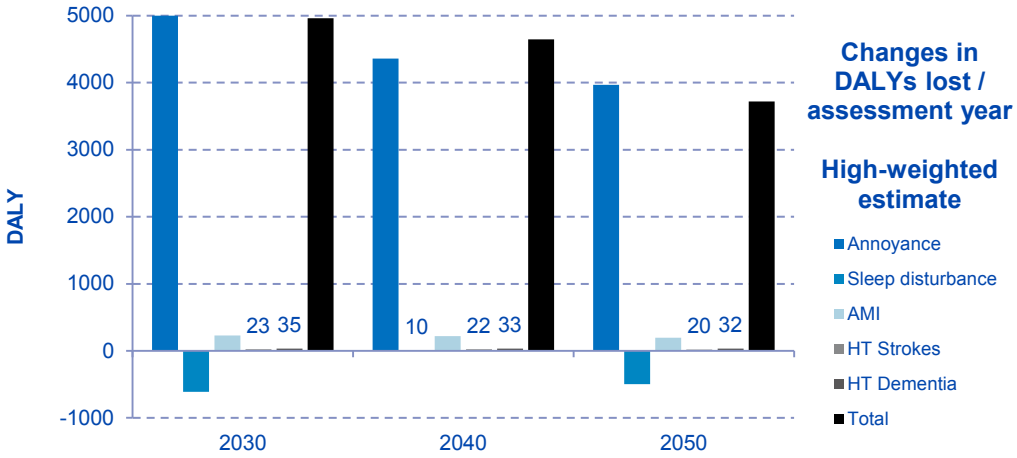


Figure 4-23: LHR-ENR High-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN Carbon Traded)

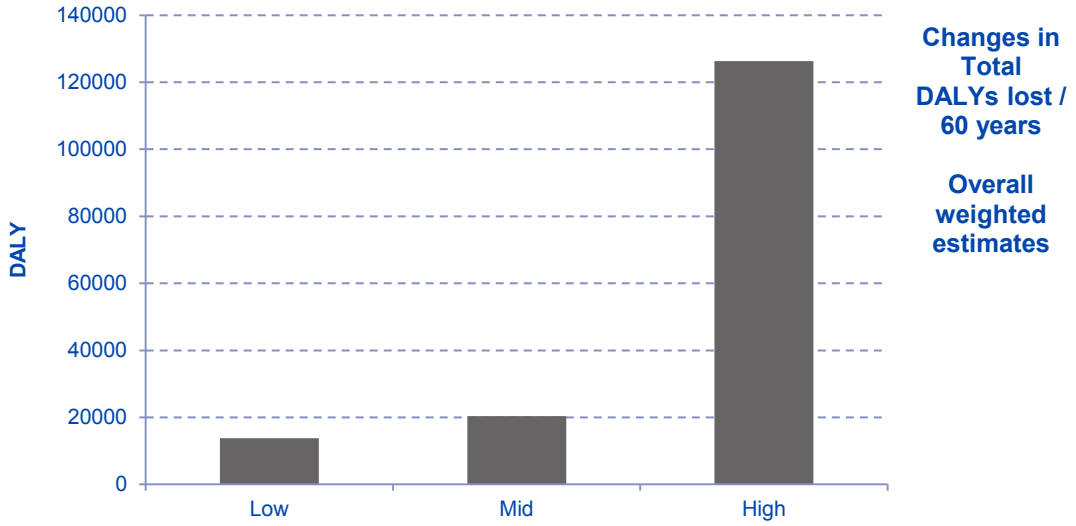


4.9.38 The health effects assessment illustrated across Figure 4-21, Figure 4-22 and Figure 4-23 indicates:

- with the exception of sleep disturbance, all health effects are expected to result in increases in DALYs lost compared with the do minimum;
- DALYs lost due to sleep disturbance are expected to be reduced compared with the do minimum for the 2030 and 2050 assessment years across all disability weightings, and marginally increased for the 2040 assessment year;
- the combined effects of annoyance, sleep disturbance and AMI dominate total estimated DALYs lost for all disability weightings in the 2030 and 2050 estimates (the influence of sleep disturbance effects in the total DALYs is much reduced in 2040); and
- annoyance becomes the dominant adverse health effect as the disability weightings are increased.

4.9.39 60-year appraisal period estimations of total DALYs lost due to noise in the LHR-ENR do something case (compared with the do minimum) are shown for all weightings in Figure 4-24 (AoN carbon traded scenario).

Figure 4-24: LHR-ENR All Weighted Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (AoN, Carbon Traded)



4.9.40 Under the AoN carbon traded scenario, the effects of the LHR-ENR scheme for the health outcomes assessed are considered to be predominantly Significant Negative. It is recognised however that some positive effects may be expected due to potential relative reductions in sleep disturbance for the 2030 and 2050 assessment years, compared with the do minimum.

4.9.41 The LHR-ENR scheme is expected to result in broad increases in exposure of schools to noise (e.g. increases in exposure to the >63 dB $L_{Aeq,16hr}$ SOAEL are expected to be 14 in 2030, 11 in 2040 and 11 in 2050) A reduction in exposure to levels >54 dB $L_{Aeq,16hr}$ is also predicted for one assessment year (4 in 2030). These results can be interpreted as having predominantly Significant Negative effects for children's cognitive development.

Local Effects: Cumulative

4.9.42 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.43 Although a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be offset by increases in airspace noise for the affected populations in close proximity to the airport. For some areas, in particular towards the northwest of the northern runway, there is a risk that cumulative airspace and ground noise could be sufficient to bring populations above the thresholds considered.

4.9.44 In view of the criteria set out in Table 4-3, the local cumulative effects of the LHR-ENR scheme for the 2030 assessment year are considered to be Significant Negative.

National Effects

4.9.45 The national population exposures for the airspace AELs over the assessment periods for LHR-ENR are compared with the UK do minimum in Figure 4-25, Figure 4-26 and Figure 4-27 (AoN carbon capped scenario). As discussed in Section 4.8, the results of this assessment are derived from calculations using adjustments to the original ENR scenario and have not been modelled directly. This approach assumes that national flight movements at other airports would not be affected by an offset arrivals strategy at LHR-ENR.

Figure 4-25: LHR-ENR National Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Capped) [NB. Non-zero axis]

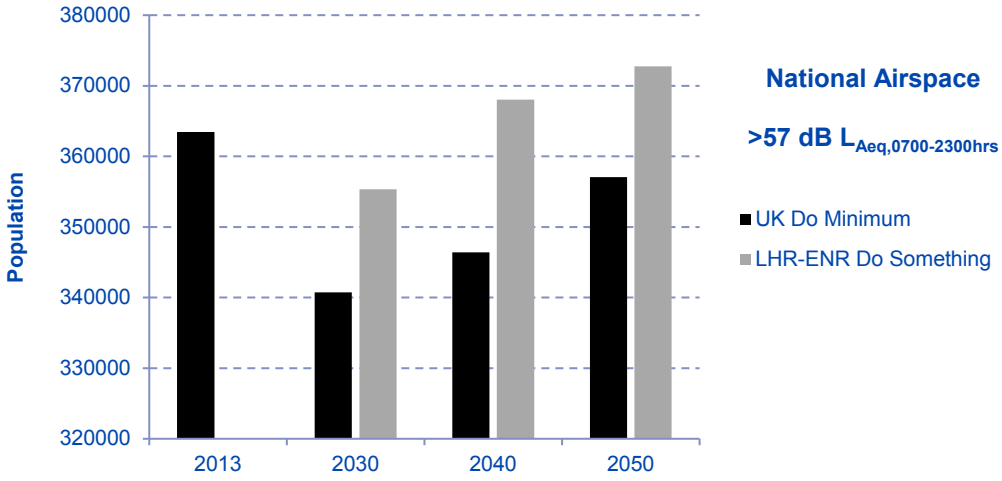


Figure 4-26: LHR-ENR National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Capped)

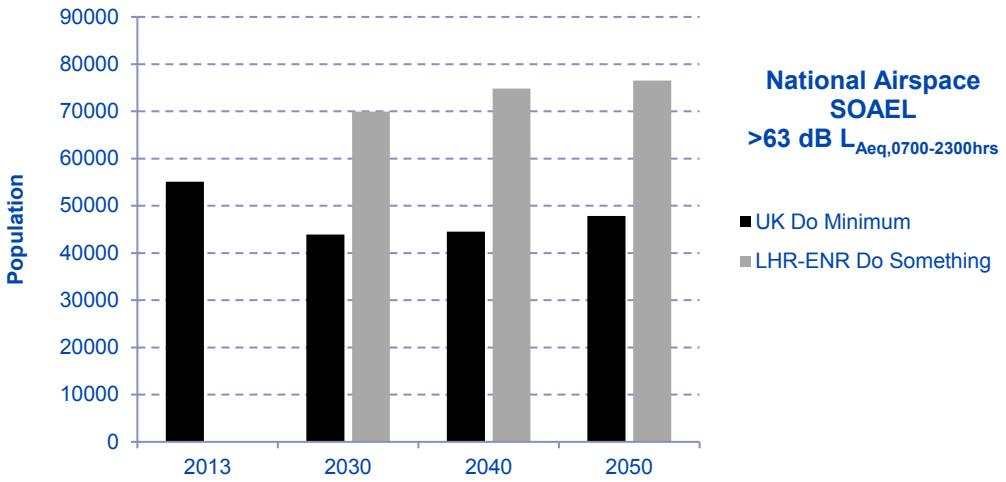
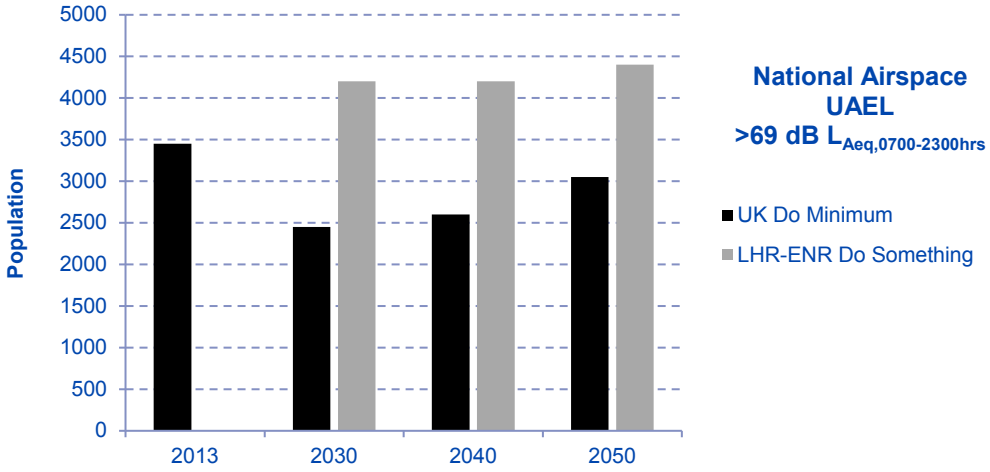


Figure 4-27: LHR-ENR National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Capped)



4.9.46 The national assessment indicates that the LHR-ENR scheme would result in increased population exposure to airspace noise above the thresholds over the full assessment period, compared with the do minimum.

4.9.47 In view of the criteria set out in Table 4-3, the national effects of the LHR-ENR scheme are considered to be Significant Negative.

LHR-ENR Individual Assessment Summary

4.9.48 It is clear from consideration of the various elements of the individual assessment that the LHR-ENR scheme is principally expected to have predominant Significant Negative (--) overall effects, and this outcome is broadly consistent across the differing carbon scenario assumptions. This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

LHR-NWR

Construction Phase

4.9.49 During the construction phase, noise (and potentially, vibration) impacts could be generated by on-site traffic, works, plant and off-site traffic. In view of the proximity of existing residential areas, it is considered that construction noise and vibration impacts for LHR-NWR would be likely to be Significant Negative, depending on the nature and extent of the works and mitigation proposals. The duration of the construction phase would be several years in length. For the purpose of this AoS, as a worst case estimate these effects are considered likely to be Significant Negative. Mitigation for construction impacts is discussed in Section 4.10. Assessment of construction mitigation would need to be considered in detail at the EIA stage, in order to minimise negative impacts, in particular to areas nearest to the new runway and along construction traffic routes.

Local Effects: Discrete

4.9.50 The local population exposures for the airspace thresholds over the assessment periods for LHR-NWR are compared with the do minimum in Figure 4-28, Figure 4-29 and Figure 4-30 (AoN carbon traded scenario).

Figure 4-28: LHR-NWR Local Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Traded)

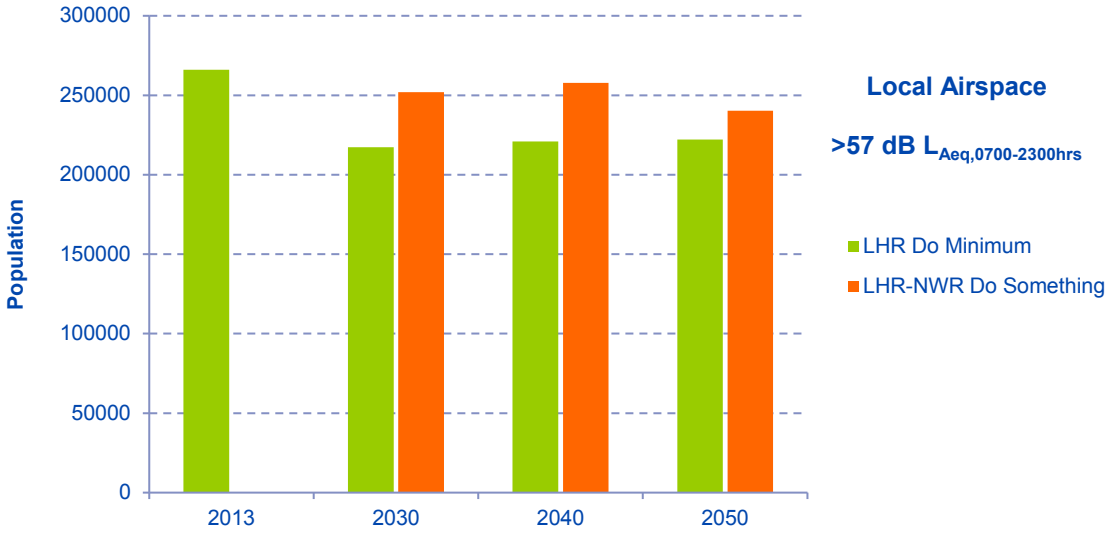


Figure 4-29: LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Traded)

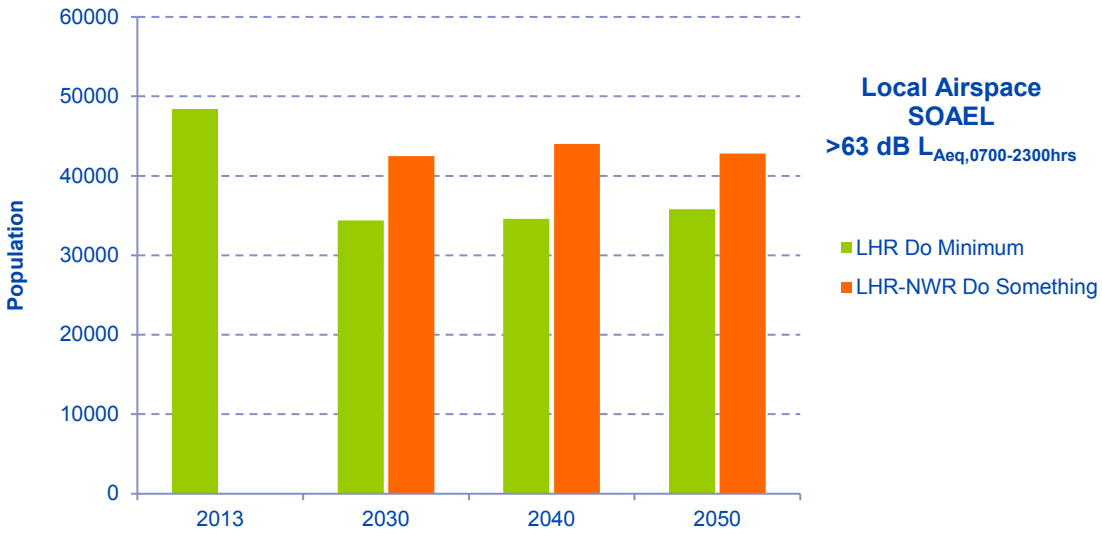
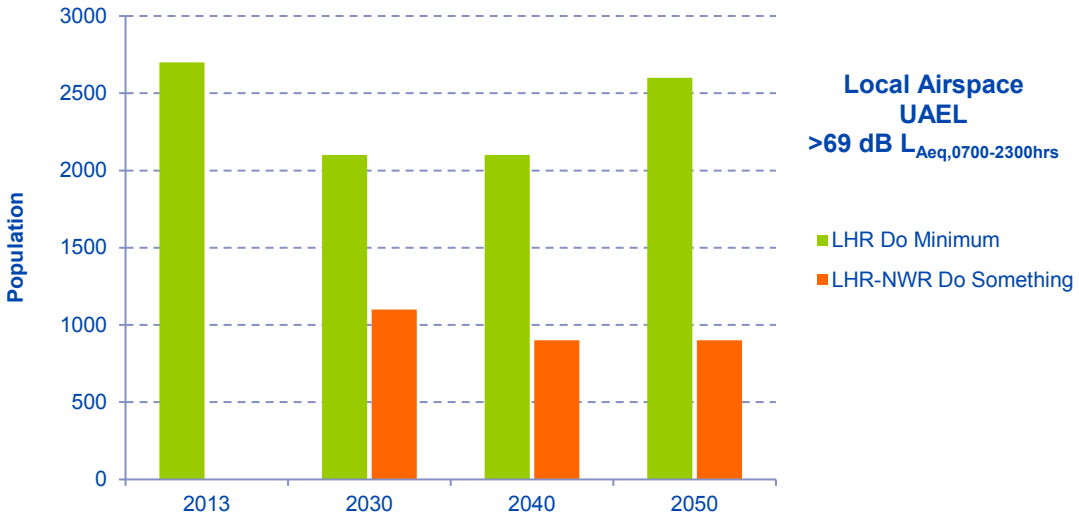


Figure 4-30: LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Traded)



4.9.51 The local population assessment indicates that the LHR-NWR scheme would result in increases in population exposure to the 57 dB $L_{Aeq,16hr}$ and SOAEL thresholds over the full assessment period, compared with the do minimum. The scheme is expected to result in reductions in the population exposed to the UAEL over the full assessment period. This is due to reduced populations within the >69 dB $L_{Aeq,16hr}$ contour, but also because some dwellings exposed in the do minimum scenario would be within the expanded boundary of LHR-NWR, and so no longer exist in the do something exposure[88].

4.9.52 In view of the criteria set out in Table 4-3, the effects of changes in airspace noise exposure on the local population for the LHR-NWR scheme (AoN carbon traded scenario) are considered to be predominantly Significant Negative.

[88] Jacobs, 2014. *5. Noise: Local Assessment*, p. 189, paragraph 2. [online] Accessed 21/12/2015.

4.9.53 The local NSB exposures (comprising hospitals and religious places of worship; schools are addressed separately below) for the airspace thresholds over the assessment periods for LHR-NWR are compared with the do minimum in Figure 4-31, Figure 4-32 and Figure 4-33 (AoN carbon traded scenario).

Figure 4-31: LHR-NWR Local Airspace >57 dB Daytime Average Noise NSB Exposure (AoN, Carbon Traded)

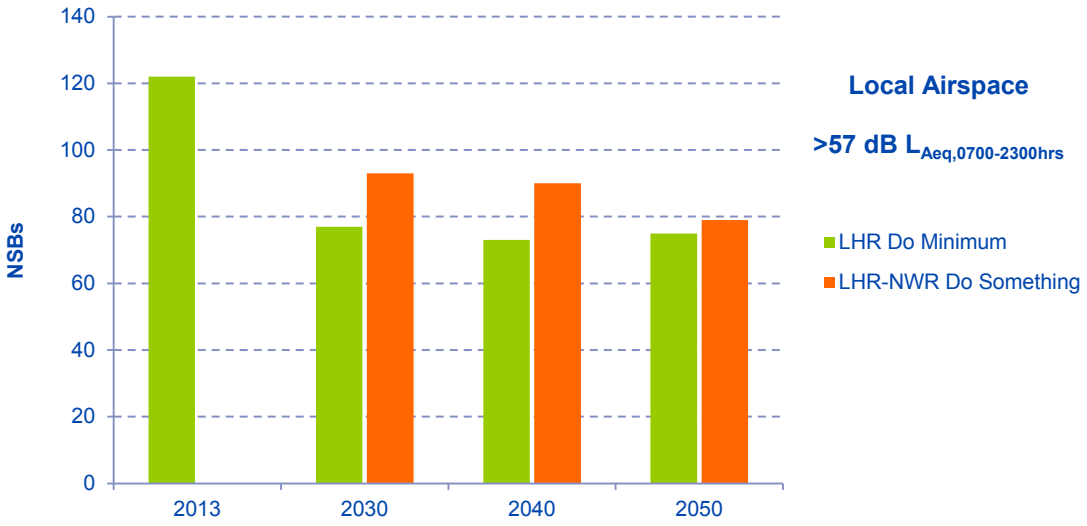


Figure 4-32: LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL NSB Exposure (AoN Carbon Traded)

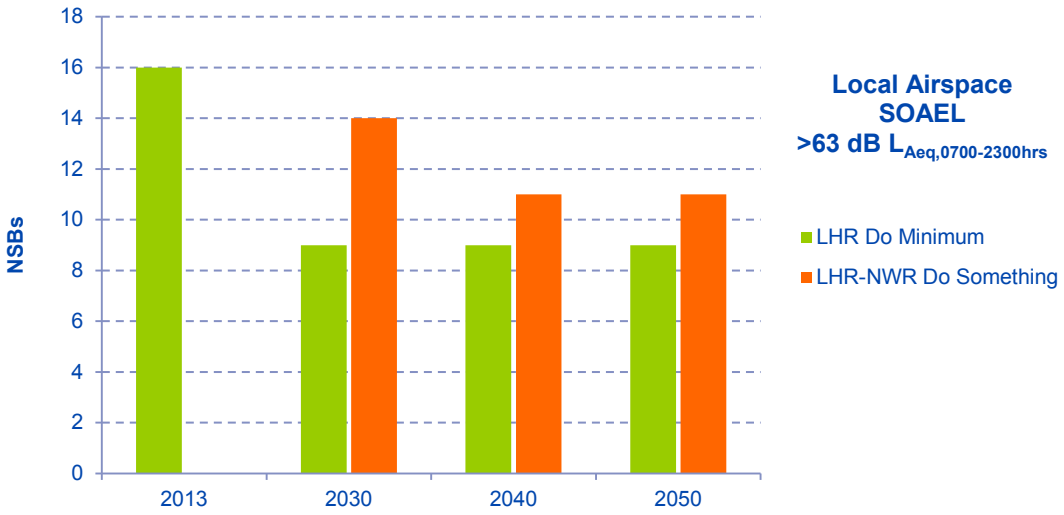
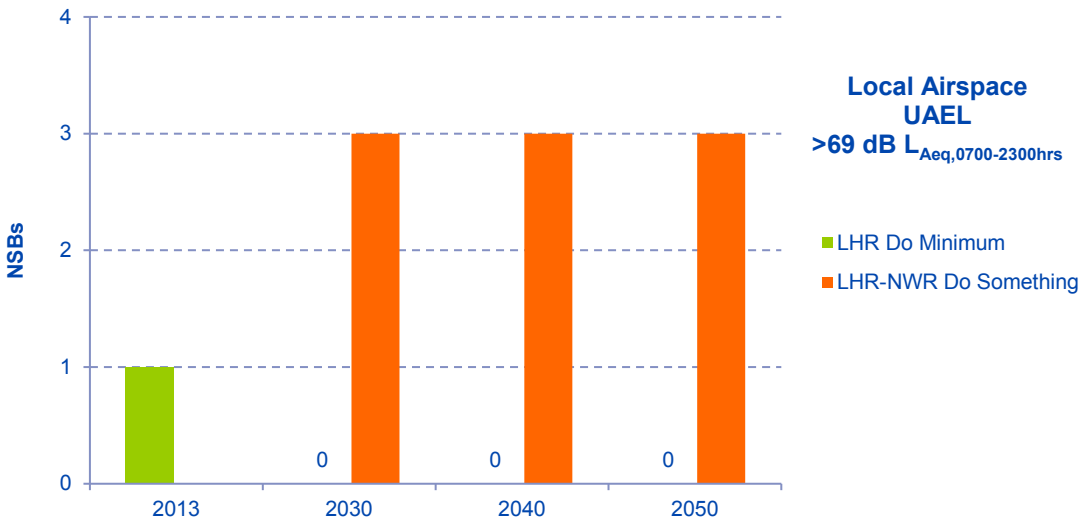


Figure 4-33: LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL NSB Exposure (AoN, Carbon Traded)

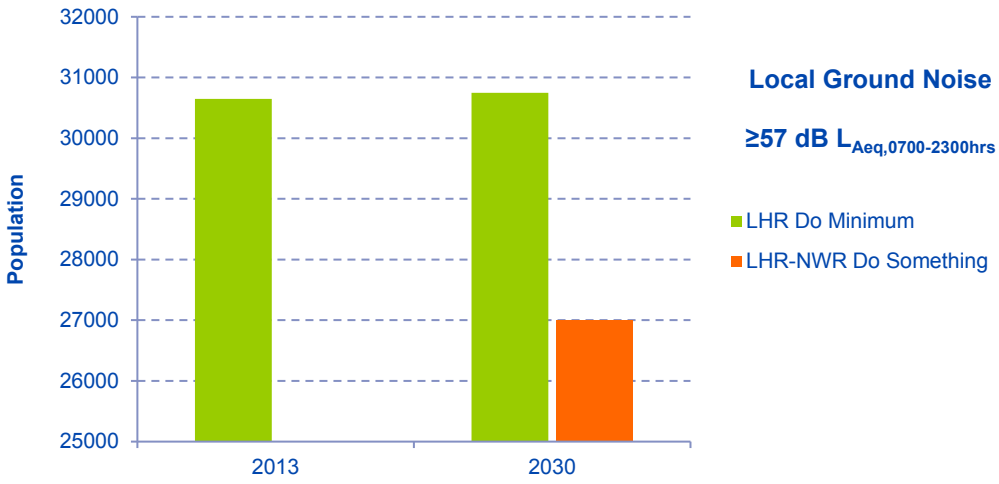


4.9.54 The local NSB assessment indicates that the LHR-NWR scheme would result in increases in NSB exposure to all thresholds over the full assessment period, compared with the do minimum.

4.9.55 In view of the criteria set out in Table 4-3, the effects of changes in airspace noise exposure on local NSBs for the LHR-NWR scheme are considered to be Significant Negative.

4.9.56 The local population exposure to the ground noise threshold is compared with the do minimum in Figure 4-34.

Figure 4-34: LHR-NWR Local Ground >57 dB Daytime Average Noise Population Exposure [NB. Non-zero axis]



4.9.57 The ground noise assessment for LHR-NWR indicates that the total local population exposure to the 57 dB $L_{Aeq,16hr}$ threshold is expected to reduce compared with the do minimum in the 2030 assessment year. This is due to relocation of some sources of ground noise away from more densely-populated areas[89]. In view of the criteria set out in Table 4-3, the local effects of ground noise for the LHR-NWR scheme are considered to be Positive, since a reduction in exposure to the 57 dB $L_{Aeq,16hr}$ threshold is expected compared with the do minimum.

4.9.58 The predicted scale of noise-related health effects, in terms of DALYs lost for low, mid and high-weighted estimations for LHR-NWR (compared with the do minimum), is shown in Figure 4-35, Figure 4-36 and Figure 4-37 (AoN carbon traded scenario).

Figure 4-35: LHR-NWR Low-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN, Carbon Traded)

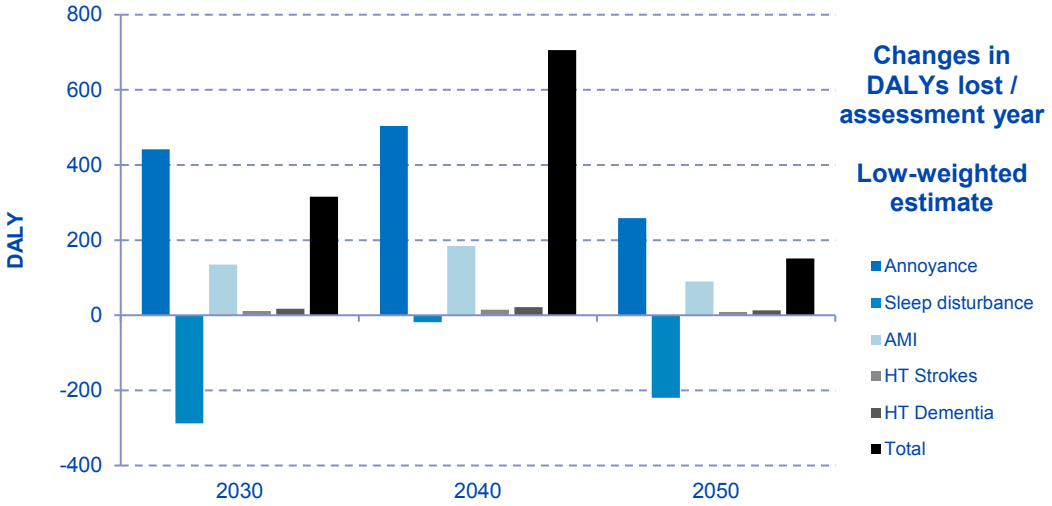
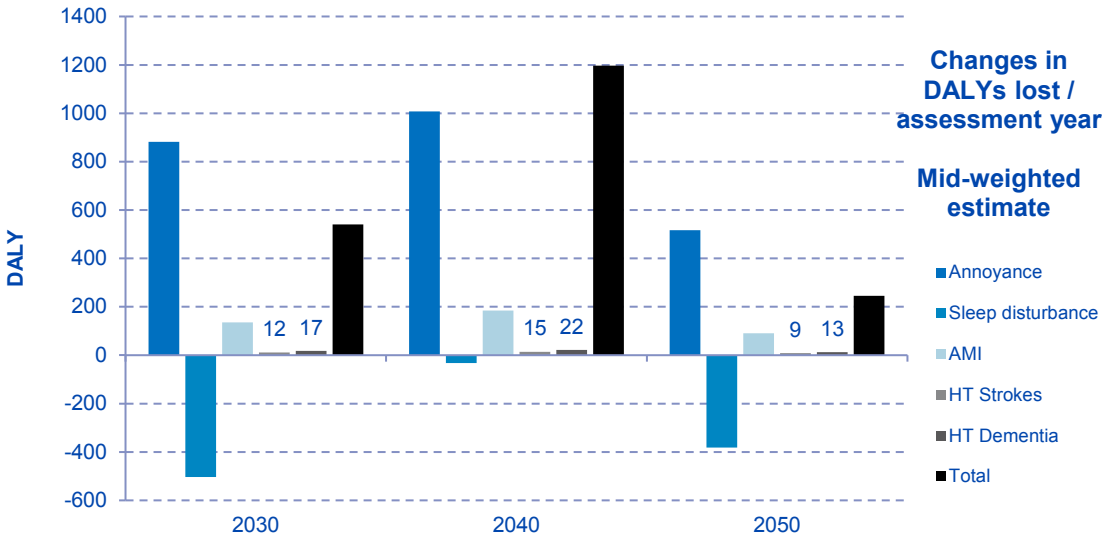
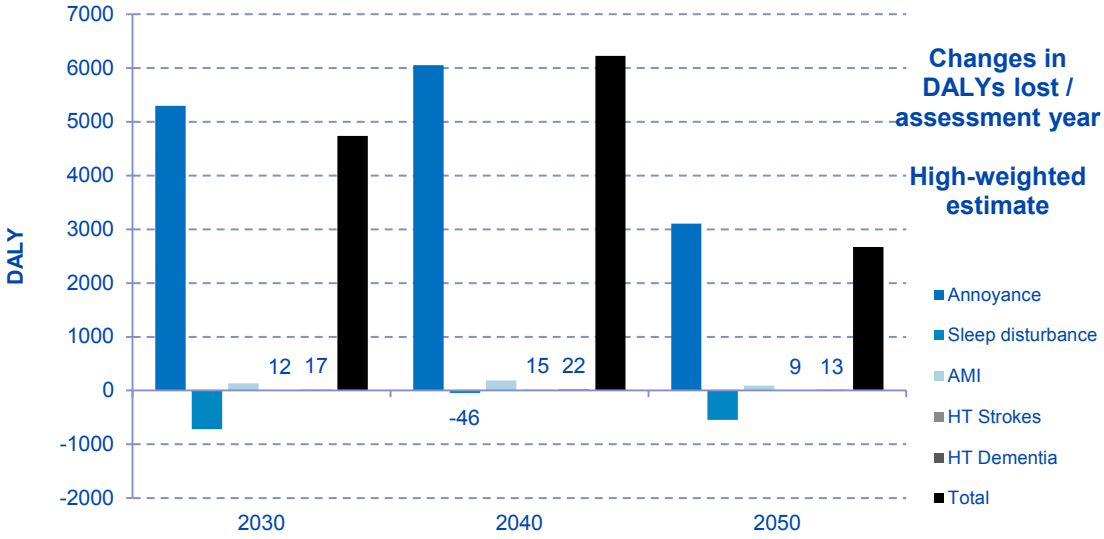


Figure 4-36: LHR-NWR Mid-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN, Carbon Traded)



[89] Jacobs, 2014. *5. Noise: Local Assessment*, p. 197. [online] Accessed 21/12/2015.

Figure 4-37: LHR-NWR High-weighted Estimated Changes in DALYs Lost Compared with Do Minimum, by Health Effect (AoN, Carbon Traded)

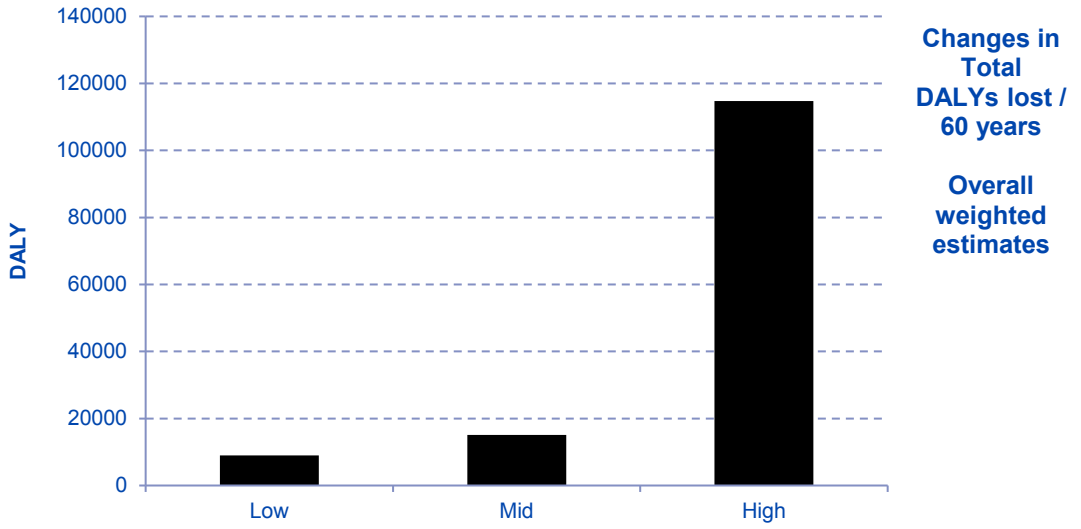


4.9.59 The health effects assessment illustrated across Figure 4-35, Figure 4-36 and Figure 4-37 indicates:

- with the exception of sleep disturbance, all health effects are expected to result in additional DALYs lost compared with the do minimum;
- for sleep disturbance, reductions in DALYs lost are expected (compared with the do minimum);
- annoyance, sleep disturbance and AMI effects dominate total estimated differences in DALYs lost for all disability weightings in the 2030 and 2050 assessment years (sleep disturbance is expected to have a smaller influence on total DALYs lost in 2040);
- annoyance becomes the dominant adverse health effect as the disability weightings are increased; and
- the increase in total DALYs lost is expected to be greatest in 2040 compared with 2030 and 2050, mainly due to increased annoyance and decreases in the potential benefits from lower instances of sleep disturbance.

4.9.60 60-year appraisal period estimations of total DALYs lost due to noise in the LHR-NWR do something case (compared with the do minimum) are shown for all weightings in Figure 4-38 (AoN carbon traded scenario).

Figure 4-38: LHR-NWR All Weighted Estimated Changes in DALYs Lost Over 60-year Period, Compared with Do Minimum (AoN, Carbon Traded)



4.9.61 The effects of the LHR-NWR scheme for the health outcomes assessed are considered to be predominantly Significant Negative, although it is recognised that some positive effects may also be expected, due to potential reductions in sleep disturbance compared with the do minimum.

4.9.62 The LHR-NWR scheme is expected to generally result in increases in exposure of schools to the metrics assessed (e.g. increases in exposure to the >63 dB $L_{Aeq,16h}$ SOAEL are 3 in 2030, 2 in 2040 and 1 in 2050), with the exception of a reduction in exposure to noise >54 dB $L_{Aeq,16hr}$ (12 in 2030 and 11 in 2050). These results can be interpreted as having predominantly Significant Negative effects for children's cognitive development.

Local Effects: Cumulative

4.9.63 Based on the available information, it is estimated that there are areas that could be brought above the thresholds by the combination of ground and airspace noise.

4.9.64 Some areas could experience increases in both ground and airspace noise, particularly towards the northwest around the new runway. The combined noise may in some cases be sufficient to push areas above the thresholds.

4.9.65 Whilst a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected in 2030, this potential benefit may be somewhat counteracted by increases in airspace noise for areas in close proximity to the airport. However, there are also some areas that (in the 2030 assessment year) may experience a reduction in both ground and airspace noise (averaged over the daytime period), such as the area to the southwest of the southernmost runway.

4.9.66 The local cumulative effects of the LHR-NWR scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).

National Effects

4.9.67 The national population exposures for the airspace thresholds over the assessment periods for LHR-NWR are compared with the UK do minimum in Figure 4-39, Figure 4-40 and Figure 4-41 (AoN carbon capped scenario).

Figure 4-39: LHR-NWR National Airspace >57 dB Daytime Average Noise Population Exposure (AoN, Carbon Capped) [NB. Non-zero axis]

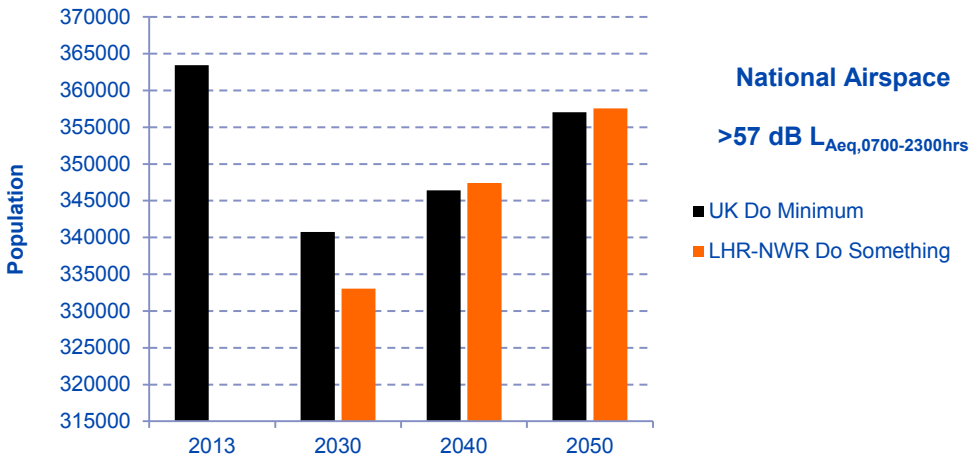


Figure 4-40: LHR-NWR National Airspace Noise >63 dB Daytime Average Noise SOAEL Population Exposure (AoN, Carbon Capped)

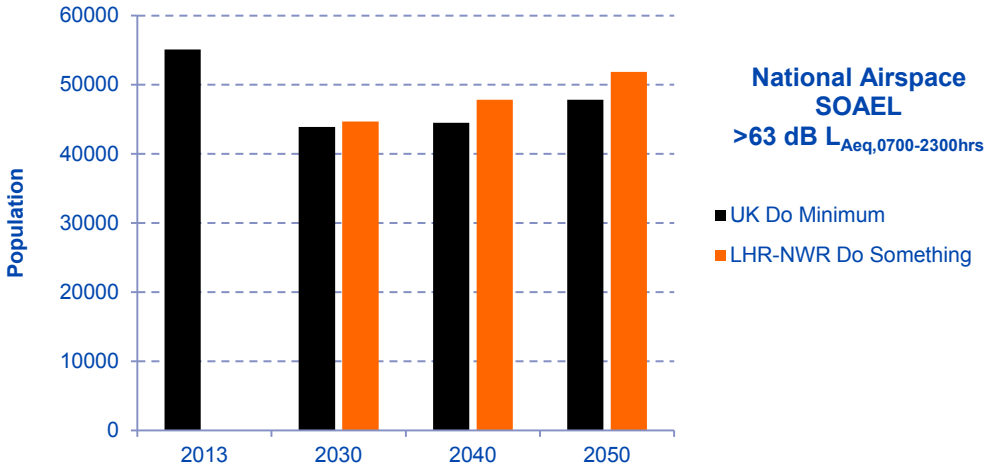
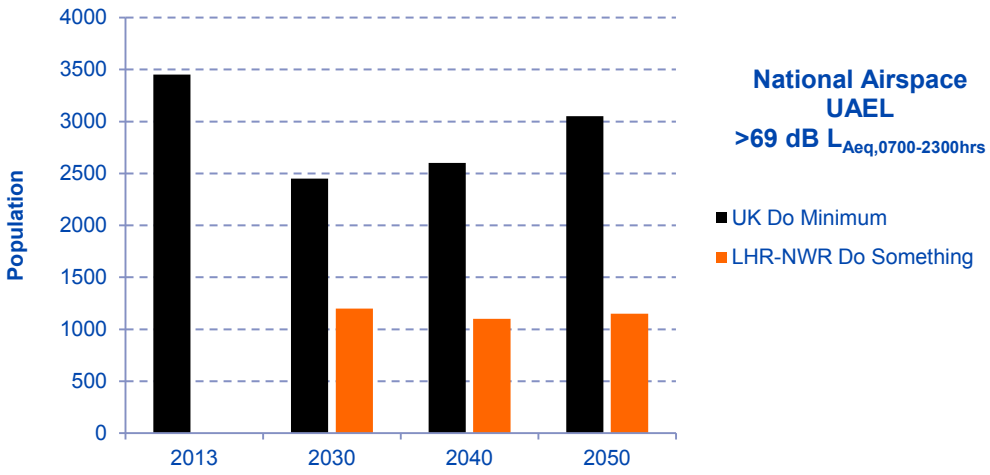


Figure 4-41: LHR-NWR National Airspace Noise >69 dB Daytime Average Noise UAEL Population Exposure (AoN, Carbon Capped)



4.9.68 The national assessment indicates that compared with the do minimum, the LHR-NWR scheme is expected to result in reduced population exposure to airspace noise above the 57 dB $L_{Aeq,16hr}$ threshold in the 2030 assessment year, which would be a positive effect. In the longer term however, the population exposed to noise >57 dB $L_{Aeq,16hr}$ is expected to be slightly higher (but similar to) the do minimum. Population exposure to the SOAEL is expected to be slightly increased in the 2030 assessment year, and increased further in the longer terms, ie Significant Negative effects. On the other hand, the population exposure to the UAEL would be expected to be reduced over the full assessment period, compared with the do minimum. In consideration of the criteria set out in Table 4-3, the national effects of the LHR-NWR scheme are considered to be mixed Positive/Significant Negative (+/--).

LHR-NWR Individual Assessment Summary

4.9.69 It is considered from the various elements of the individual assessment that the LHR-NWR scheme is expected to have predominant Significant Negative (--) overall effects, and this outcome is broadly consistent across the differing carbon scenario assumptions. This individual scheme assessment is summarised in the table at the end of Section 4.9. A comparative assessment of all the schemes is found in Section 4.12.

All Schemes

4.9.70 For all three schemes, local and national cumulative noise effects may arise from airport expansion in combination with other major infrastructure development. This may include: transport infrastructure which is associated directly with airports expansion, or delivered in support of the National Networks National Policy Statement[90]; construction noise from other infrastructure such as HS2 or Crossrail; nearby residential, commercial or infrastructure development that is planned by local authorities as part of their plans for growth, as set out in individual local development plan documents. Given the range of possibilities and uncertainty in such developments, it is impractical to assess these potential effects, which are therefore classified as Uncertain.

4.9.71 Performance comparisons between the different schemes are discussed in Section 4.12. The tables below detail the data used in the assessment figures above, along with the relevant source references.

[90] Department for Transport, 2014. *National Policy Statement for National Networks.* [online] Accessed 17/03/2016.

Objective 6: To minimise and where possible reduce noise impacts on human receptors.

Question 11: Will It Avoid, Prevent Or Reduce The Harmful Effects Due To Exposure Of People And Sensitive Buildings To Noise?

SEA Topic	LGW-2R	LHR-ENR	LHR-NWR
Description of Impact (including receptor)	**CONSTRUCTION**		
Construction noise and vibration	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the new runway or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the runway extension or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.	Construction phase impacts are likely to be negative, with potential for significance at sensitive receptors near to the new runway or along construction routes. The effects cannot yet be assessed in detail but as a worst case estimate can be considered as potentially Significant Negative.
	LOCAL EFFECTS: DISCRETE		
Airspace noise: daytime	**Airspace noise – total exposures in do something[91]**	**Airspace noise – total exposures in do something[92]**	**Airspace noise – total exposures in do something[93]**

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	5900	1	6500	1	6700	2
SOAEL	600	0	700	0	700	0
UAEL	<50	0	<50	0	<50	0

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	268500	104	262700	102	263000	97
SOAEL	69900	18	66600	15	67300	15
UAEL	4300	1	4000	1	3900	1

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	252000	93	257800	90	240200	79
SOAEL	42500	14	44000	11	42800	11
UAEL	1100	3	900	3	900	3

[91] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables A20-A22 and B5-B7. [online] Accessed 21/12/2015.
[92] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* Tables A67-A69 and B26-B28. [online] Accessed 21/12/2015.
[93] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Tables A48-A50 and B18-B20. [online] Accessed 21/12/2015.

AoN carbon traded

Airspace noise – changes in exposure relative to Do minimum[94]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	3200	(1)	4200	(1)	3900	0
Effect	--	+	--	+	--	00
SOAEL	200	(2)	200	(2)	300	(2)
Effect	--	+	--	+	--	+
UAEL	(151 to 200)	0	(151 to 200)	0	(151 to 200)	0
Effect	+	00	+	00	+	00

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LGW-2R scheme are considered to be predominantly Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LGW-2R scheme are considered to be Positive.

Airspace noise – changes in exposure relative to Do minimum[95]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	51200	27	41800	29	40800	22
Effect	--	-	--	-	--	-
SOAEL	35500	9	32000	6	31500	6
Effect	--	--	--	--	--	--
UAEL	2200	1	1900	1	1300	1
Effect	--	--	--	--	--	--

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LHR-ENR scheme are considered to be Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LHR-ENR scheme are considered to be Significant Negative.

Airspace noise – changes in exposure relative to Do minimum[96]

	2030		2040		2050	
	Pop.	NSB	Pop.	NSB	Pop.	NSB
>57 dB $L_{Aeq,16hr}$	34700	16	36900	17	18000	4
Effect	--	-	--	-	--	-
SOAEL	8100	5	9400	2	7000	2
Effect	--	--	--	--	--	--
UAEL	(1,000)	3	(1,200)	3	(1,700)	3
Effect	+	--	+	--	+	--

NOTE: Decreases indicated by values in parentheses

The effects of changes in airspace noise exposure on the local population from the LHR-NWR scheme are considered to be predominantly Significant Negative.

The effects of changes in airspace noise exposure on local NSBs from the LHR-NWR scheme are considered to be Significant Negative.

[94] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, calculated from data in Tables A5-A7, A20-A22, B2-B4, and B5-B7. [online] Accessed 21/12/2015.
[95] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* calculated from data in Tables A30-A32, A67-A69, B9-B11, and B26-B28. [online] Accessed 21/12/2015.
[96] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, calculated from data in Tables A30-A32, A48-A50, B9-B11, and B18-B20. [online] Accessed 21/12/2015.

Ground noise

Ground noise – population exposure and changes, Do minimum vs do something[97]

	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	1,000	(2150)
Effect	N/A	+

NOTE: Decreases indicated by values in parentheses

The local effects of ground noise from the LGW-2R scheme are considered to be Positive.

Ground noise – population exposure and changes, Do minimum vs do something[98]

	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	29300	(1450)
Effect	N/A	+

NOTE: Decreases indicated by values in parentheses

The local effects of ground noise from the LHR-ENR scheme are considered to be Positive.

Ground noise – population exposure and changes, Do minimum vs do something[99]

	2030	
	Population (DS)	Population change (DS vs DM)
>57 dB $L_{Aeq,16hr}$	27000	(3750)
Effect	N/A	+

NOTE: Decreases indicated by values in parentheses

The local effects of ground noise from the LHR-NWR scheme are considered to be Positive.

Airspace noise: health effects (AoN carbon traded)

A) Annoyance

B) Sleep disturbance

C) AMI

D) HT Strokes

E) HT Dementia

DW: Disability Weighting

Airspace noise – health effects, do minimum vs do something, Changes in DALYs lost/assessment year[100]

	2030			2040			2050		
DW	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
A	41	83	494	54	109	651	60	119	713
B	29	51	73	26	45	64	32	55	78
C	17	17	17	22	22	22	29	29	29
D	1	1	1	1	1	1	1	1	1
E	1	1	1	1	1	1	3	3	3
Total	90	154	587	105	179	739	125	208	825

NOTE: Decreases indicated by values in parentheses.

Airspace noise – health effects, do minimum vs do something, Changes in DALYs lost/assessment year[101]

	2030			2040			2050		
DW	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
A	440	882	5285	363	726	4360	331	662	3971
B	(245)	(428)	(613)	4	7	10	(199)	(349)	(498)
C	229	229	229	218	218	218	195	195	195
D	23	23	23	22	22	22	20	20	20
E	35	35	35	33	33	33	32	32	32
Total	482	739	4960	641	1008	4645	378	559	3720

NOTE: Decreases indicated by values in parentheses.

Airspace noise – health effects, do minimum vs do something, Changes in DALYs lost/assessment year[102]

	2030			2040			2050		
DW	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**
A	442	882	5294	504	1008	6052	259	517	3104
B	(288)	(504)	(719)	(19)	(32)	(46)	(219)	(382)	(546)
C	135	135	135	184	184	184	90	90	90
D	12	12	12	15	15	15	9	9	9
E	17	17	17	22	22	22	13	13	13
Total	315	540	4736	706	1197	6226	151	245	2670

NOTE: Decreases indicated by values in parentheses.

[97] Jacobs, 2014. *5. Noise: Local Assessment*, p. 68, calculated from data in Table 3.47 [online] Accessed 21/12/2015.
[98] Jacobs, 2014. *5. Noise: Local Assessment,* p. 270, calculated from data in Table 5.50. [online] Accessed 21/12/2015.
[99] Jacobs, 2014. *5. Noise: Local Assessment,* p. 196, calculated from data in Table 4.99. [online] Accessed 21/12/2015.
[100] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, calculated from the data in Table D2. [online] Accessed 21/12/2015.
[101] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* calculated from the data in Table D14. [online] Accessed 21/12/2015.
[102] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, calculated from the data in Table D8. [online] Accessed 21/12/2015.

	Total DALYs are calculated from the total health cost values, not from summation of the separate effects, which are based on rounded data. Changes in the total DALYs lost over a 60-year design life period are estimated at 3486 (low), 5810 (mid), and 23239 (high) for the 45 dB(A) threshold case. The overall effects of the LGW-2R scheme on the health outcomes assessed are considered to be Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.	**Total DALYs are calculated from the total health cost values, not from summation of the separate effects, which are based on rounded data.** Changes in the total DALYs lost over a 60-year design life period are estimated at 13798 (low), 20334 (mid), and 126360 (high) for the 45 dB(A) threshold case. The overall effects of the LHR-ENR scheme on the health outcomes assessed are considered to be predominantly Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.	**Total DALYs are calculated from the total health cost values, not from summation of the separate effects, which are based on rounded data.** Changes in the total DALYs lost over a 60-year design life period are estimated at 9005 (low), 15105 (mid), and 114741 (high) for the 45 dB(A) threshold case. The overall effects of the LHR-NWR scheme on the health outcomes assessed are considered to be predominantly Significant Negative, since it would result in increases in DALYs lost compared with the Do minimum.
Airspace noise : effects on children's cognitive development (AoN carbon traded)	**Airspace noise – school exposures in do something**[103]	**Airspace noise – school exposures in do something**[104]	**Airspace noise – school exposures in do something**[105]

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	18	20	21
>57 dB	3	3	5
>60 dB	1	1	1
SOAEL	0	0	1
>66 dB	0	0	0
UAEL	0	0	0
>72 dB	0	0	0

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	300	283	257
>57 dB	140	133	130
>60 dB	74	71	71
SOAEL	25	22	22
>66 dB	4	3	3
UAEL	2	2	2
>72 dB	0	0	0

Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	292	285	246
>57 dB	131	127	111
>60 dB	59	57	51
SOAEL	14	13	12
>66 dB	5	5	4
UAEL	1	1	1
>72 dB	0	0	0

[103] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, data from Tables B5-B7. [online] Accessed 21/12/2015.
[104] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, data from Tables B26-B28. [online] Accessed 21/12/2015.
[105] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, data from Tables B18-B20. [online] Accessed 21/12/2015.

Airspace noise – changes in school exposures relative to do minimum[106]			
Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	8	12	13
Effect	-	-	-
>57 dB	0	0	2
Effect	00	00	-
>60 dB	(1)	(1)	(1)
Effect	+	+	+
SOAEL	(2)	(2)	(1)
Effect	++	++	++
>66 dB	0	0	0
Effect	00	00	00
UAEL	0	0	0
Effect	00	00	00
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LGW-2R scheme on children's cognitive development are considered to be mixed Significant Positive/Negative (++/-).

Airspace noise – changes in school exposures relative to do minimum[107]			
Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	(4)	15	0
Effect	+	-	00
>57 dB	31	31	29
Effect	-	-	-
>60 dB	38	38	33
Effect	-	-	-
SOAEL	14	11	11
Effect	--	--	--
>66 dB	2	1	2
Effect	--	--	--
UAEL	2	2	2
Effect	--	--	--
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LHR-ENR scheme on children's cognitive development are considered to be predominantly Significant Negative.

Airspace noise – changes in school exposures relative to do minimum[108]			
Daytime $L_{Aeq,16hr}$	2030	2040	2050
>54 dB	(12)	17	(11)
Effect	+	-	+
>57 dB	22	25	10
Effect	-	-	-
>60 dB	23	24	13
Effect	-	-	-
SOAEL	3	2	1
Effect	--	--	--
>66 dB	3	3	3
Effect	--	--	--
UAEL	1	1	1
Effect	--	--	--
>72 dB	0	0	0
Effect	00	00	00
NOTE: Decreases indicated by values in parentheses			

The local effects of airspace noise from the LHR-NWR scheme on children's cognitive development are considered to be predominantly Significant Negative.

LOCAL EFFECTS: CUMULATIVE

[106] Clark,C, 2015. *Aircraft noise effects on health* p. 22, data from Table 3.1. [online] Accessed 21/12/2015.
[107] Clark,C, 2015. *Aircraft noise effects on health* pp. 23-24, data from Table 3.3. [online] Accessed 21/12/2015.
[108] Clark,C, 2015. *Aircraft noise effects on health*, p. 23, data from Table 3.2. [online] Accessed 21/12/2015.

Airspace noise and ground noise	The combination of airspace and ground noise could lead to cumulative negative or mixed effects for some areas, specifically: → For receptors exposed to airspace noise levels of at least 62 dB $L_{Aeq,16h}$, the addition of ground noise of 57 dB L_{Aeq} or more could push those areas above the SOAEL. → For receptors exposed to airspace noise at levels of 68 dB $L_{Aeq,16h}$, ground noise would need to be at least 63 dB $L_{Aeq,16hr}$ to push these areas above the UAEL. → For receptors in some areas, there may be a reduction in ground noise but increases in airspace noise, or vice versa. Aviation noise (ie both ground and airspace-generated) could also lead to cumulative effects when considered in combination with the potential impacts from surface access transportation. This could include both that associated with infrastructure changes required to facilitate airport expansion, and with other local and national developments (such as the implementation of the National Networks National Policy Statement[109], or from nearby development planned by local authorities as part of their plans for growth); these potential effects are uncertain.		
	→ It is estimated based on the available information[110] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → For some areas, reductions in exposure to ground noise may to some extent be counteracted by increases in airspace noise; conversely some areas (particularly in close proximity to the north of the existing runway) may experience some reductions in both ground and airspace noise. The local cumulative effects of the LGW-2R scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).	→ It is estimated based on the available information[111] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → Although a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be offset by increases in airspace noise for the affected populations in close proximity to the airport. For some areas, in particular towards the northwest of the northern runway, there is a risk that cumulative airspace and ground noise could be sufficient to bring populations above the relevant AEL thresholds. The local cumulative effects of the LHR-ENR scheme for the 2030 assessment year are considered to be Significant Negative.	→ It is estimated based on the available information[112] that there are some areas that could be brought above the AEL thresholds by the combination of ground and airspace noise. → Some areas would experience increases in both ground and airspace noise, particularly towards the northwest around the new runway. The combined noise may in some cases be sufficient to push areas above the AEL thresholds. → Whilst a reduction in the total population exposure to ground noise exceeding 57 dB $L_{Aeq,16hr}$ is expected, this potential benefit may be somewhat counteracted by increases in airspace noise for areas in close proximity to the airport. However, there are also some areas that (in the 2030 medium term) may experience a reduction in both ground and airspace noise (averaged over the daytime period), such as the area around the southwest of the southernmost runway. The local cumulative effects of the LHR-NWR scheme for the 2030 assessment year are considered to be mixed Positive/Significant Negative (+/--).
	NATIONAL EFFECTS: DISCRETE		

[109] Department for Transport, 2014. *National Policy Statement for National Networks*. [online] Accessed 17/03/2016

[110] For ground noise refer to p. 68, Figure 3.68, Jacobs, 2014. *5. Noise: Local Assessment*. Prepared for the Airports Commission. [online] Accessed 21/12/2015; for airspace noise refer to Figures E-7 and E-58, CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results* (Parts E-02 to E-20 and F-01 to F-02). [online] Accessed 21/12/2015.

[111] For ground noise refer to p. 271, Figure 5.76, Jacobs, 2014. *5. Noise: Local Assessment. Prepared for the Airports Commission*. [online] Accessed 21/12/2015; for airspace noise refer to Figures E-118 and E-310, CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results* (Parts E-02 to E-20 and F-01 to F-02). [online] Accessed 21/12/2015.

[112] For ground noise refer to p. 197, Figure 4.137, Jacobs, 2014. *5. Noise: Local Assessment*. Prepared for the Airports Commission. [online] Accessed 21/12/2015; for airspace noise refer to figures E-118 and E-187, CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results* (Parts E-02 to E-20 and F-01 to F-02). [online] Accessed 21/12/2015.

Airspace noise
(AoN carbon capped)

Airspace noise – changes in national exposure relative to do minimum[113]

	2030 Population	2040 Population	2050 Population
>57 dB $L_{Aeq,16hr}$	(3200)	(4600)	(1950)
Effect	+	+	+
SOAEL	(750)	(1750)	(900)
Effect	+	+	+
UAEL	(150)	(150)	(400)
Effect	+	+	+
NOTE: Decreases indicated by values in parentheses			

The national effects of the LGW-2R scheme are considered to be Positive (+).

Airspace noise – changes in national exposure relative to do minimum[114]

	2030 Population	2040 Population	2050 Population
>57 dB $L_{Aeq,16hr}$	14600	21650	15700
Effect	--	--	--
SOAEL	26050	30350	28700
Effect	--	--	--
UAEL	1750	1600	1350
Effect	--	--	--
NOTE: Decreases indicated by values in parentheses			

The national effects of the LHR-ENR scheme are considered to be Significant Negative.

The results presented above are calculations using adjustments derived from the original ENR scenario (ie not including an offset arrivals strategy), and assume that ATMs at other airports would not be affected by an offset arrivals strategy at LHR-ENR.

Airspace noise – changes in national exposure relative to do minimum[115]

	2030 Population	2040 Population	2050 Population
>57 dB $L_{Aeq,16hr}$	(7700)	1000	500
Effect	+	--	--
SOAEL	750	3300	3950
Effect	--	--	--
UAEL	(1250)	(1500)	(1900)
Effect	+	+	+
NOTE: Decreases indicated by values in parentheses			

The national effects of the LHR-NWR scheme are considered to be mixed Positive/Significant Negative (+/--).

NATIONAL EFFECTS: CUMULATIVE

Aviation noise could result in cumulative effects when considered nationally in combination with the potential impacts from surface access transportation. This could include both that associated with infrastructure changes required to facilitate airport expansion, and with other major national projects; these potential effects are uncertain.

Direct/ Indirect/ Cumulative	**Direct and cumulative**	**Direct and cumulative**	**Direct and cumulative**

[113] Jacobs, 2014. *5. Noise: National Assessment*, calculated from data in Tables A1-A2, A13-A14, A17-A18, Appendix A. [online] Accessed 21/12/2015.
[114] Jacobs, 2014. *5. Noise: National Assessment*, calculated from national data in Tables A1, A4, A13, A16, A17 and A20, Appendix A. [online] Accessed 21/12/2015 and local data in tables A54-A56 and A64-A66, CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*. [online] Accessed 21/12/2015.
[115] Jacobs, 2014. *5. Noise: National Assessment*, calculated from data in Tables A1, A3, A13, A15, A17 and A19, Appendix A. [online] Accessed 21/12/2015.

	People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.	People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.	People and sensitive buildings could experience direct and cumulative effects during the construction and operational phases.
Probability (High, Medium, Low, Very Low)	**High** There is a High probability of the identified effects occurring.	**High** There is a High probability of the identified effects occurring.	**High** There is a High probability of the identified effects occurring.
Phase, Duration (Long-term, Medium-term, Short-term), Frequency	**Construction** Short term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.	**Construction** Short-term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.	**Construction** Short-term (0-5 years) **Operation** Long-term The identified effects could occur throughout the 60-year design life.
Permanent/ Temporary **Irreversible/ Reversible**	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.	**Construction** Temporary, Reversible: The effects would occur during the construction phase. **Operation** Permanent: The effects would arise from fundamental infrastructure. Irreversible: The effects would arise from changes in infrastructure and, although operations could be altered via management, the scheme would require significant intervention to return to baseline conditions.
Magnitude and Spatial Extent, incl. Transboundary	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent: Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent: Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.	**Construction** Unknown, but likely to be low magnitude as impacts will only affect those in close proximity to construction activities (ie local extent). **Operation** High magnitude given numbers of population exposed. National extent: Primary effects will be local but wider national effects will also occur due to changes in ATMs at other UK airports.
Assumptions and Limitation	The most significant assumptions apply to all the schemes, and include: → Indicative flight path designs used for the modelling;		

	→ Future mixes of different fleet aircraft types; → Future operational procedures; and → Future changes in population densities. All of these assumptions will have significant influence on the predictions of noise exposure. Limitations are discussed in Section 4.11 below.		
Significance:	Predominant **Significant Negative** effects **(--)**	Predominant **Significant Negative** effects **(--)**	Predominant **Significant Negative** effects **(--)**
Explanatory:	This outcome is justified by emphasising the negative impacts on people in the local area in consideration of the AoS Noise topic Objective. However, it is acknowledged that the potential for some Positive effects from LGW-2R has also been identified, in particular due to a reduction in the exposure at a small number of schools (although larger numbers of schools could have increased exposure).	This outcome is broadly consistent across the differing carbon scenario assumptions.	This outcome is broadly consistent across the differing carbon scenario assumptions.
	Construction: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.	**Construction**: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.	**Construction**: People and sensitive buildings could experience direct and cumulative effects due to noise and vibration impacts. High probability of short-term effects occurring during construction, which are temporary and reversible. Low magnitude and local extent. **Operation**: People and sensitive buildings could experience direct and cumulative effects due to airspace and ground noise impacts. High probability of long-term effects occurring during operation, which are permanent and irreversible. High magnitude and potential national extent.
Note:	**This assessment table presents the identified effects for each scheme individually and not comparatively. A comparative assessment is presented in Section 4.12.**		

4.10 MITIGATION

Construction Phase

4.10.1 Mitigation for construction noise and vibration will need to be assessed in detail at the EIA stage for any scheme taken forward. The design of mitigation should draw on best practice guidance and ensure that relevant regulations are met. Noise impacts from construction works are regulated under section 60 of the Control of Pollution Act 1974[116]. A code of practice for assessing and mitigating construction noise and vibration impacts is contained in BS 5228:2009[117]. Standard forms of mitigation include (but are not limited to):

- utilisation of low-noise equipment and acoustic attenuation (control at source);
- planned layout of construction sites to maximise distances between noisy equipment and sensitive receptors, and screening by solid structures such as buildings, barriers etc. (control on transmission path);
- operational controls (hours, activities, working practices etc, detailed in an environmental management plan); and
- in some cases, further mitigation for unavoidable and significant impacts could also be considered, such as temporary rehousing or offers of noise insulation (control at receptor).

Operational Phase

4.10.2 Suggestions made by the AC in its Final Report for ways in which airports can reduce noise at source include[118]:

- preferential routing over areas with lower population densities (discussed further below);
- steeper descent angles (discussed further below);
- displaced runway landing thresholds (discussed further below);
- limiting sharp turns;
- keeping landing gear up as long as possible;
- new aircraft technology (discussed further below);
- incentives for airlines to optimise noise performance (eg fines); and
- air traffic movement limits.

[116] Control of Pollution Act 1974. Crown Copyright [online]. Accessed 06/01/2017.
[117] BSI, 2014. *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*. London: British Standards Institution.
[118] Airports Commission, 2015. *Final Report*, p. 277, paragraph 14.12. [online] Accessed 21/12/2015.

4.10.3 Noise-preferential routing, steeper descent angles and displaced landing thresholds have been investigated as part of the AC assessment work[119,120,121,122]. Preferential flight path routing has been incorporated into the assessment scenarios considered in this AoS, as discussed in Section 4.8. Developing aircraft technologies and future fleet mixes form a key part of the assumptions underpinning the AC noise modelling work[123], and are also adopted in this assessment.

4.10.4 Assumptions regarding the adoption of newer, quieter aircraft technology formed an inherent component of the AC modelling, including the results from which the AoS has drawn its conclusions.

4.10.5 The AC's assessment report also included consideration of specific mitigation proposals offered by the scheme promoters for each scheme. Relevant measures are summarised below.

4.10.6 The mitigation measures proposed by the promoter for the LGW-2R scheme include[124]:

- continuation of the Continuous Descent Approach and Aeronautical Information Publication joining height limits, with the runway and airspace designed to facilitate these measures;
- compensation and noise insulation schemes for dwellings and commitment to provide £1,000 annual compensation for households inside the 57 dB $L_{Aeq,16hr}$ contour; and
- development of new noise preferential routes (taking advantage of P-RNAV), including increased stakeholder engagement on the design of preferential routes.

4.10.7 The mitigation measures proposed by the promoter for the LHR-ENR scheme (subject to agreement from the airport operator) include:

- no night-time operations within a 6½-hour 'core' night period 2330-0600hrs[125];
- noise preferential routes using curved and angled approaches[126];
- displacement of runway landing thresholds (ie deeper landings)[127]; and
- provision of a scheduled runway alternation scheme to enable predictable respite (NB. as discussed below, the AC considered the scope for runway alternation respite under the LHR-ENR scheme more limited than available under the LHR-NWR scheme)[128].

4.10.8 The mitigation measures proposed by the scheme promoter for the LHR-NWR scheme include[129]:

- incentives to promote incorporation of quieter aircraft in fleet mixes;

[119] Multiple references, Jacobs, 2014. *5. Noise: Local Assessment.* [online] Accessed 21/12/2015.
[120] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, pp. 1-35. [online] Accessed 21/12/2015.
[121] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 187-196. [online] Accessed 21/12/2015.
[122] Jacobs, 2015. *5. Noise: Local Assessment Addendum*, pp. 36-40. [online] Accessed 21/12/2015.
[123] Jacobs, 2014. *5. Noise: Local Assessment*, Appendix A.1-A.3. [online] Accessed 21/12/2015.
[124] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 73-74. [online] Accessed 21/12/2015.
[125] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 275-276, paragraphs 5.17-5.18 [online] Accessed 21/12/2015.
[126] The effect of offset arrival approaches for LHR-ENR is assessed within Jacobs, 2015. *5. Noise: Local Assessment Addendum.* [online] Accessed 21/12/2015 and has been included in the assessment detailed herein.
[127] Jacobs, 2015. *5. Noise: Local Assessment Addendum*. [online] Accessed 21/12/2015.
[128] Airports Commission, 2015. *Final Report*, p. 181, Paragraphs 9.31-9.32. [online] Accessed 21/12/2015.
[129] Jacobs, 2014. *5. Noise: Local Assessment,* p. 205. [online] Accessed 21/12/2015.

- designing airport infrastructure to be as quiet as possible through positioning of a third runway;
- compensation and noise insulation schemes for dwellings and community buildings;
- displacement of runway landing thresholds;
- development of quieter operating procedures, including steeper approach slopes (discussed further below), and night fleet management;
- provision of pre-conditioned air (PCA) and fixed electrical group power (FEGP) or ground power units (GPUs) for all aircraft stands to reduce use of auxiliary power units (APUs);
- reduced taxi and holding times; and
- use of modern airside equipment such as electric vehicles and clatter-resistant baggage trolleys, maintained using enhanced procedures to avoid excessive noise.

4.10.9 In its Final Report, the AC made a number of recommendations on mitigation measures for the LHR-NWR scheme (which they assessed as offering the strongest solution to the UK's aviation capacity and connectivity needs[130]), including[131]:

- clear and legally-binding noise performance targets, in the form of a 'noise envelope';
- periods of predictable respite to be more reliably maintained (discussed further below). The airport operator to work with local communities to determine how respite would best be provided;
- a ban on all scheduled flights during the 6½-hour 'core' night period 2330-0600hrs (discussed further below);
- holding the promoter for LHR-NWR to its public commitment to deliver a compensation package valued at more than £1bn, including £700m for noise insulation, and significant investment in noise insulation and other support for schools;
- introduction of a noise levy at major UK airports; and
- creation of an Independent Aviation Noise Authority and Community Engagement Board under an independent Chair.

4.10.10 The AC compared the scope for provision of predictable respite under runway alternation schemes for each Heathrow scheme. It was stated that:[132]

> "*Neither Heathrow option would be able to deliver the same level of respite as is currently provided, which sees communities around the airport generally benefiting from respite for half of the operating day. The Northwest Runway scheme would reduce this to a third, but would maintain the ability to offer respite throughout the operating day. The Extended Northern Runway scheme would reduce this further, as runway alternation would only be possible outside peak hours. In both cases however, new navigational technologies would enable this to be supplemented with more effective respite through flightpath design. Although not quantifiable at this stage, there is also potential for the respite provided by runway alternation to be more predictable than today as resilience is enhanced through the provision of new capacity. This is true for both* [Heathrow] *schemes, but the effects are likely to be greatest under the Northwest Runway proposal.*"

[130] Airports Commission, 2015. *Final Report*, p. 274, paragraph 13.96. [online] Accessed 21/12/2015.
[131] Airports Commission, 2015. *Final Report*, chapter 14, pp. 275-310. [online] Accessed 21/12/2015.
[132] Airports Commission, 2015. *Final Report*, p. 183, paragraphs 9.34-9.35. [online] Accessed 21/12/2015.

4.10.11 It has also been stated[133] that runway alternation for LGW-2R would not be feasible if the runways were operated in mixed-mode, as proposed by the scheme promoter. However, respite could be enabled by varying flightpaths[134]. The AC analysed the feasibility of a runway segregation respite scheme for LGW-2R, concluding that this could provide respite from noise, at the cost of substantially-reduced capacity[135].

4.10.12 The CAA/ERCD analysis of a core night-flight ban indicates such a measure would offer potential reductions in the cost of health impacts due to sleep disturbance for all schemes[136] (which represent corresponding reductions in the estimations of DALYs lost in each assessment year). However, the AC considered a night-flight ban to be a credible measure in the immediate term only at an expanded Heathrow[137].

4.11 ASSUMPTIONS AND LIMITATIONS

4.11.1 The assessment is based on the outputs of the CAA ERCD ANCON modelling. The modelling is very sensitive to its inputs including[138]:

- assumed ATMs and fleet mixes;
- flight paths, approach angles, landing thresholds, take-off power and climb rates;
- ATM distribution to flightpaths and runways;
- the assumed noise characteristics of future aircraft types;
- assumed operational modal splits; and
- the data used to calculate populations and buildings within exposure contours (incorporating future population growth assumptions).

4.11.2 It should be noted that the flight paths used in the modelling are indicative, and would not necessarily be the same as implemented in practice[139]. A degree of uncertainty in flight path centrelines is however inherent in the modelling, which incorporates dispersion factors considered to be representative for each scheme[140]. The routes used are considered compatible with anticipated future airspace and navigational technology[141].

4.11.3 The differing scenario assumptions underpinning the assessments at local and national levels imply a degree of uncertainty. In general, noise exposure is expected to be greater under the carbon traded assumptions, and greater emphasis has been placed on the results from this scenario. Noise impacts could be increased further by adoption of the LCiK (rather than AoN) aviation forecasts, and a sensitivity test considering the effects of this can be found in Section 4.13; the analysis indicates that the assessment outcomes would be broadly the same as for the main case considered (albeit with more strongly negative impacts identified).

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[133] Airports Commission, 2015. *Final Report*, p. 178, paragraph 9.27, [online] Accessed 21/12/2015.
[134] Airports Commission, 2015. *Final Report*, p. 178, footnote 64, [online] Accessed 21/12/2015.
[135] Airports Commission, 2015. *Consideration of Consultation Responses*, p. 53, paragraph 2.7.26. [online] Accessed 04/07/2016.
[136] CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results*, Table D18. [online] Accessed 21/12/2015.
[137] Airports Commission, 2015. *Final Report*, p. 185, paragraph 9.45, [online] Accessed 21/12/2015.
[138] Jacobs, 2014. *5. Noise: Local Assessment*, section A.1.2, Appendix A. [online] Accessed 21/12/2015.
[139] Airports Commission, 2015. *Final Report*, p. 171, paragraph 9.13, [online] Accessed 21/12/2015.
[140] Jacobs, 2014. *5. Noise: Local Assessment*, section A.3, Appendix A, p. 12, paragraph 3.27. [online] Accessed 21/12/2015.
[141] Jacobs, 2014. *5. Noise: Local Assessment*, section A.3, Appendix A, p. 12, paragraph 3.28. [online] Accessed 21/12/2015.

4.11.4 The lower threshold used in assessing population and NSB noise exposure has been selected with reference to current aviation policy at 57 dB $L_{Aeq,16h}$. A consultation on lower aviation noise exposure effect thresholds is being conducted by DfT, and modelling data are available for a threshold of 54 dB $L_{Aeq,16h}$. Accordingly, a second sensitivity test has been carried out to examine the possible outcome if this threshold were used as an alternative. This test also indicates the outcomes would be largely the same, although greater total numbers of people would be counted within the 54 dB contour compared with the 57 dB contour.

4.11.5 The assessment data show only estimations of the numbers of receptors (people or NSBs) exposed to lower threshold noise levels (eg >57 dB $L_{Aeq,16hr}$). A limitation of this approach is that it is not possible to assess changes in noise level exposure that may be experienced by each receptor over time[142]. For example, a receptor exposed to 57 dB in 2013, and then 60 dB by 2030, would experience a 3 dB increase within the 17 year interval. Changes in noise exposure over time could have greater tangible meaning for the experiences of individuals and communities.

4.11.6 Similarly, no distinction has been made between those already exposed to a given level of noise, and those that may be 'newly-exposed' as result of a scheme. This approach is deemed suitable for a strategic-level appraisal, and reflects current Government policy to reduce the number of significantly affected people[143], but it would also be appropriate at a later stage (such as EIA) to expand the approach to include consideration of the predicted impacts from changes in noise for communities and areas. Over time, subjective responses to significant step-changes in aviation noise (such as increases in annoyance reactions due to being exposed to higher noise levels from the introduction of a new or extended runway) may in some cases reduce[144]. However at the current state of knowledge it is unclear whether any 'change effect' in relation to aviation noise can be considered broadly equivalent to those corresponding to noise exposure from other forms of transport[145,146], since it has been observed that responses to aviation noise exposure differ (eg to those relating to road noise)[147,148].

4.11.7 There is no definitive agreement on assessment methodology for airport ground noise[149]. The assessment of ground noise impacts has been based on an approximation of the total geographical area exposed to noise exceeding 57 dB $L_{Aeq,16hr}$ in the 2030 assessment year. The limitations of the model preclude consideration of the screening that could be expected from buildings and structures at ground level, and the effects in longer term assessment years. Furthermore, the assumptions of aviation demand and future carbon policy underpinning the ground noise calculations have not been stipulated, and lower emphasis has therefore been placed on these results compared with the airspace noise modelling.

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[142] Jacobs, 2014. *5. Noise: Local Assessment*, p 10, final paragraph. [online] Accessed 21/12/2015.
[143] Department for Transport, 2013. *Aviation Policy Framework*, p. 11, paragraph 17, [online] Accessed 21/12/2015.
[144] Gemeinnützige Umwelthaus GmbH. NORAH Study Results: Noise-related annoyance and quality of life over time. [online]. Accessed 27/07/2016.
[145] Brown, A. L. *et al*., 2009. Response to a change in transport noise exposure: a review of evidence of a change effect. *Journal of the Acoustical Society of America*. 125, 5, 3018-3029.
[146] Highways Agency, 2011. *Design manual for roads and bridges,* Volume 11 Section 3 - Environmental assessment techniques Part 7. HD 213/11 – Revision 1: Noise and Vibration*,* Paragraph A6.16, Annex 6. [online]. Accessed 01/03/2016.
[147] Babisch, W. et al, 2009. Annoyance due to aircraft noise has increased over the years–results of the HYENA study. *Environment International,* 35, 1169-1176.
[148] Janssen, S.A. et al, 2011. *Trends in aircraft noise annoyance: the role of study and sample characteristics.* Journal of the Acoustical Society of America. 129,4, 1953-1962.
[149] Jacobs, 2014. *5. Noise: Local Assessment*, Section A.1.5, Appendix A. [online] Accessed 21/12/2015.

4.11.8 The differences in the weighted estimates of adverse health effects and the sensitivity of the methods to threshold selection show that there remain large uncertainties in estimating the effects of noise on public health. In some cases the uncertainties are sufficiently large that a potentially negative effect identified for one set of parametric assumptions (ie resulting in increases in lost DALYs) could become a positive effect under others (a reduction in DALYs). Estimations of health effects must be interpreted with caution, and should be considered alongside the direct estimations of noise exposures.

4.11.9 Changes to surface transportation access for all schemes would be expected to generate noise and vibration that could result in cumulative effects with aviation noise. These have not been assessed at the current stage, as there is uncertainty surrounding possible routes and modal options that could be taken forward and modelling has not been undertaken for surface transport. This is because the dominant source of noise is from aviation. However it would be necessary to consider surface transport effects as part of an EIA for any scheme taken forwards when more information is available about the proposed surface transport package.

4.11.10 Similarly, the impacts of construction noise and vibration could adversely affect receptors in the vicinity of the works, including any changes to surface access infrastructure necessary to accommodate passenger transport. This would need to be addressed in detail in an EIA.

4.11.11 Finally, it should be recognised that human receptors (both individuals and communities) can react to environmental noise in different ways, and that the outcome of effects often depends greatly on local conditions, attitudes and expectations. Standardising these complex responses involves inevitable simplification, but provides a means to directly compare expected effects from the strategic perspective required for the AoS.

4.12 CONCLUSIONS

Objective 6: "To minimise and where possible reduce noise impacts on human receptors

INDIVIDUAL ASSESSMENT SUMMARY

4.12.1 The LGW-2R scheme has the potential for predominant Significant Negative effects (--). However, it is acknowledged that the potential for some Positive effects has also been identified. Key considerations in reaching this outcome are:

- → local population exposure to noise levels >57 dB $L_{Aeq,0700\text{-}2300hrs}$ and the SOAEL[150] would be expected to be increased compared with the do minimum situation (AoN carbon traded scenario);
- → local population exposure to the UAEL[151] would be expected to be reduced compared with the do minimum situation (AoN carbon traded scenario);
- → local NSBs[152] exposure to the SOAEL would be expected to be reduced compared with the do minimum situation (AoN carbon traded scenario);
- → total DALYs[153] lost to adverse health effects are expected to be increased compared with a do minimum (AoN carbon traded scenario);

[150] Significant Observed Adverse Effects Level, identified as 63 dB $L_{Aeq,0700\text{-}2300hrs}$ for the purpose of this assessment.
[151] Unacceptable Adverse Effects Level, identified as 69 dB $L_{Aeq,0700\text{-}2300hrs}$ for the purpose of this assessment.
[152] Noise Sensitive Buildings (excluding schools), ie hospitals and religious places of worship.
[153] Disability-adjusted life years.

- effects on cognitive development of children are expected to be mixed (++/-) due to some increases and reductions in schools noise exposure (AoN carbon traded scenario);
- national population exposure to noise levels >57 dB $L_{Aeq,16hr}$, as well as the SOAEL and UAEL would be expected to be reduced compared with a do minimum situation (AoN carbon capped scenario); and
- the overall outcome (--) is justified by emphasising the negative impacts on people in the local area in consideration of the AoS Noise topic Objective 'To minimise and where possible reduce noise impacts on human receptors'.

4.12.2 The LHR-ENR scheme has the potential for predominant Significant Negative effects (--) on the Noise topic objective. Key considerations in reaching this outcome are:

- local population exposure to noise levels >57 dB $L_{Aeq,16hr}$, the SOAEL and UAEL would be expected to be increased compared with a do minimum situation (AoN carbon traded scenario);
- local NSBs exposure to noise levels >57 dB $L_{Aeq,16hr}$, the SOAEL and UAEL would be expected to be increased compared with a do minimum situation, AoN carbon traded scenario);
- total DALYs lost to adverse health effects would be expected to be increased compared with a do minimum (AoN carbon traded scenario), although reductions in DALYs lost due to sleep disturbance have also been identified;
- effects on cognitive development of children are expected to be Significant Negative due to broad increases in schools exposed to daytime noise (AoN carbon capped scenario);
- national population exposure to noise levels >57 dB $L_{Aeq,16hr}$, the SOAEL and UAEL would be expected to increase compared with a do minimum situation (AoN carbon capped scenario); and
- the outcome (--) is broadly consistent across the differing carbon scenario assumptions.

4.12.3 The LHR-NWR scheme has the potential for predominant Significant Negative effects (--). Key considerations in reaching this outcome are:

- local population exposure to noise levels >57 dB $L_{Aeq,16hr}$, as well as the SOAEL would be expected to be increased compared with a do minimum situation (AoN carbon traded scenario);
- local population exposure to the UAEL would be expected to be reduced compared with a do minimum situation (AoN carbon traded scenario);
- local NSB exposure to noise levels >57 dB $L_{Aeq,16hr}$, as well as the SOAEL and UAEL would be expected to be increased compared with a do minimum situation (AoN carbon capped scenario);
- total DALYs lost to adverse health effects would be expected to be increased compared with a do minimum (AoN carbon traded scenario), although potential reductions in sleep disturbance have also been identified;
- effects on cognitive development of children are expected to be Significant Negative due to broad increases in schools exposed to daytime noise (AoN carbon capped scenario);
- national population exposure to noise levels >57 dB $L_{Aeq,16hr}$ (2040 and 2050 assessment years), and the SOAEL (all assessment years) would be expected to be increased compared with a do minimum situation (AoN carbon capped scenario);

- → national population exposure to the UAEL would be expected to be reduced compared with a do minimum situation (AoN carbon capped scenario); and
- → the outcome (--) is broadly consistent across the differing carbon scenario assumptions.

COMPARATIVE ASSESSMENT SUMMARY

4.12.4 A comparative assessment drawing on the same data presented in Section 4.9 is shown below. Figure 4-42, Figure 4-43 and Figure 4-44 show the total local population exposures to airspace noise expected as a result of each scheme (AoN carbon traded scenario).

Figure 4-42: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >57 dB $L_{Aeq,16hr}$ Daytime Average Noise Population Exposures (AoN, Carbon Traded)

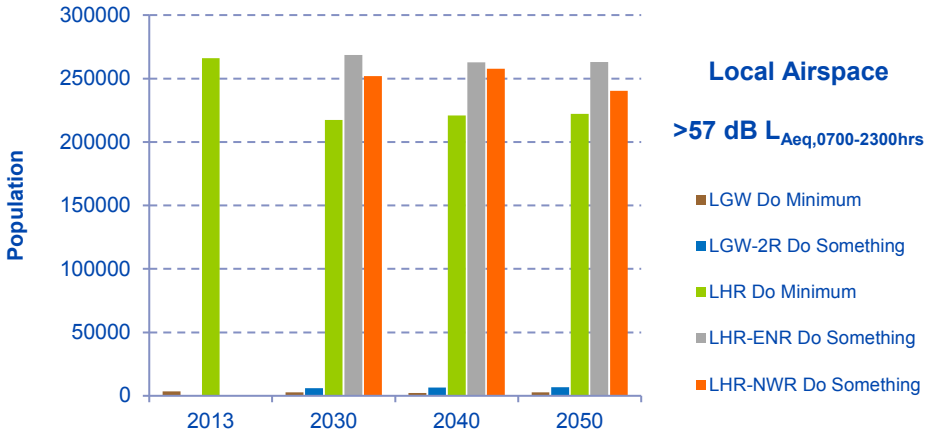


Figure 4-43: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >63 dB Daytime Average Noise SOAEL Population Exposures (AoN, Carbon Traded)

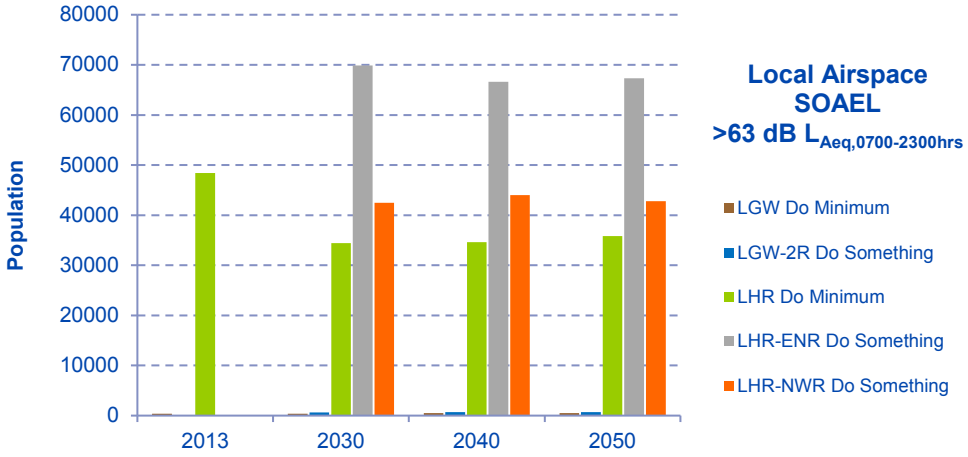
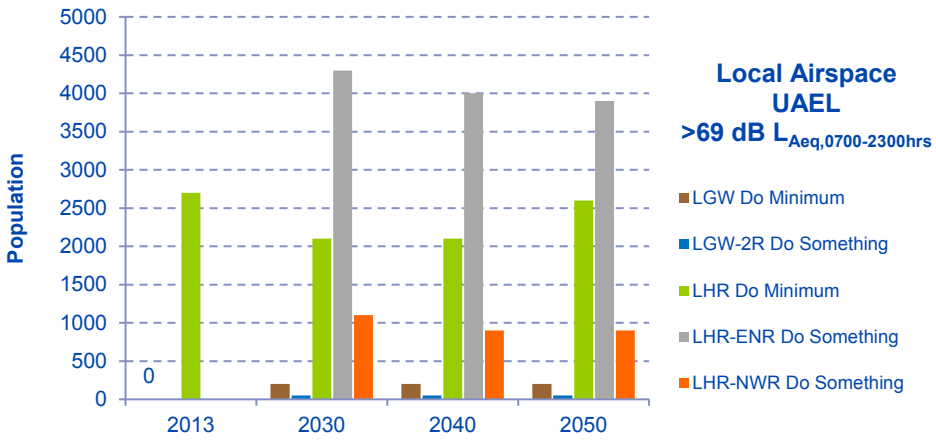


Figure 4-44: Comparison of LGW-2R, LHR-ENR and LHR-NWR Local Airspace >69 dB Daytime Average Noise UAEL Population Exposures (AoN, Carbon Traded)[154]



4.12.5 The assessment illustrated in Figure 4-42, Figure 4-43 and Figure 4-44 indicates that:

- → the local population exposed to noise >57 dB $L_{Aeq,16hr}$, the SOAEL and UAEL near to LGW-2R is expected to be a fraction of those exposed near to LHR-ENR or LHR-NWR;
- → both LGW-2R and LHR-NWR schemes are expected to result in smaller populations exposed to the UAEL, compared with the respective do minimum cases; and
- → the LHR-NWR scheme is expected to result in a smaller proportion of the local population exposed to the SOAEL and UAEL compared with LHR-ENR.

4.12.6 A comparison of estimated differences in DALYs lost due to the key health effects (annoyance, sleep disturbance and AMI) assessed for each scheme is set out in Figure 4-45, Figure 4-46 and Figure 4-47 (AoN carbon traded scenario). Here, only the mid-weighted estimates are presented for the sake of brevity; the different weightings multiply each DALY value by the same factor for each scheme, so the relative relationships between schemes remains very similar across all the weightings when viewed by individual key health effects, as detailed in previous sections.

[154] The population for the LGW-2R UAEL exposure is given as a range of possible values (<50); in the figure, the worst-case value of 49 has been assumed.

Figure 4-45: Mid-weighted Estimated Changes in DALYs Lost Due to Annoyance Compared with Do Minimum (AoN, Carbon Traded)

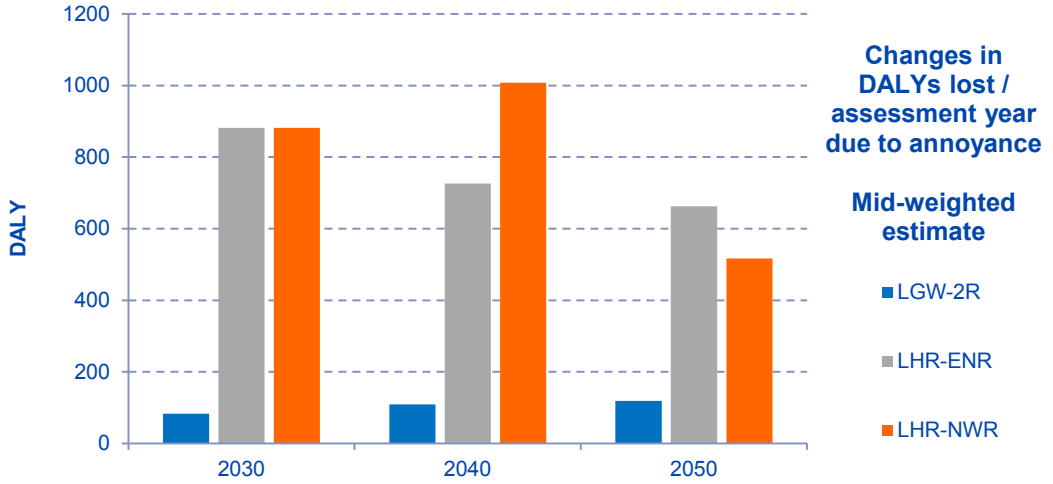


Figure 4-46: Mid-weighted Estimated Changes in DALYs Lost Due to Sleep Disturbance Compared with Do Minimum (AoN, Carbon Traded)

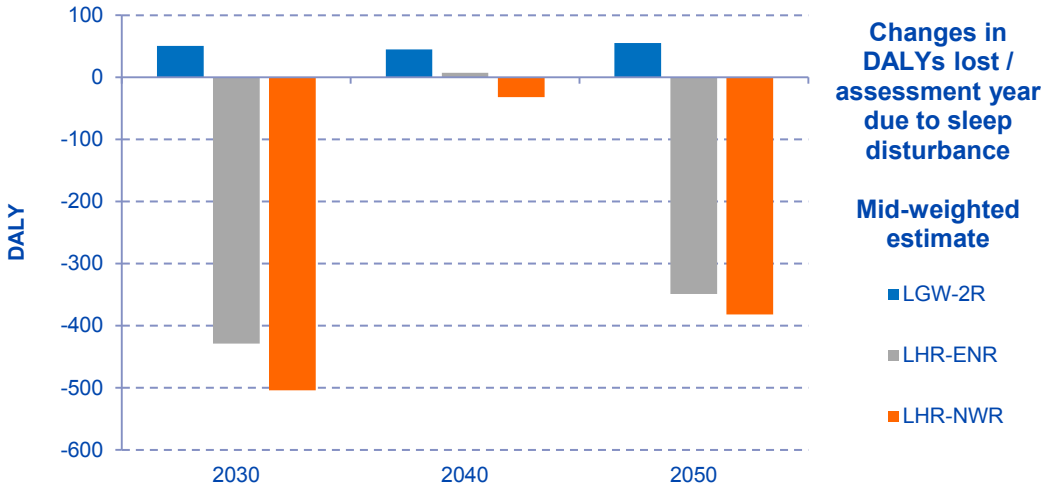
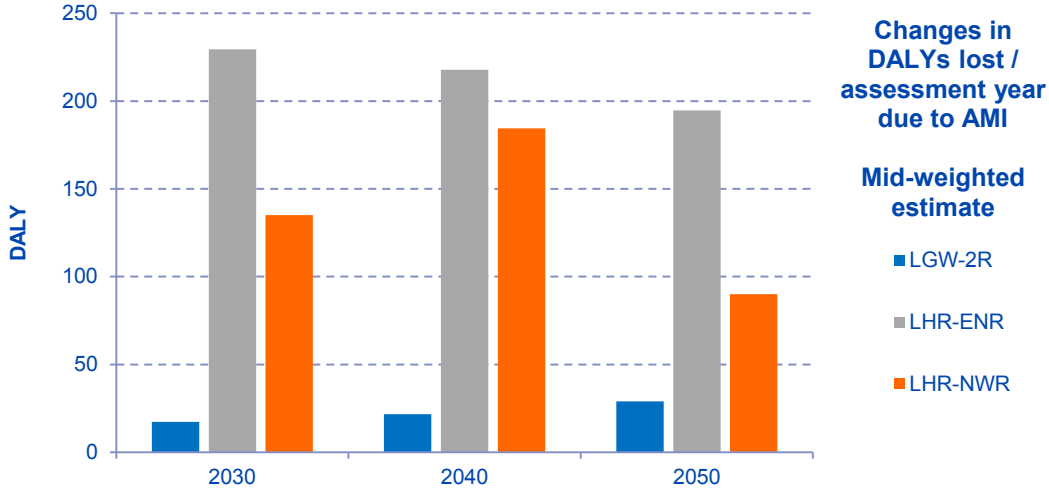


Figure 4-47: Mid-weighted Estimated Changes in DALYs Lost Due to Acute Myocardial Infarction Compared with Do Minimum (AoN, Carbon Traded)



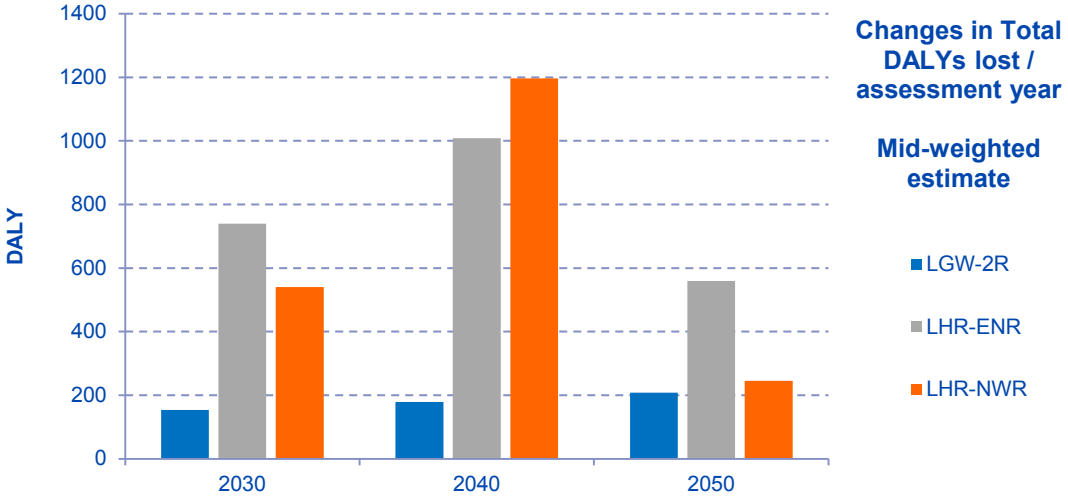
4.12.7 The assessment illustrated in Figure 4-45, Figure 4-46: and Figure 4-47: indicates:

- with respect to annoyance and AMI effects, LGW-2R is predicted to result in the smallest adverse changes in health effects, compared with the do minimum;
- with respect to sleep disturbance, both Heathrow schemes result in relatively large reductions in the estimations of lost DALYs in the 2030 and 2050 assessment years. LHR-NWR is predicted to result in the most positive changes compared with the do minimum, due to reductions in numbers of DALYs lost across all assessment years (especially in 2030). However, it is important to note that a positive change compared with the do minimum for Heathrow is based on a much larger total population exposure to night noise than for Gatwick (as shown in Table 4-4); and
- with respect to annoyance, both Heathrow schemes are expected to generate the same increases in lost DALYs in 2030. The LHR-ENR scheme is then expected to show incrementally smaller increases over the 2040 and 2050 assessment years. In contrast, lost DALYs for the LHR-NWR scheme are highest in 2040 (and higher than LHR-ENR for that year), but in the 2050 assessment year are expected to be lower than those for LHR-ENR.

4.12.8 The estimated mid-weighted differences in total DALYs lost compared with the do minimum for all health effects assessed are shown for each scheme in Figure 4-48 (AoN carbon traded scenario). This indicates that:

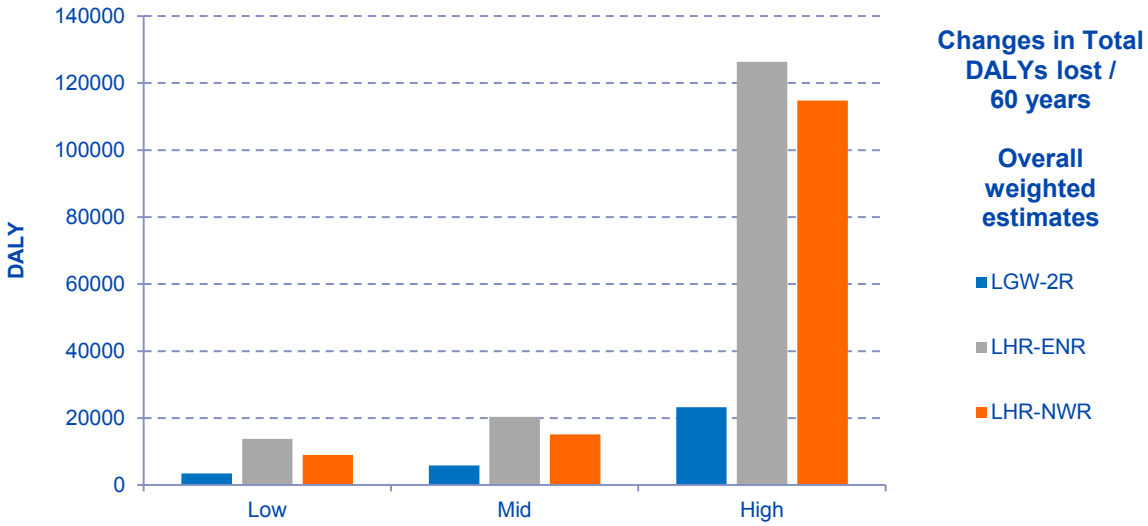
- LGW-2R is predicted to result in the smallest total increases in adverse health effects for each assessment year;
- LHR-ENR is expected to result in the largest total increases in adverse health effects for the 2030 and 2050 assessment years, while LHR-NWR is expected to result the largest increases in the 2040 assessment year;
- the increases in adverse health effects around LGW-2R are expected to be similar for each year, but suggest a steady gradual rise; and
- increases in adverse health effects are expected to rise for both LHR schemes in 2040, but be smaller by 2050 (compared with 2030).

Figure 4-47: Mid-weighted Estimated Changes in Total DALYs Lost Due to All Assessed Health Effects Compared with Do Minimum (AoN, Carbon Traded)



4.12.9 The estimated differences in total DALYs lost over a 60-year assessment period compared with the do minimum for all health effects assessed (including all disability weightings and both threshold cases) are shown for each scheme in Figure 4-49 (AoN carbon traded scenario).

Figure 4-49: Estimated Changes in Total DALYs Lost Due to All Assessed Health Effects Over 60-year Period Compared with Do Minimum (AoN, Carbon Traded)



4.12.10 Figure 4-49 indicates that:

- → LGW-2R performs most strongly due to proportionally smaller increases in DALYs lost to adverse health effects over the 60-year assessment period;
- → both LHR schemes perform similarly, but LHR-NWR performs slightly better than LHR-ENR as there are less DALYs lost;
- → over the 60 year period considered, all the schemes would be expected to increase adverse health effects associated with aviation noise, compared with the do minimum. The analysis above only considers changes in DALYs, not the total health impact associated with a scheme, which is indicated by total population exposures to noise levels exceeding thresholds associated with adverse health effects.

4.12.11 With respect to cognitive development of children, the assessment in Section 4.9 indicates that LGW-2R performs most strongly as it is expected to result in some reductions as well as increases in noise exposure of schools. Both LHR schemes perform similarly; LHR-NWR is broadly expected to result in marginally smaller adverse effects (and some reduction in exposure to the lowest noise contour) but both schemes show Significant Negative effects.

4.12.12 Figure 4-50, Figure 4-51 and Figure 4-52 show the total national population exposures to airspace noise expected as a result of each scheme (AoN carbon capped scenario).

Figure 4-50: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >57 dB Daytime Average Noise Population Exposures (AoN, Carbon Capped) [NB. Non-zero axis]

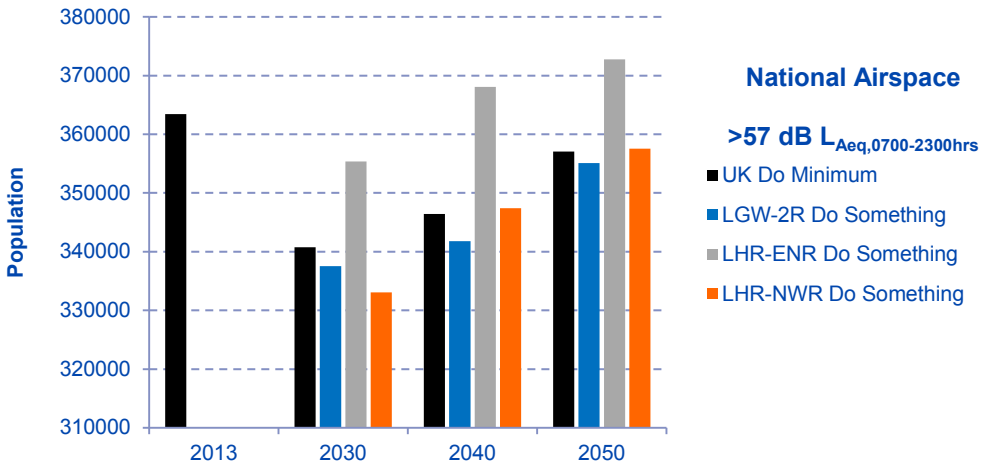


Figure 4-51: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >63 dB Daytime Average Noise SOAEL Population Exposures (AoN, Carbon Capped)

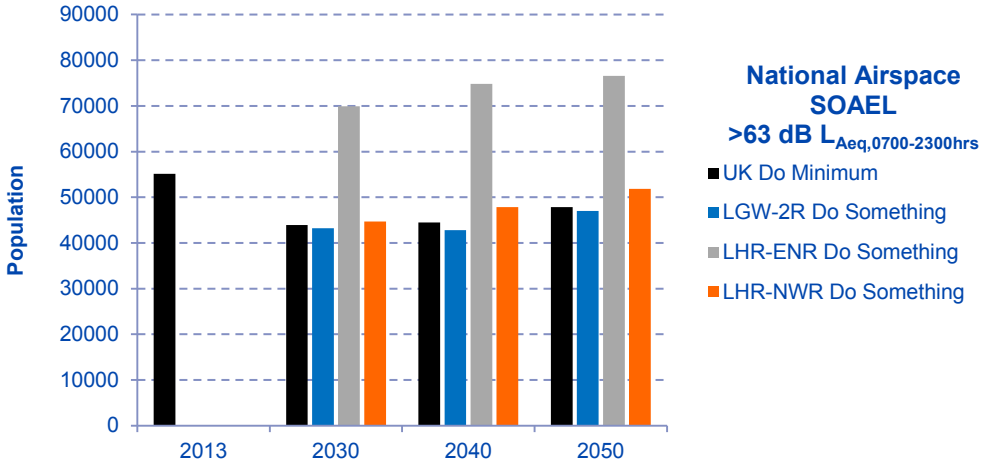
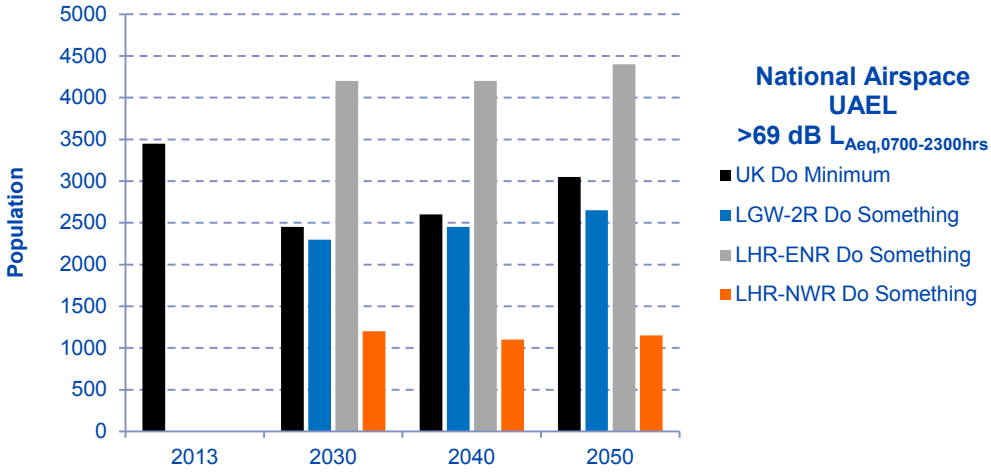


Figure 4-52: Comparison of LGW-2R, LHR-ENR and LHR-NWR National Airspace >69 dB Daytime Average Noise UAEL Population Exposures (AoN Carbon Capped)



4.12.13 The assessments in Figure 4-50, Figure 4-51 and Figure 4-52 show that:

- → national population exposure to the identified noise AELs and thresholds is expected to be highest for the LHR-ENR scheme over the full assessment period;
- → national population exposures to noise >57 dB $L_{Aeq,16hr}$, and the >63 dB $L_{Aeq,16hr}$ SOAEL for the LGW-2R and LHR-NWR schemes are comparable over the full assessment period; and
- → national population exposure to the >69 dB $L_{Aeq,16hr}$ UAEL is expected to be lowest for the LHR-NWR scheme.

4.12.14 In conclusion, the LGW-2R presents the scheme with the least negative effects in relation to the Noise topic objective, and may offer some positive effects. Of the two Heathrow schemes, the LHR-NWR scheme is expected to offer reduced local and national exposure to the higher noise levels compared with the LHR-ENR scheme, but both schemes are expected to have predominant Significant Negative effects in relation to the Noise topic objective. In terms of expected noise-related adverse health effects, the overall performance of each scheme depends heavily on the disability weightings used in the assessment; however, LGW-2R generally performs most strongly. Both LHR schemes may offer some reductions in sleep disturbance compared with the do minimum, but this depends on the estimation assumptions. Overall, LHR-NWR performs better than LHR-ENR. In this analysis it is important to consider that the estimations are of *changes* in health effects relative to the respective do minimum, and do not represent the total health impact that might be associated with the operations of individual airports. Due to the much lower total population exposures, the overall impact of aviation noise on human health associated with Gatwick is expected to be lower than at Heathrow.

4.12.15 The AC assessment also concluded that the LGW-2R scheme performed most strongly[155] with regards to the sustainability objective for noise outlined in its Appraisal Framework[156]. This was primarily due to the relative differences in the sizes of local populations adversely affected by noise; population noise exposure around Gatwick[157] with a second runway was predicted to be around 40 times smaller than for either of the Heathrow expansion schemes LHR-ENR and LHR-NWR[158].

[155] Airports Commission, 2015. *Final Report*, p. 186, paragraph 9.49. [online] Accessed 21/12/2015.
[156] Airports Commission, 2014. *Appraisal Framework*. p. 55, Chapter 5. Noise. [online] Accessed 21/12/2015.
[157] *assessment of need, low cost is king, global growth, global fragmentation* and r*elative decline of Europe*; see: Airports Commission, 2015. *Final Report*, p. 172, paragraph 9.19. [online] Accessed 21/12/2015.
[158] Predicted population exposure to 57 dB $L_{Aeq,16h}$ contour in 2040, from data in CAA ERCD, 2015. *Noise Modelling for the Airports Commission: Compendium of Results,* Tables A21, A49, and A68. [online] Accessed 21/12/2015.

4.13 ANNEX: SENSITIVITY ANALYSIS

4.13.1 This section analyses two separate sensitivity factors affecting the noise assessment; the first tests a worst case noise scenario as considered by the AC[159] and the second presenting the impacts with a lower noise threshold consistent with the consultation on UK Airspace Policy published alongside the Airports NPS.

SENSITIVITY TEST 1: WORST CASE NOISE IMPACTS

4.13.2 This sensitivity presents the noise impacts for the demand scenario where their magnitude is expected to be highest of all five global economic demand scenarios analysed by the AC[160]. This is to demonstrate what the impacts of expansion might be under something approaching a 'worst case scenario' for noise.

SCENARIO USED

4.13.3 The demand and carbon scenario used in this sensitivity test has been selected as it produces the highest noise impact out of the scenarios available across the three assessment years modelled (2030, 2040 and 2050). For both LHR-NWR and LGW-2R this is the LCiK scenario. The scenario presented in the main assessment for the LHR-ENR scheme is already the worst case available. The AC produced only two scenarios with the 'offset approaches' flight path design for the ENR scheme. These were AoN, carbon capped and AoN, carbon traded; the relevant results from these scenarios are already presented in the preceding sections and are therefore not duplicated here.

4.13.4 It should be noted that the 'do minimum' case used for comparison with the 'do something' is based on an AoN demand forecast; no LCiK do minimum data are available. The expected effect of this would be to slightly reduce estimated impacts of an LCiK do something relative to the do minimum, due to the increased demand. It follows that the analysis below may slightly overestimate LCiK health impacts, which are calculated relative to the do minimum.

NOISE IMPACTS

4.13.5 Under the LCiK carbon traded scenario, the population exposed to noise increases compared to the AoN scenario. This is largely a result of changes to fleet mix and traffic on flight paths as well as a change in air traffic movements. The LCiK scenario sees growth of low-cost carriers in the short haul and long haul market. GDP is higher and operating costs are lower than in the AoN scenario for all world regions resulting in higher passenger demand growth rates[161]. These differences result in a change in the traffic mix and flight paths used which means noise exposure is increased from the AoN scenario. The results for LHR-NWR and LGW-2R are shown below.

LHR-NWR

4.13.6 As shown in Figure 4-53, Figure 4-54 and Figure 4-55, the LCiK scenario results in at least as many, if not more, people exposed to aviation noise than in the AoN scenario.

[159] Airports Commission, 2015. *Final Report,* p. 171, paragraph 9.12, [online] Accessed 21/12/2015.
[160] Airports Commission, 2015. *Final Report,* p. 107, paragraph 6.11, [online] Accessed 21/12/2015.
[161] Airports Commission, 2015. *Final Report,* p. 108, paragraph 6.13, [online] Accessed 21/12/2015.

Figure 4-53: Worst Case Noise Impact Sensitivity Test LHR-NWR Local Airspace >57 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)

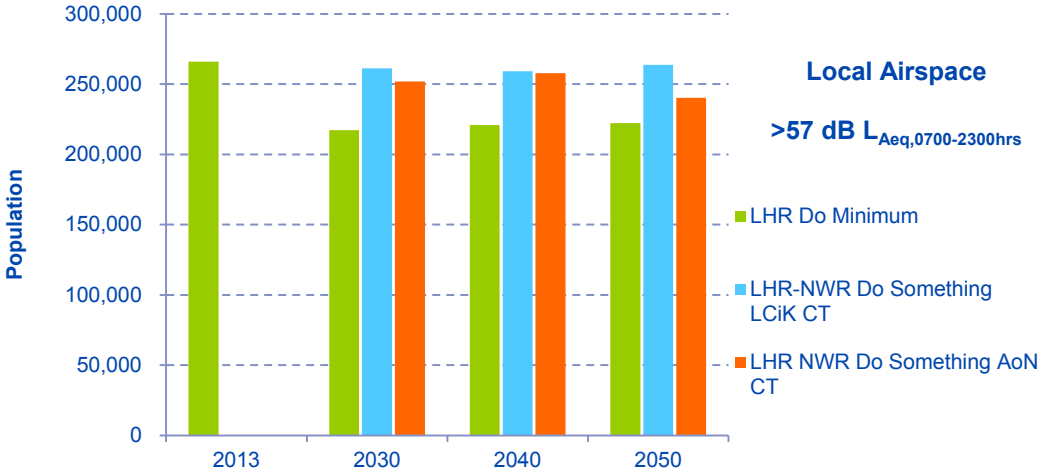


Figure 4-54: Worst Case Noise Impact Sensitivity Test LHR-NWR Local Airspace >63 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)

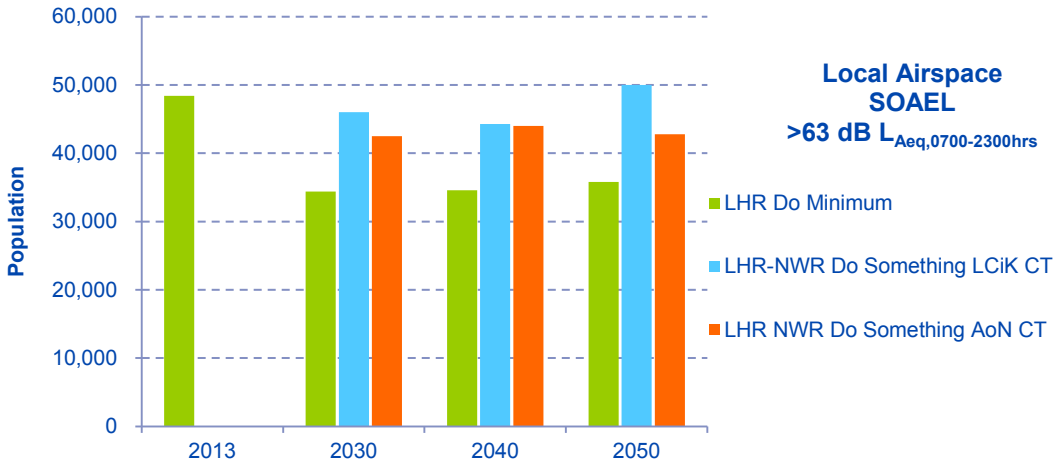
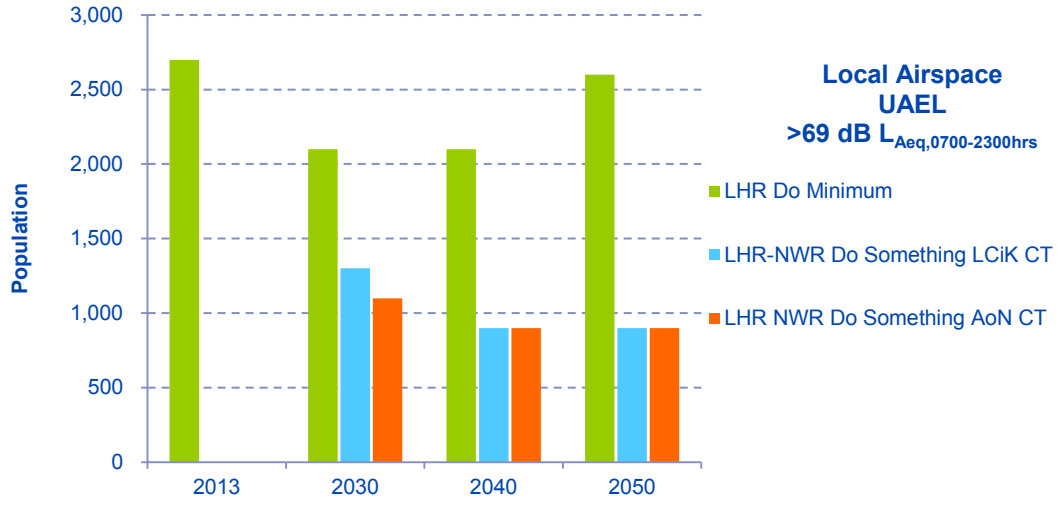


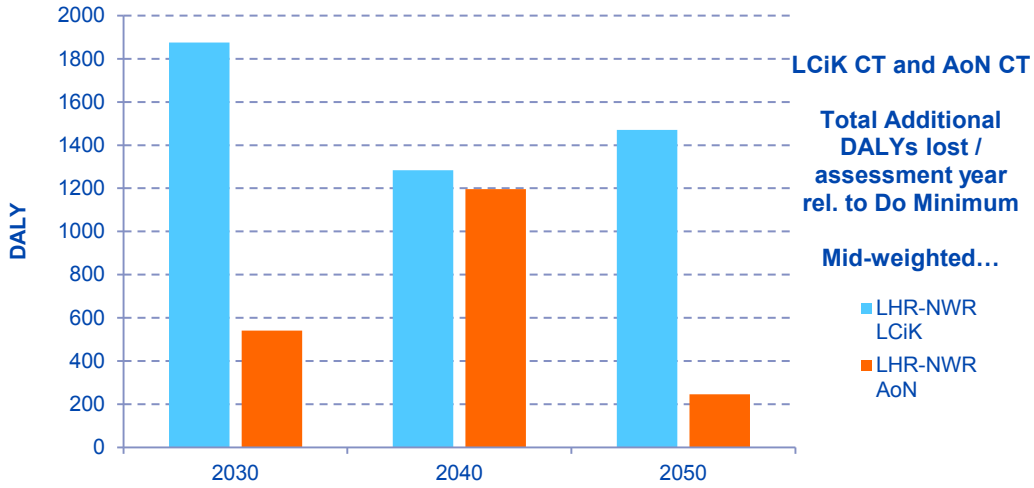
Figure 4-54: Worst Case Noise Impact Sensitivity Test LHR-NWR Local Airspace >69 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)



4.13.7 At the higher contour levels (>69 dB $L_{Aeq\ 16hr}$) there is little or no variation between the LCiK and AoN scenarios. These contours are closer to the airport runways, at this distance there is little room for flight path variation and so changes in the traffic routes and fleet mix result in limited change on the ground in terms of noise.

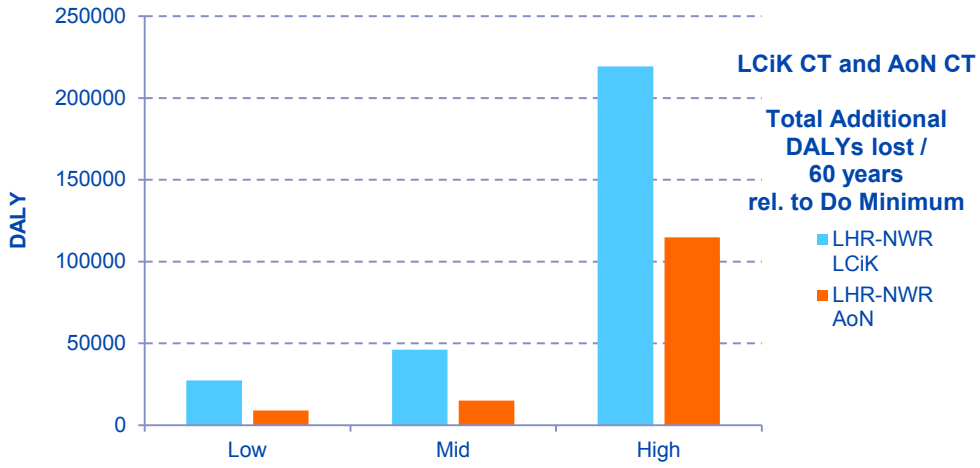
4.13.8 The estimated health impacts of noise for the LCiK scenario are also proportionately larger compared with the do minimum than AoN, reflecting the wider noise footprint. For example, in 2030 there are approximately 1,300 more DALYs lost under the LCiK demand scenario than under the AoN. Figure 4-55 presents the health impacts measured in additional DALYs lost for the LCiK scenario compared to the AoN scenario (both relative to the do minimum).

Figure 4-55: Worst Case Noise Impact Sensitivity Test LHR-NWR Effects on Health (Carbon Traded Comparison)



4.13.9 Over a 60 year period, the LCiK demand scenario is expected to increase DALYs lost across the affected population by approximately 46,000 in the mid-weighting assessment compared to the do minimum demand scenario (ranging from 27,000 to 219,000 in the low and high weighted assessments). The impacts compared to the do minimum and the AoN scenario are presented in Figure 4-56. In the mid-weighting assessment the LCiK scenario increases DALYs lost by 31,000 compared to the AoN and 46,000 compared to the do minimum.

Figure 4-56: Worst Case Noise Impact Sensitivity Test LHR-NWR Effects on Health, 60 years (Carbon Traded Comparison)



4.13.10 Exposure to noise sensitive buildings (NSBs: schools, hospitals and places of religious worship) is also increased under the LCiK scenario compared with the AoN carbon traded scenario, as presented in Table 4-10.

Table 4-10: Worst Case Noise Impact Sensitivity Test LHR-NWR Noise Exposure of NSBs (Carbon Traded Comparison)

Noise Exposure of NSBs						
2030 LHR Do Something LCiK Carbon traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	322	+30	6	0	198	+16
>57	136	+5	2	0	97	+6
>60	60	+1	1	0	42	+2
>63	16	+2	0	0	16	+2
>66	5	0	0	0	6	0
>69	1	0	0	0	3	0
>72	0	0	0	0	1	0
2040 LHR Do Something LCiK Carbon traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	293	+8	6	0	188	+4
>57	128	+1	2	0	89	+1
>60	57	0	1	0	40	+1
>63	13	0	0	0	11	0
>66	5	0	0	0	6	0
>69	1	0	0	0	3	0
>72	0	0	0	0	1	0
2050 LHR Do Something LCiK Carbon traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	302	+56	6	0	190	+38
>57	125	+14	2	0	91	+14
>60	59	+8	1	+1	40	+7
>63	12	0	0	0	13	+2
>66	5	+1	0	0	6	0
>69	1	0	0	0	3	0
>72	0	0	0	0	1	+1

LGW-2R

4.13.11 For the majority of noise contours, the LCiK scenario results in greater population exposure than the AoN scenario presented in the main noise annex. Only for the >69dB $L_{Aeq\ 16hr}$ contour is the population exposure equal to the AoN scenario, and lower than the do minimum. As stated earlier, this is partly due to reductions in the size of the contour over populated areas, but also because some properties would be within the expanded geographical boundary of the airport and therefore no longer exist in the do something scenario[162]. The difference between the two LGW-2R scenarios and the do minimum can be seen in Figures 4-57 to 4-59.

4.13.12 At the higher contour levels (>69 dB $L_{Aeq\ 16hr}$) there is little variation between LCiK and AoN scenarios. These contours are closer to the airport runways, at this distance there is little room for flight path variation and so changes in the traffic routes and fleet mix result in limited change on the ground in terms of noise.

Figure 4-57: Worst Case Noise Impact Sensitivity Test LGW-2R Local Airspace >57 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)

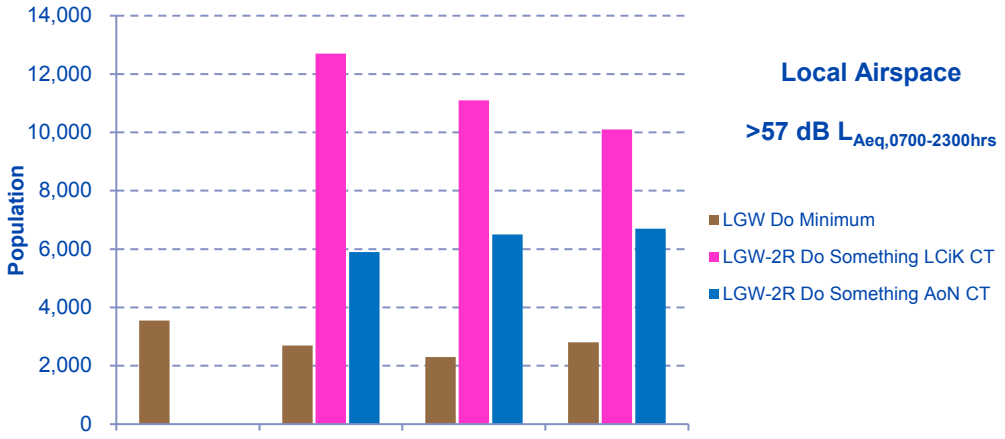
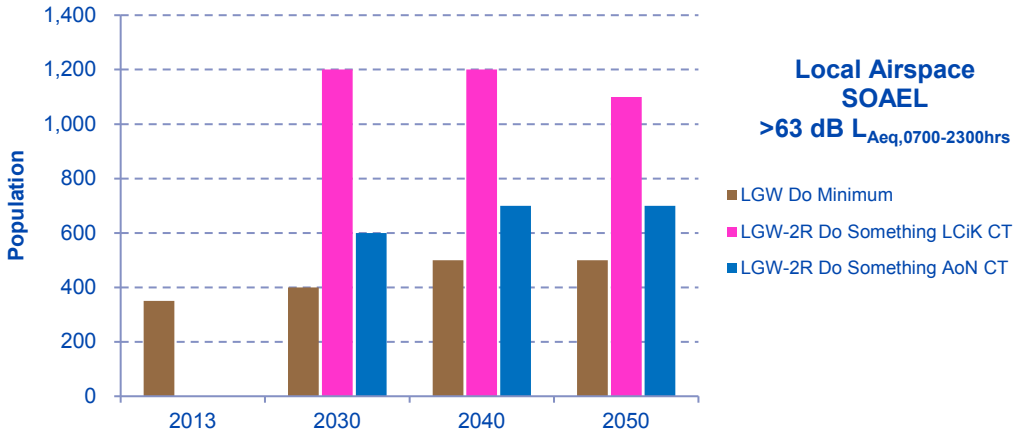
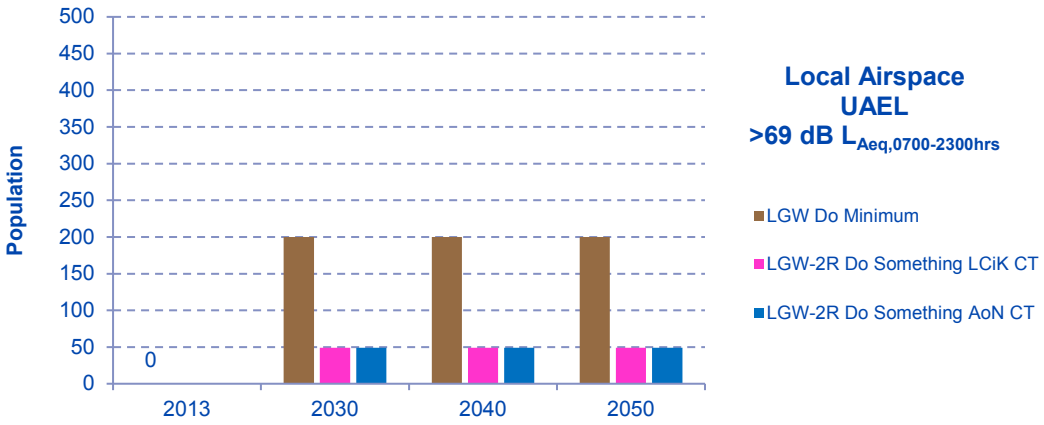


Figure 4-58: Worst Case Noise Impact Sensitivity Test LGW-2R Local Airspace >63 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)



[162] Jacobs, 2014. *5. Noise: Local Assessment*, pp. 19-22. [online] Accessed 21/12/2015.

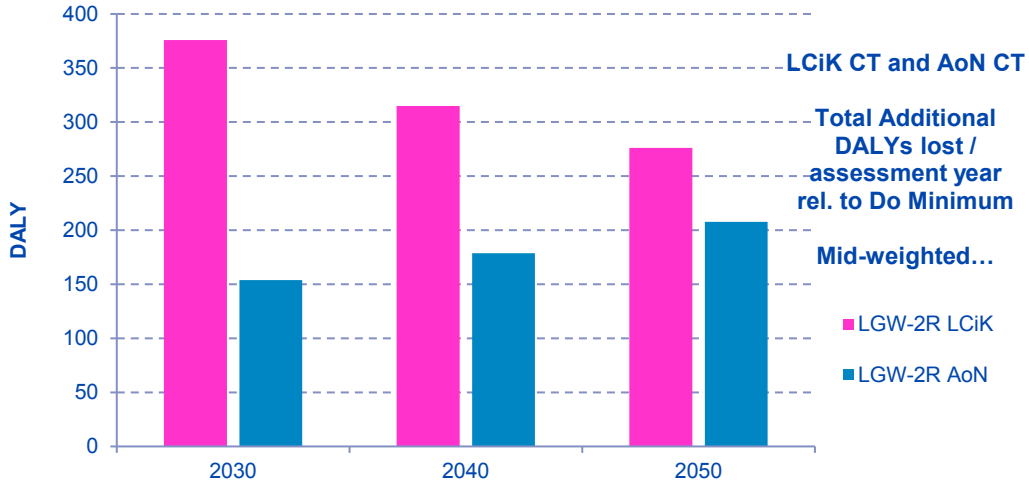
Figure 4-59: Worst Case Noise Impact Sensitivity Test LGW-2R Local Airspace >69 dB Daytime Average Noise Population Exposures (Carbon Traded Comparison)[163]



HEALTH EFFECTS

4.13.13 As the noise exposure is increased so are the expected health impacts. For example, in 2030 there are approximately 222 more DALYs lost under the LCiK demand scenario than compared to the AoN and 376 more than compared to the do minimum. Figure 4-60 presents the health impacts measured in DALYs for the LCiK scenario compared to the do minimum.

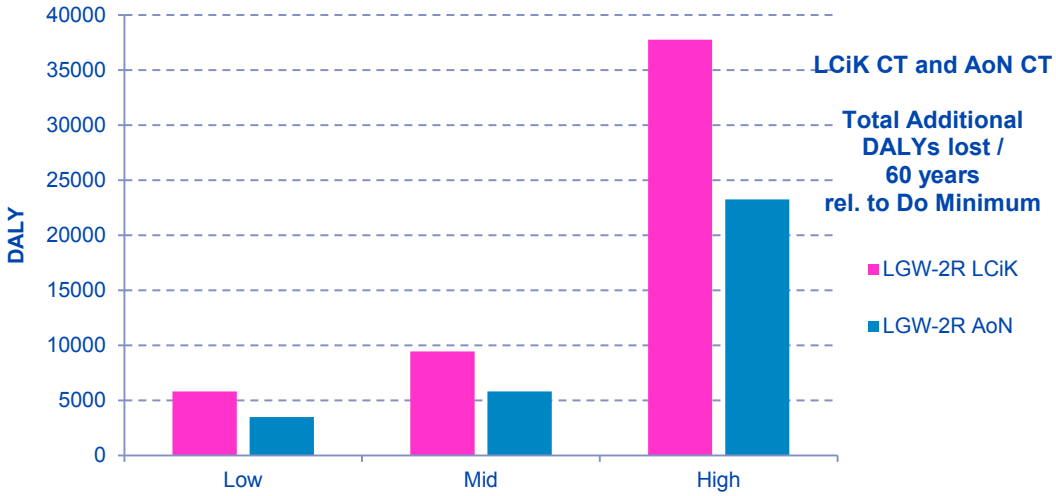
Figure 4-60: Worst Case Noise Impact Sensitivity Test LGW-2R Effects on Health (Carbon Traded Comparison)



4.13.14 Over a 60 year period, the LCiK scenario is expected to increase DALYs lost to noise-related health impacts across the affected population by approximately 9,500 in the mid-weighted scenario (ranging from 6,000 to 38,000 in the low and high weighted scenarios) compared to the do minimum scenario. The impacts compared to the do minimum and the AoN scenario are presented in Figure 4-61. In the mid-weighting assessment the LCiK scenario increases statistical life years lost by 3,500 compared to AoN and by 9,400 compared to the do minimum.

[163] The population for the LGW-2R UAEL exposure is predicted as a range of possible values (<50); here, the worst-case value of 49 has been assumed.

Figure 4-61: Worst Case Noise Impact Sensitivity Test LGW-2R Effects on Health, 60 years (Carbon Traded Comparison)



4.13.15 Exposure to NSBs is also increased. A comparison to the AoN scenario is presented in Table 4-11.

Table 4-11: Worst Case Noise Impact Sensitivity Test LGW-2R Noise Exposure of NSBs (Carbon Traded Comparison)

Noise Exposure of NSBs						
2030 LGW Do Something LCiK Carbon Traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	28	+10	1	0	19	+8
>57	9	+6	0	0	5	+4
>60	1	0	0	0	0	0
>63	1	+1	0	0	0	0
>66	0	0	0	0	0	0
>69	0	0	0	0	0	0
>72	0	0	0	0	0	0

Noise Exposure of NSBs						
2040 LGW Do Something LCiK Carbon Traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	26	+6	1	0	15	+2
>57	8	+5	0	0	4	+3
>60	1	0	0	0	0	0
>63	1	+1	0	0	0	0
>66	0	0	0	0	0	0
>69	0	0	0	0	0	0
>72	0	0	0	0	0	0
2050 LGW Do Something LCiK Carbon Traded						
	Schools		Hospitals		Places of Worship	
Contour (dB $L_{Aeq16hr}$)	Number	difference from AoN	Number	difference from AoN	Number	difference from AoN
>54	23	+2	1	0	14	+1
>57	8	+3	0	0	4	+2
>60	1	0	0	0	0	0
>63	1	0	0	0	0	0
>66	0	0	0	0	0	0
>69	0	0	0	0	0	0
>72	0	0	0	0	0	0

CONCLUSION

4.13.16 This sensitivity shows that, as expected under a higher demand scenario (LCiK), noise impacts could be higher than compared to the central case demand scenario (AoN). The higher demand scenario increases estimated noise impacts for both Heathrow and Gatwick expansion schemes, so the impact of adopting the worst case assumptions would not alter the overall conclusion that LGW-2R presents the least negative effects for the noise topic objective.

4.13.17 This assessment is based on noise impacts before any mitigation measures are implemented. Even in the higher demand scenario, there are measures which could be employed to reduce the noise impact. Noise exposure is dependent on a number of factors including: land use and population density, flight paths, aircraft technology, operating procedures, and number of ATMs. So, regardless of the demand scenario and number of ATMs, measures can be taken to target some of these other factors and reduce noise impact. These include: land use planning and noise insulation; flight path design to avoid populated areas as far as possible or to offer respite to the population around airports; operational procedures that determine how aircraft are flown; and where none of these other measures are sufficient, operating restrictions. Specific mitigation measures for noise have been identified by the individual scheme sponsors and the AC, as discussed in Section 4.10.

SENSITIVITY TEST 2: LOWER THRESHOLD FOR NOISE IMPACT

4.13.18 Alongside the Airports NPS and this AoS, the DfT are consulting on changes to several national aviation and noise policies and the Air Navigation Guidance[164]. One of the proposals is to adopt a LOAEL, for the purposes of assessing and quantifying the noise impacts of airspace changes on health and quality of life, and in order to aid decisions between different schemes. It is proposed that these LOAELs should be 51dB $L_{Aeq16hr}$ for the day time and 45dB L_{Aeq8hr} for the night time. Currently, 57dB $L_{Aeq16hr}$ is the level the Government recognises as the approximate onset of significant community annoyance. This is based on evidence from the 1980s, but new evidence suggests tolerance to aircraft noise has decreased[165,166]. The DfT's Survey of Noise Attitudes (SoNA) 2014[167] suggests the level of impacts that were previously seen at 57 dB $L_{Aeq16hr}$ now occurs at 54 dB $L_{Aeq16hr}$, and that some adverse effects of annoyance can be seen to occur down to 51dB $L_{Aeq16hr}$. The night time LOAEL is based on increasing evidence, including that which informed the WHO 2009 Night Noise Guidelines for Europe[168], on the link between noise exposure at night, sleep disturbance and other adverse effects. The 45dB $L_{Aeq\ 8hr}$ contour is consistent with the methodology proposed in the WHO's methodological guidance for estimating the burden of disease from environmental noise[169] and used in the DfT's WebTAG noise assessment module[170]. It is proposed that airspace changes are appraised using the WebTAG noise tool. This tool takes population numbers affected by the change and weights noise impacts accordingly to produce a monetary result. These assessments do not use absolute population noise contours or maps.

4.13.19 The CAA ERCD have advised against producing population noise contours or maps below 54dB $L_{Aeq16hr}$ or 48dB L_{Aeq8hr} for the following reasons:

- → due to variability in aircraft position in the air at these greater distances from the airport, the absolute noise levels (and thus also the position of the contour lines) have a lower level of certainty.
- → it is difficult to measure aircraft noise levels at greater distances from an airport where aircraft noise levels are closer to those of other noise sources. Since measurements are used to validate the model, the ability to validate the model reduces with increasing distance, leading to increased uncertainty in the position of the contours lines.

4.13.20 As a sensitivity test, the population exposure to the >54dB $L_{Aeq16hr}$ contour is shown below. This sensitivity is presented to illustrate the impacts based on the proposals in the consultation on aviation policy[171]. It should be made clear at this point that this policy and associated guidance refers to examining schemes for airspace changes and not airport capacity changes or routine noise assessment for the reasons outlined above.

[164] Department for Transport, 2014. *Guidance to the Civil Aviation Authority on Environmental Objectives Relating to the Exercise of its Air Navigation Functions.* [online] Accessed 06/01/2017.
[165] Babisch, W. et al., 2009. Annoyance due to aircraft noise has increased over the years–results of the HYENA study. *Environment International*. 35, 1169-1176.
[166] Airports Commission, 2013. *Discussion Paper 05: Aviation Noise,* p. 33, paragraph 4.16. [online] Accessed 06/07/2017.
[167] Results pending publication. Details of the research commission available online at https://data.gov.uk/data/contracts-finder-archive/contract/1546790/.
[168] World Health Organisation, 2009. *Night Noise Guidelines for Europe*. [online] Accessed 06/01/2017.
[169] World Health Organisation, 2011. *Burden of disease from environmental noise*. [online] Accessed 03/05/2016.
[170] Department for Transport, 2015. *TAG Unit A3 Environmental Impact Appraisal.* [online] Accessed 04/07/2016.
[171] Department for Transport (2017) UK Airspace Policy: A framework for balanced decisions on the design and use of airspace.

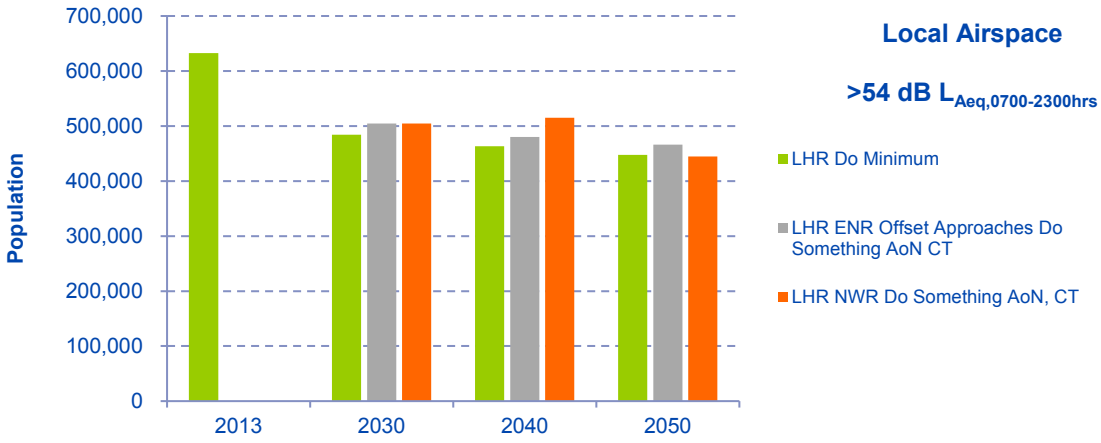
NOISE IMPACTS

4.13.21 Figure 4-62 illustrates the population noise exposures at all three schemes in 2013, 2030, 2040 and 2050 for the >54dB $L_{Aeq16hr}$ contour. Overall, the total population exposed to the >54 dB $L_{Aeq16hr}$ contour is greater than the >57 dB $L_{Aeq16hr}$ contour, although it should be noted that the health and quality of life impacts are lower on a per person basis[172] (due to consideration of a lower level of noise exposure).

4.13.22 Figure 4-62 shows that with the LHR-ENR scheme, between 17,000 and 20,000 additional people are exposed to noise in the >54 dB $L_{Aeq16hr}$ contour compared to the do minimum.

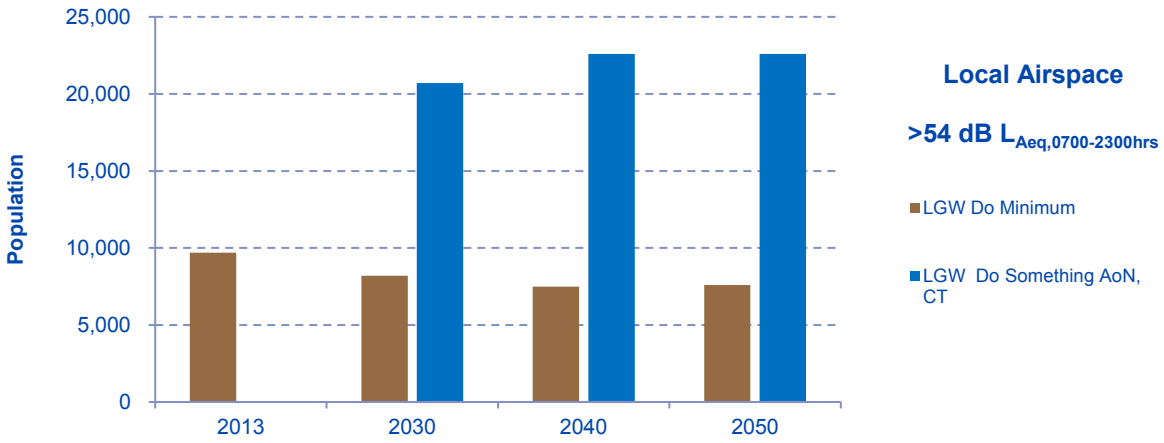
4.13.23 Figure 4-62 also shows that the LHR-NWR scheme increases population exposure to at least 2040, when approximately 52,000 additional people are exposed to the >54 dB $L_{Aeq16hr}$ noise contour. In 2050 however, 1,700 fewer people are expected to be exposed to noise in the >54dB $L_{Aeq16hr}$ contour. Compared with LHR-ENR, the LHR-NWR scheme assessed at 54 dB $L_{Aeq16hr}$ is less favourable in 2040, approximately equal in 2030 and more favourable in 2050. This assessment does not affect the outcomes of the assessments for the other thresholds value considered, ie >63 dB $L_{Aeq16hr}$ and >69 dB $L_{Aeq16hr}$; at these higher exposure levels LHR-ENR performs consistently less favourably than LHR-NWR. Taken overall, this indicates that, in terms of noise exposure, LHR-NWR would remain the more favourable Heathrow expansion scheme.

Figure 4-62: Lower Threshold Sensitivity Test LHR Local Airspace >54 dB Daytime Average Noise Population Exposures



[172] World Health Organisation, 2011. *Burden of disease from environmental noise*. [online] Accessed 03/05/2016.

Figure 4-63: Lower Threshold Sensitivity Test LGW Local Airspace >54 dB Daytime Average Noise Population Exposures



4.13.24 Figure 4-63 indicates that for LGW-2R, between 12,500 and 15,000 additional people are exposed to noise in the >54 dB $L_{Aeq16hr}$ contour compared to the do minimum scenario. Compared with either Heathrow scheme, these figures confirm that Gatwick would remain the scheme with least negative effects in terms of the Noise topic objective.

4.13.25 The health assessment carried out by the AC and presented in Section 4.9 includes impacts on people down to the 45dB $L_{Aeq\ 8hr}$ contour and accordingly is not repeated here.

CONCLUSION

4.13.26 National aviation noise policy is to limit, and where possible, reduce the number of people in the UK significantly affected by aircraft noise[173]. Assessing noise at a lower contour threshold would not alter the overall conclusions of the assessment.

[173] Department for Transport, 2013. *Aviation Policy Framework.* [online] Accessed 21/12/2015.